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

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1236.

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

Examination of Broken Allied Products Limited Universal Carrier Pins.

(Copy No. 14)

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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Universal Carrier Pins.

Origin of Material and Object of Investigation:

On May 13th, 1942, at a Universal Carrier track pin meeting, held at Ford Motor Company of Canada Limited, Windsor, Ontario, it was reported that twenty-five pins had broken on a carrier during a field trial. The failures occurred after the carrier had gone approximately 500 miles on pavement. Officials of the Ford Motor Company stated that the Universal Carrier in

(Origin of Material and Object of Investigation, cont'd) -

in question was being used as a pilot vehicle to test various types of rubber on the bogey wheels and as a result the dimensions of the wheels were not uniform. Consequently this series of breakages might be due to the mechanical irregularities of the particular vehicle. However, a thorough examination of 5 typical pin specimens was requested to determine whether there was a metallurgical defect in the production of these pins.

Macroscopic Examination:

The fractures of the pins were examined and a definite duplex structure was observed. These are shown in Figure 1. The diameters of the pins were measured, using a micrometer. The averages of ten readings for each pin are listed below:

Pin No.		Diameter, inches
1	-	0.430
2	-	0.430
3	-	0.430
4	-	0.431
5	-	0.435

Figure 1.

Chemical Analysis:

	As found	SAE 3115
	- Per cent -	
Carbon	0.18	0.10 - 0.20
Manganese	0.54	0.30 - 0.60
Silicon	0.19	0.15 min.
Phosphorus	0.024	0.040 max.
Sulphur	0.015	0.050 max.
Chromium	0.53	0.45 - 0.75
Nickel	1.21	1.00 - 1.50

Case Depth:

The depth of case was measured, using the Brinell microscope. The results are listed below:

Pin No.	Depth of case, in inches
1	0.020
2	0.025
3	0.016
4	0.016
5	0.022

Depth-Hardness Relationship:

Hardness readings were taken on polished micro-specimens, using the Vickers hardness machine and the 10-kilogram weight. Table I and Figures 2 and 3 show the depth-hardness relationship for each of the five pins:

Table I.

VICKERS HARDNESS NUMBERS.

Pin No.	At the surface	At depths in inches from the surface						
		0.005	0.010	0.020	0.030	0.040	0.050	0.2
1	829	665	560	387	268	267	265	267
2	796	705	635	500	397	345	338	300
3	673	608	542	322	266	260	256	228
4	841	770	698	455	345	333	322	296
5	802	767	724	508	370	371	372	330

(Figures 2 and 3 appear on next page)

Figure 2.

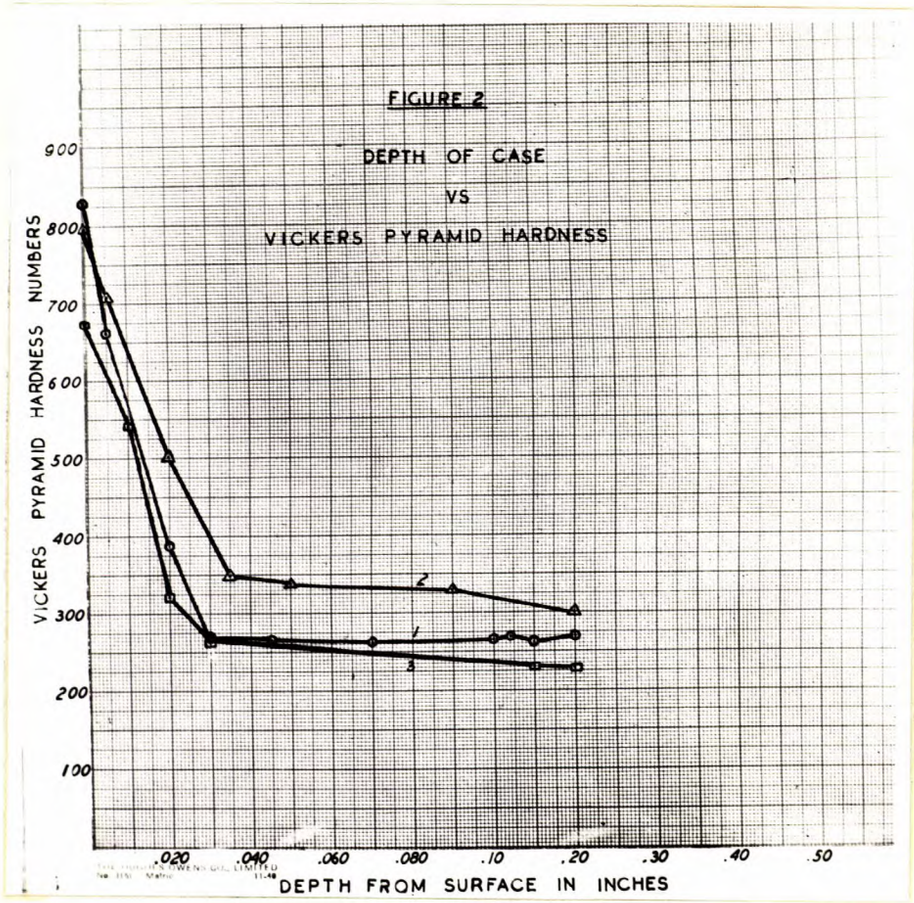
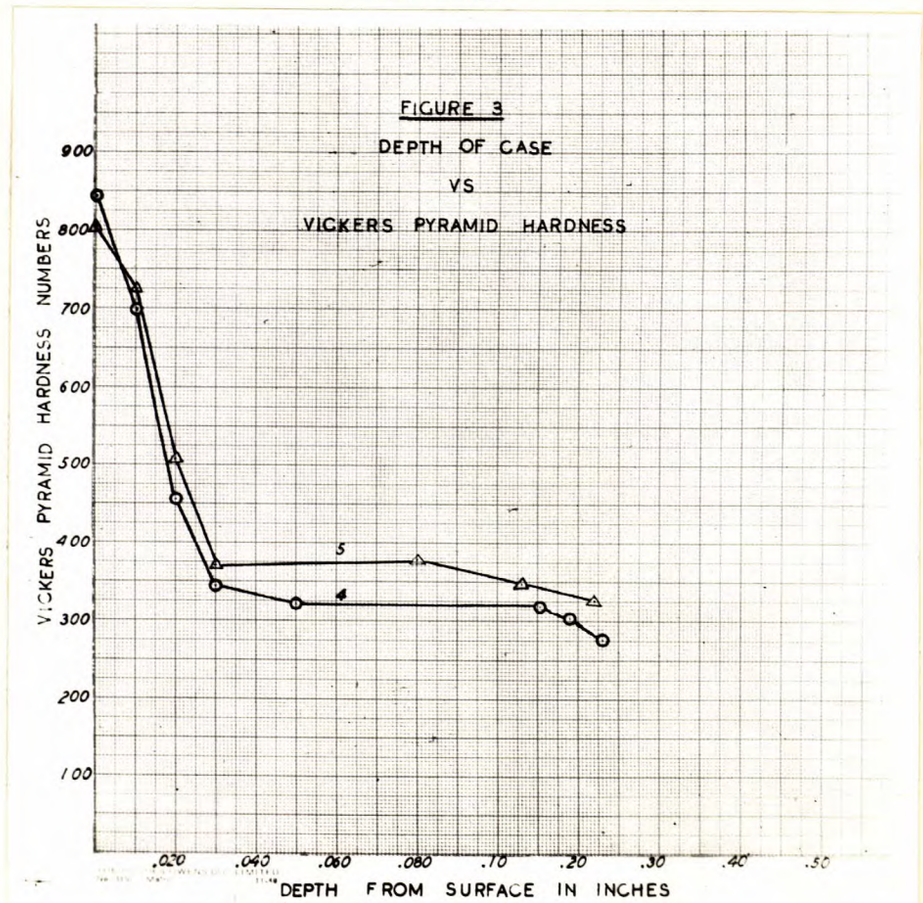


Figure 3.



Microscopic Examination:

Microspecimens were cut from the pins about 0.1 inch from the fractured end. The specimens were examined both in the etched and unetched condition. The unetched specimens showed that the steel was clean. Figures 4 and 5 are photomicrographs of the typical core and case, taken at X500 and X1000 magnification respectively.

Figure 4.

X500, nital etch.
TYPICAL CORE.

Figure 5.

X1000, nital etch.
TYPICAL CASE.

Discussion:

The chemical analysis shows that the bar stock conforms to the limits of S.A.E. 3115 steel.

The duplex structure of the fractures, shown in Figure 1, is of the well-known "fatigue" type.

The case depth results show that Pins Nos. 2 and 5 are over the limits set by the specification, 0.012-0.020 inch. The initial case depth is unknown, but it would be still greater than the figure quoted, since the pins have been subjected to a certain amount of wear. It is felt that increasing

(Discussion, cont'd) -

the case depth beyond the specification limit means decreasing the margin of safety of the pins.

From Table I it can be seen that the core hardnesses (at 0.2 inch from the surface) vary considerably, e.g. 228 to 330. This is probably due to a non-uniform quenching temperature. Visual examination of the core structures confirmed this, since varying amounts of ferrite were observed in the different pins. Figure 4 is a photomicrograph of a pin containing an intermediate amount of ferrite.

Metallurgically, these pins do not differ greatly from any previous Allied Products pins tested in these laboratories. Consequently, from a knowledge of the history of the pins examined in this report it is felt that the failures were probably due to the mechanical irregularities of the particular vehicle upon which these pins were mounted. The fact that the pins did fail under a slight change from normal conditions reveals the low margin of safety of the pins now being produced. Every effort should be made to increase the margin of safety, since under actual combat conditions numerous factors occur affecting the vehicle which cannot be forecast.

Conclusions:

1. The chemical analysis corresponds to specification for S.A.E. 3115 steel.

2. The duplex fractures are of the "fatigue" type.

3. Case depths should not exceed 0.020 inch, otherwise a lowering of the safety factor results.

4. Variation in core hardness is probably due to

(Conclusions, cont'd) -

a non-uniform quenching temperature.

5. Metallurgically these pins do not differ greatly from other Allied Products pins examined in these laboratories.

6. It is felt that these pins probably broke because of mechanical irregularities of the vehicle upon which they were mounted.

7. The margin of safety of the pins is too low.

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