O T T A W A  June 24th, 1942.

# R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1253.

(M. & S. No. 9/A/7)

## Investigation of SAE X1315 Universal Carrier Pins.

(Copy No. 28.)

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 June 8th, 1942, in accordance with a recommendation of the Track Pin Committee, twelve SAE X1315 pins were submitted by the Ford Motor Company of Canada Limited, Windsor, Ontario, for examination. It was reported that these pins received the regular Chapmanizing process at Allied Products Limited, Detroit, Michigan. The investigation on this type of pin was to be undertaken to determine the suitability of SAE X1315 as a possible track pin steel.

Chemical Analysis:

A chemical analysis was taken of drillings from the core of a pin.

| | As Found - Per cent - | Specification SAE X1315 |
|---|---|---|
| Carbon - | 0.21 | 0.10 - 0.20 |
| Manganese - | 1.61 | 1.30 - 1.60 |
| Silicon - | 0.16 | 0.15 min. |
| Phosphorus - | 0.024 | 0.045 max. |
| Sulphur - | 0.13 | 0.075 - 0.15 |

Depth of Case:

The depth of case was measured by etching a micro-specimen and using the Brinell microscope. Four different pins were examined. The case-depth ranged from 0.012 to 0.016 inch.

Depth-Hardness Relationship:

Hardness readings were taken, using the Vickers hardness machine and the 10-kilogram weight. Table I, below, lists the results obtained at various distances from the surface.

TABLE I.

| Pin | VICKERS HARDNESS NUMBERS (10-kilogram weight) At depths in inches from the surface. | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | At Surface | 0.005 | 0.01 | 0.02 | 0.04 | 0.06 | 0.08 | 0.10 | 0.20 |
| 1 | 648 | 497 | 497 | 402 | 345 | 332 | 340 | 372 | 383 |
| 2 | 616 | 582 | 542 | 445 | 355 | 353 | 366 | 366 | 397 |
| 3 | 653 | 624 | 593 | 585 | 345 | 353 | 360 | 370 | 365 |

Bend Tests:

Bend tests were carried out on an Amsler Universal testing machine using a 12-inch radius and 8-inch centres. Charts of increment vs. load were plotted. The elastic limit and break point were then determined from these charts. The

(Bend Tests, cont'd) -

method used has been illustrated in a previous investigation, No. 1197 (April 2nd, 1942), carried out in these laboratories. Table II records the results obtained.

TABLE II.

Bend Tests.

| Pin No. | 8 | | 9 | | 10 | |
|---|---|---|---|---|---|---|
| Physical Property | Angle | Load, in pounds | Angle | Load, in pounds | Angle | Load, in pounds |
| Elastic Limit | 1°15' | 400 | 1°2' | 350 | 1°28' | 405 |
| Permanent Bend | 2°25' | 625 | 2°17' | 625 | 2°21' | 540 |
| Break | 5°12' | 1000 | 5°49' | 1100 | 6°32' | 1000 |

Drop Impact Tests:

Drop impact tests were carried out to determine the reaction of the pins to sudden shock, both at room temperatures and at -50° F. A 5-kilogram weight (11.02 pounds approximately) was dropped from successively increasing heights. This was continued until the pin showed the first signs of cracking. For the low-temperature tests the pins were kept in a bath of acetone and dry ice for ½ hour at -50° F. prior to testing. The results are shown in Table III.

(See Table III on next page)

(Drop Impact Tests, cont'd) -

TABLE III.

Drop Impact Tests on
Universal Carrier X1315 Chapmanized Pins.

| Height of drop, cm. (5-kilogram weight) | SAMPLE IDENTIFICATION | | | |
|---|---|---|---|---|
| | ROOM TEMPERATURE | | -50° F. | |
| | - Angle of Bend - | | | |
| | Pin No. 5 | Pin No. 6 | Pin No. 3 | Pin No. 4 |
| 20 | 1° | 1° | 1° | 2° |
| 40 | 2.5° | 2.5° | 2.5° Cracked | Broke in two |
| 50 | 3.5° | - | | |
| 60 | Broke in two | Broke in two | | |
| 80 | | | | |
| 100 | | | | |
| Core Hardness, V. P. N. | 360 | 249 | 365 | 342 |
| Case Hardness, V. P. N. | 725 | 730 | 653 | 725 |

Microscopic Examination:

Microsections of the pins were polished and examined under the microscope in the unetched and the nital-etched condition. The unetched specimen showed the presence of sulphides. Figures 1 and 2, taken at X500 and X1000 magnifications respectively, are photomicrographs of a typical core and case.

(Continued on next page)

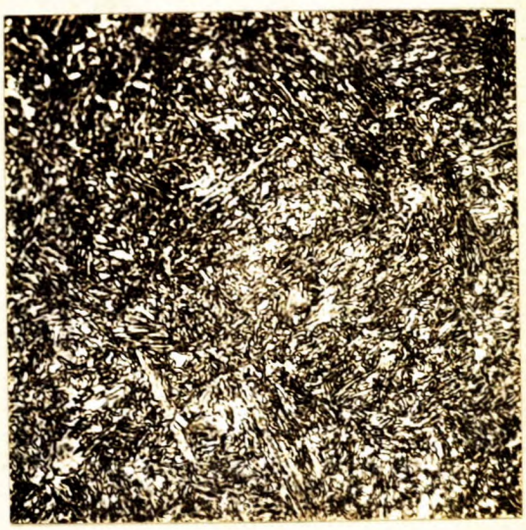
(Microscopic Examination, cont'd) -

Figure 1.

X500, nital etch.

TYPICAL CORE.

Figure 2.



X1000, nital etch.

TYPICAL CASE.

Discussion of Results:

The steel conforms to SAE X1315, with the exception of 0.01 per cent excess in carbon and manganese. This amount should not have any influence on the test results obtained.

The depth of case is within the Universal Carrier track pin limits of 0.012 to 0.020 inch.

The core hardness for all of the pins tested, with the exception of one, was over 340 V.P.N. Thus it appears that with this steel and the Chapmanizing process a hard core is usually obtained.

The bend test results parallel closely those obtained for the carbo-nitrided SAE 3115 pins (reported in Investigation No. 1224, May 18th, 1942, carried out in these laboratories), although the latter had somewhat lower surface hardnesses. As with all cased pins, however, these bend test results are not very favourable.

(Continued on next page)

(Discussion of Results, cont'd) -

The drop impact tests show that this pin can withstand 6 Kg/m. of impact work at room temperatures. In this respect these pins are weaker than the previous SAE 5115 Chapmanized pins tested here and also weaker than the above-mentioned SAE 5115 carbo-nitrided pins. At -50° F., like most cased pins tested, these pins only withstood two blows of the drop impact weight.

Figure 1 shows that the core structure is of the pseudo-martensite type. Figure 2 shows the structure of the case to be a drawn martensite containing small particles of cementite. Cementite in this nodular form is not harmful.

CONCLUSIONS:

1. The steel conforms to SAE X1315 with a very slight excess of carbon and manganese.

2. The depth of case obtained is within 0.012 to 0.020 inch specified for the Universal Carrier pin.

3. A core over 340 V.P.N. appears characteristic for this type of pin after Chapmanizing.

4. The bend tests show results similar to those obtained previously for cased SAE 5115 steel.

5. The drop impact test results are not as good as those obtained for cased SAE 3115 or 2115 steel at room temperatures.

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SLG:GHB.