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OTTAWA September 17th, 1942.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1300.

(M. & S. Nos.:)
(7/A/11)
(7/A/12)
(7/A/13)

Investigation of C.P.R. Pack-Carburized Valentine Tank Track Pins Bent in Service.

(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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Valentine Tank Track Pins Bent in Service.

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Origin of Material and Object of Investigation:

On August 21st, 1942, Dr. C. W. Drury, Director of Metallurgy, Army Engineering Design Branch, Department of Munitions and Supply, 24 Adelaide Street East, Toronto, Ontario, submitted three track pins for investigation. It was reported that these pins were produced by the Canadian Pacific Railway Company (Angus Shops), Montreal, Quebec. They had been used with high manganese steel links in a field test and had worn and bent. The mileage at which the pins were removed from the track was unstated.

General:

Pin No. 2 in this report represents that submitted as Requisition No. 16 (Munitions and Supply, August 19th, 1942).

Pin No. 3 represents Requisition No. 17.

Pin No. 4 " " No. 18.

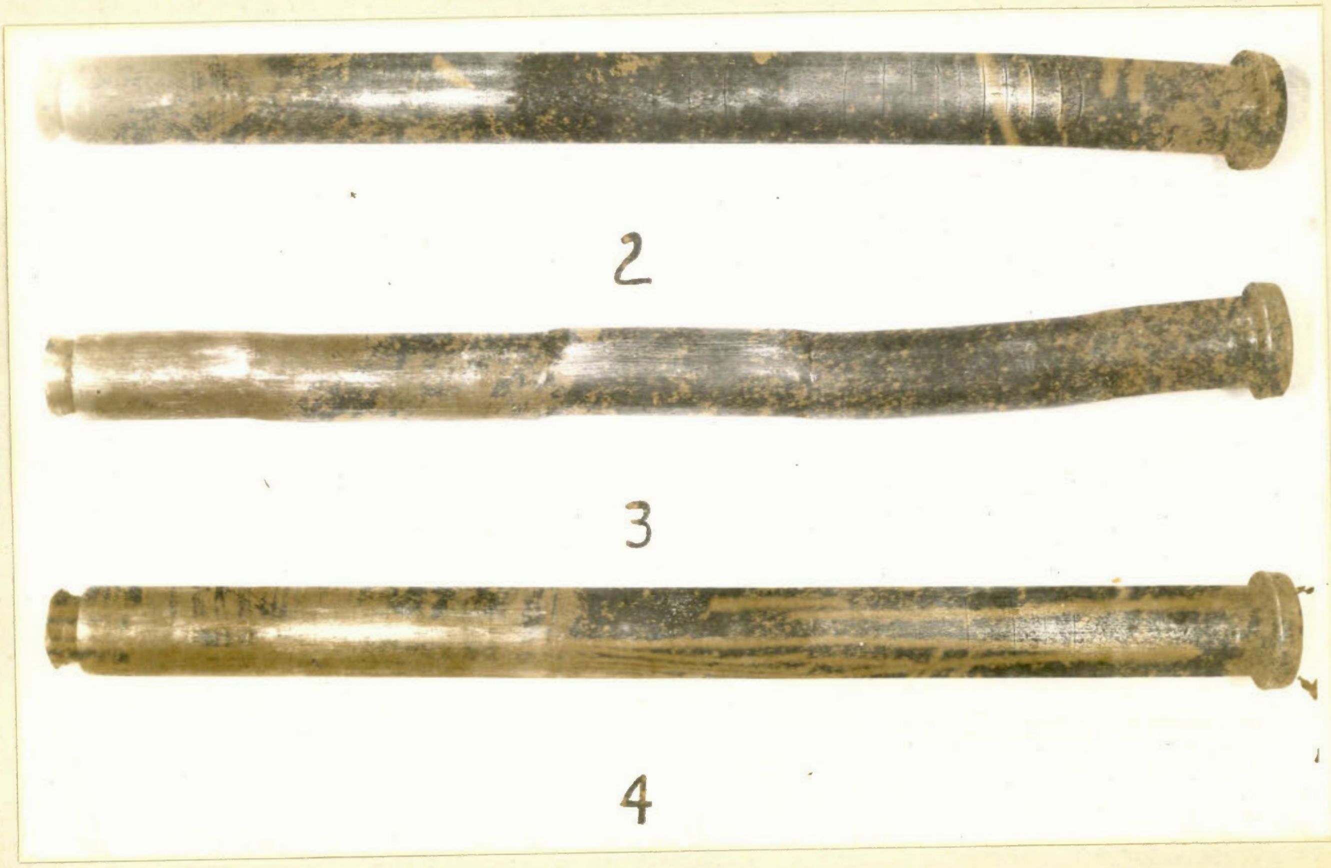
Macro Examination:

Pin No. 2 (See Figure 1) had a series of cracks across the surface; the pin had bent at an angle of about 8-10° near the head.

Pin No. 3 was worn unevenly and bent, as shown in Figure 1.

Pin No. 4 had a series of cracks across the surface and was also bent. The cracks in Pins Nos. 2 and 4 had propagated part way through the core.

Figure 1.



PINS AS RECEIVED.

Chemical Analysis:

Drillings were taken from the core and analysed:

	(Per cent)		
	Pin No. 2	Pin No. 3	Pin No. 4
Carbon -	0.11	0.13	0.085
Silicon -	0.26	0.24	0.25
Manganese -	0.36	0.55	0.36
Sulphur -	0.033	0.029	0.020
Phosphorus -	0.020	0.026	0.020
Nickel -	1.59	1.54	1.86
Chromium -	None	Trace	Trace

Physical Properties:

Tensile specimens were machined from the cores of the pins. Specimens of 2-inch gauge length and 0.505-inch diameter were used.

	Pin No. 2	Pin No. 3	Pin No. 4
Ultimate strength, p.s.i. -	78,100	66,200	79,000
0.1% proof stress, p.s.i. -	53,300	46,800	54,000
Elongation, per cent -	32	31	31
Reduction of area, per cent -	73	65	73

Depth-Hardness:

A transverse microsection was cut from each of the pins and hardness readings were taken across the face, using the Vickers hardness machine and a 10-kilogram weight. Table I lists the results obtained.

TABLE I.

	VICKERS HARDNESS NUMBERS							
Pin	AT THE	AT DEPTHS IN INCHES FROM THE SURFACE						
No.	SURFACE	0.005	0.010	0.025	0.050	0.075	0.10	0.35
2	514	446	422	333	155	158	155	156
3	333	305	283	228	155	152	155	160
4	673	620	566	455	185	170	156	155

Depth of Case:

Nital-etched microspecimens were examined for case depth, using the Brinell microscope. The case-depth ranges are shown below:

Pin No.	Case depth, inches
2	0.026 - 0.030
3	0.006 - 0.011
4	0.026 - 0.033

Microscopic Examination:

Transverse microsections of the pins were cut, polished and examined under the microscope. The unetched specimens were quite clean. Figure 2, taken at X500 magnification, is the core structure of Pin No. 3. Figure 3, taken at X500 magnification, indicates the core structure of Pin No. 4. The core structure of Pin No. 2 was similar to that of Pin No. 4. All of the cases were of the same nodular pattern. This pattern is shown by Figure 4, taken at X1000, of Pin No. 4.

Figure 2.

X500, nital etch.

CORE OF PIN NO. 3.

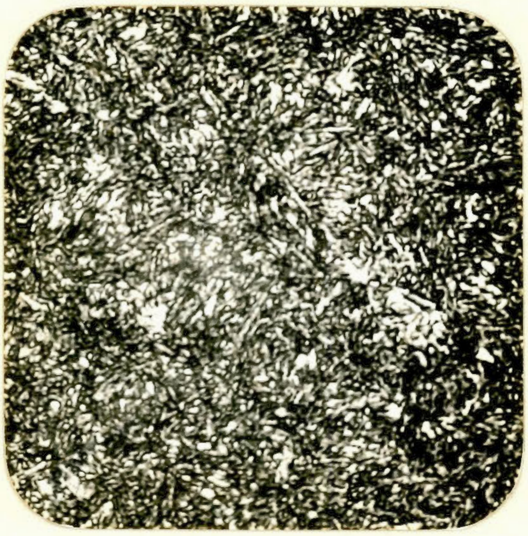
Figure 3.

X500, nital etch.

CORE OF PIN NO. 4.

(Microscopic Examination, cont'd) -

Figure 4.



X1000, nital etch.
CASE OF PIN NO. 4 .

Discussion:

The mileages of broken pins or other used pins should be stated; otherwise, it is not possible to draw conclusions relating pin properties with pin performance.

All these pins have soft cores. The tensile strengths are correspondingly low.

Pin No. 3 has the lowest tensile strength. Its core structure is mainly ferrite. A great deal of the case has been worn away. This pin, at the time of removal from the track, had no more rigidity and with the low core strength it would be prone to bend readily. This has happened, as is shown in Figure 1.

Pins Nos. 2 and 4 are very similar. In both instances the case has cracked in a number of places. The core properties are almost identical. Their structures are the same. Pin No. 2 may have worn somewhat more than Pin No. 4. It has been shown in this laboratory@ that C.P.R. present production pins of

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@ Data sheets issued at Windsor, Ontario, July 20th, 1942 at the Track Pin Committee Meeting.

(Discussion, cont'd) -

700 V.P.N. surface hardness number will crack their case at an angle of bend of 3°10' (using 12-degree radius and 8-inch centres). It is consequently expected that a number of cracks will be developed in a pin bent to an angle exceeding the above.

It is of interest to note that, with the use of a little higher carbon and less nickel, similar physical core properties were obtained in Pin No. 2 as in Pin No. 4.

CONCLUSIONS:

Pin No. 3 -

1. Most of the case has worn away and the core is not sufficiently strong to withstand the load; consequently, the pin is distorting and bending badly.

2. The physical properties of the core are low.

3. Low core hardness.

Pins Nos. 2 and 4 -

1. The bend has exceeded the maximum angle possible without getting cracks on the case.

2. Large amounts of ferrite are present in the core.

3. Low core hardness.

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