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OTTAWA January 20th, 1944.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1576.

Examination of Universal Carrier Pins
Made from Seamy Stock.

(Copy No. 18.)

Abstract

An examination of Universal Carrier pins containing longitudinal seams is described. The depths of seams were measured and it was found that the seams have little, if any, effect on the properties determined by the routine laboratory tests. Mention is made of a pin with a longitudinal seam which went 4,913 miles in a field test without failing. Impact tests at -50° F. were also carried out on the pins.

Bureau of Mines
Division of Metallic Minerals
-
Ore Dressing and Metallurgical Laboratories

CANADA
DEPARTMENT OF MINES AND RESOURCES
Mines and Geology Branch

O T T A W A January 20th, 1944.

R E P O R T

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ORE DRESSING AND METALLURGICAL LABORATORIES.

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Origin of Material and Object of Investigation:

On October 22nd, 1943, Dr. C. W. Drury, Director of Metallurgy, Army Engineering Design Branch, Department of Munitions and Supply, Toronto, Ontario, submitted Requisition No. 728, AEDB Lot No. 813, Report No. 21, Test 16, covering twelve Universal Carrier pins produced by the Campbell, Wyant and Cannon Foundry Company, Muskegon, Michigan. It was reported that the pins had variable core hardnesses and that some had longitudinal seams.

It was requested that the physical properties of the pins that had previously been received be checked against the requirements of Specification O.A. 214. A differentiation, if possible, between seamy and unseamy stock was also requested.

Macro-Examination:

Examination of the pins showed cracks in the heads which continued along the length of the pins in the form of longitudinal seams. Sectioning the pins transversely showed that the seams penetrated into the case of the pins, and in some instances penetrated through the case into the core. Figure 1 shows these seams on the surface of three pins as revealed by the magnaflux operation.

Figure 1.

MAGNAFLUXED PINS, SHOWING SEAMS.

The depth of the seams on four pins was measured microscopically. The following results were obtained:

Pin No.		Depth of seam, in inches
5	-	0.045
6	-	0.024
1	-	0.021
2	-	0.002

Chemical Analysis:

Drillings were taken from the core of one pin and analysed chemically with the following results:

		As Found	Specification SAE 3115 (modified)
		-(Per cent)-	
Carbon	-	0.12	0.10-0.20
Manganese	-	0.49	0.30-0.60
Chromium	-	0.25	0.30 max.
Nickel	-	1.18	1.00-1.50

PHYSICAL PROPERTIES:

Tensile Tests -

The following table shows the results of tensile tests on 0.252-inch-diameter test specimens from the cores of two pins.

Pin No.	Ultimate strength, p.s.i.	0.1 per cent proof stress, p.s.i.	Elongation, per cent in gauge length of 1 inch	2 inches	Reduction of area, per cent
1	105,300	57,100	20	15.5	46.9
2	117,500	74,500	24	15	63.2

Bend Tests -

Bend tests were carried out on three pins, using the standard inspection machine, the pins being supported on eight-inch centres and centrally loaded through a bending block with a 12-inch-radius cylindrical face. The following table lists the results obtained as well as the surface and core hardnesses and the case depths:

Pin No.	Surface hardness, Rockwell 'A'	Core hardness, V.P.N.	Case depth, inches	Deflection at first case crack, inches
1	83.84	235	0.0195	0.29
2	83.5-84	212	0.016	0.28
3	84	202	0.0195	0.38

(Continued on next page)

(Physical Properties, cont'd) -

Drop Impact Tests -

Drop impact tests were carried out at room temperature and -50° F. by subjecting the pin, which is freely supported on 8-inch centres, to a 45-foot-pound blow. For the low-temperature tests the pins were kept immersed in the freezing mixture at -50° F. for thirty minutes before testing, to ensure that they reached that temperature throughout. The following table lists the results of the impact tests as well as the surface and core hardnesses and case depths:

Tests at Room Temperature:

Pin No.		Surface hardness, Rockwell 'A'	Core hardness, V.P.N.	Case depth, inches	Remarks
4	-	83-84	255	0.195	Passed.
5	-	83-84	210	0.016	Passed.
6	-	83-85	215	0.0215	Passed.

Tests at -50° F:

Pin No.		Surface hardness, Rockwell 'A'	Core hardness, V.P.N.	Case depth, inches	Remarks
7	-	85	226	0.020	Passed.
8	-	85-87	232	0.024	Passed.
9	-	84-85	235	0.024	Passed.
10	-	84-86.5	206	0.024	Failed.

Micro-Examination:

Transverse sections were cut from two pins and prepared for metallographic examination. On viewing the unetched specimens with the microscope the steel was seen to be clean. The samples were then etched in 2 per cent nital and re-examined. Figure 2 shows a typical core and Figure 3

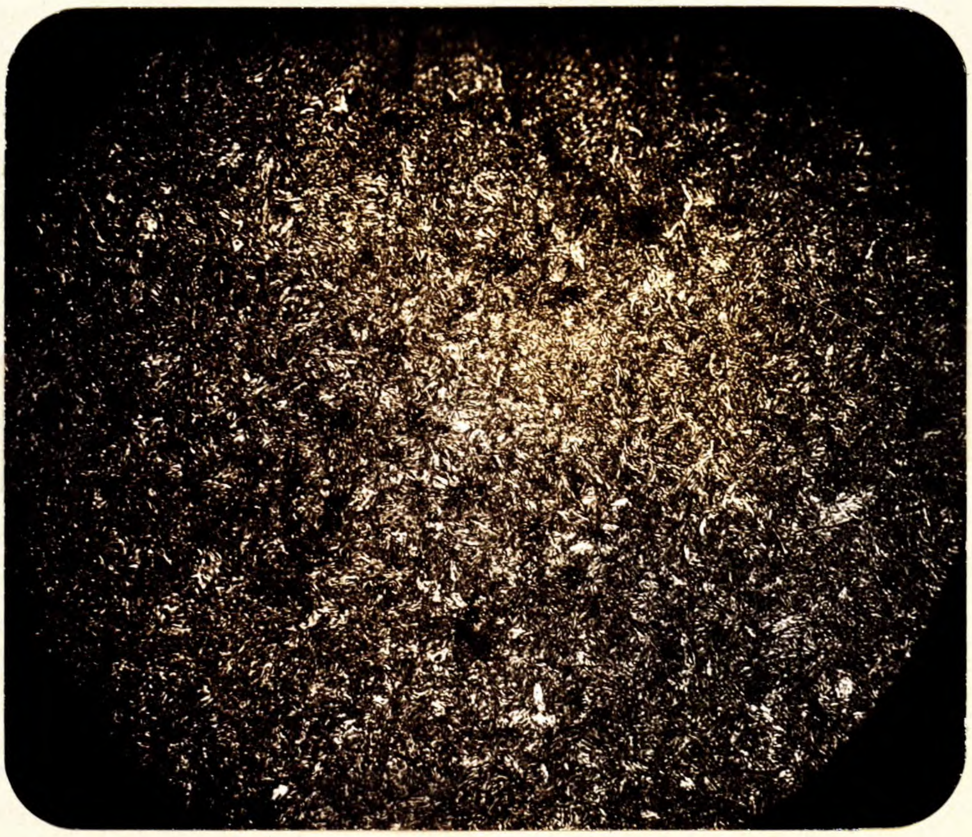
(Micro-Examination, cont'd) -

a typical case structure. Both photomicrographs are at 500 magnifications.

Figure 2.

X500, nital etch.
TYPICAL CORE STRUCTURE.
White material - massive ferrite.
Grey material - low-carbon martensite.

Figure 3.



X500, nital etch.
TYPICAL CASE STRUCTURE.
Tempered martensite.

Discussion:

The chemical analysis of the pin steel conforms to the modified specification for SAE 3115.

The physical properties of the core material, as determined by tensile tests, appear to be normal for this type of steel and heat treatment, the latter being merely an oil quench after carbo-nitriding at approximately 1575° F.

Specification O.A. 214 requires that the case depth be within the limits of 0.012 to 0.020 inch. Four of the ten pins examined had case depths above the upper limit while that of the remainder was on the high side of the range. Too great a case depth would be expected to lower the impact resistance of the pins. This may have been the cause for one of the pins failing the low-temperature impacts.

Satisfactory surface hardness has been obtained, that of all pins being above the 80 Rockwell 'A' minimum required by Specification O.A. 214.

Only one of ten pins examined had a core hardness above the minimum of 250 V.P.N. called for by Specification O.A. 214. If the assumption that pins fail due to fatigue cracks starting in the zone between the case and the core is correct, low core hardness would allow these cracks to form more readily and hence would decrease the service life of the pin. Trouble has been experienced before in obtaining the required minimum core hardness with steel of this analysis by oil quenching. It was shown, by tests carried out at these Laboratories and reported in P.M. Lab. Report No. 6563, Sept. 16th, 1943, that satisfactory core hardness could be obtained by quenching in an emulsion of water-soluble oil and water.

All three of the pins tested passed the bend test requirements satisfactorily.

In the room-temperature drop impact tests, three pins

(Discussion, cont'd) -

tested withstood the specified blow of 45 foot-pounds but at -50° F. one out of four pins failed under a blow of similar intensity. This would indicate that some of the pins have marginal impact resistance at this temperature. It is pointed out also that this may be due to the case thickness exceeding the maximum specified.

The microstructure of the core is normal for the heat treatment given the pins. The martensite in the case was tempered by heating during the cutting of the microspecimen.

Since all the pins received had longitudinal seams along their length, no differentiation could be made between seamy and unseamy stock. The depth of seams varies over a wide range, from 0.002 to 0.045 inch. No information is available correlating depth of seam and pin performance. However, it is felt that the seams would have little effect on the properties determined by the tests described in this report. The only way in which the effect of the seams could be definitely determined is by carrying out fatigue tests on pins of seamy and of unseamy stock. Since at the present time these Laboratories have no equipment for fatigue-testing track pins, this could not be done. However, it is thought that, provided the seams did not penetrate too deeply, they would have little effect on the service life of the pin. Indeed, one pin with a seam has been received in these Laboratories, unbroken, after 4,913 miles of field test. Of course, more data would have to be obtained before a definite conclusion can be reached.

CONCLUSIONS:

1. Chemical analysis shows the pin steel to conform to the specification for SAE 3115 steel.

2. Physical properties of the core material as determined by tensile tests are normal for the steel and heat treatment.

3. The case depths of four out of ten pins exceeded the specification limit. This would tend to lower the impact resistance of the pins.

4. Satisfactory surface hardness was obtained.

5. Nine out of ten pins had core hardnesses below the 250 V.P.N. minimum required.

6. All pins tested passed the bend and impact test requirements at room temperature.

7. One of four pins failed the drop impact test at -50° F. This would indicate marginal impact resistance at this temperature.

8. The depth of the longitudinal seams on the pin surface varied from 0.002 to 0.045 inch.

9. The seams had little effect on the properties determined by the tests carried out. The effect of the seams can only be determined either by field tests or by carrying out fatigue tests on pins of seamy stock and comparing the results with the results of similar tests carried out on pins containing no seams.

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