O T T A W A December 6th, 1943.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1550.

Investigation of Three Canadian Dry Pin Track Pins Which Failed in Field Test.

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(Copy No. 13.)

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 December 1st, 1943, Mr. F. C. Wilson, for Inspector General, Inspection Board of United Kingdom and Canada, Ottawa, Ontario, submitted four S.A.E. 9255 track pins for investigation. Three of these pins had broken in a field test at Montreal, Quebec, two at 1,362 miles and one at 1,372 miles. An unbroken pin from the same vehicle was included in the shipment, for comparison.

The field tests had been made in order to determine the following:

(a) The effect of using cyanided pins which had been re-drawn to 40-44 Rockwell 'C' hardness. This is below the present hardness specification of 45-51 Rockwell 'C'.

(b) The effect of reversing the track so that the grouser came in contact with the ground first after revolving around the sprocket, rather than being the trailing part as in the standard assembly.

The three pins had all failed in the right track which had been reversed. No pins had failed on the left track, which was running in the normal way, up to 1,500 miles.

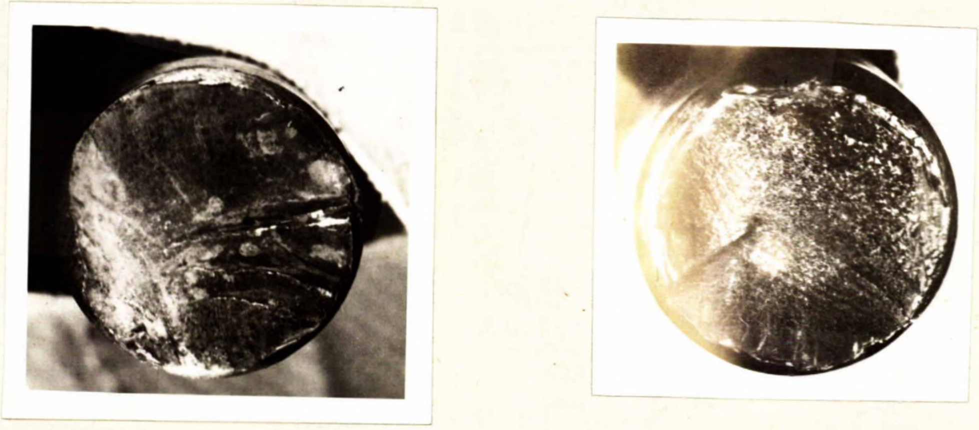
A complete metallurgical examination of these pins was desired.

Macro-Examination:

Examination of the failed surfaces revealed duplex fractures, usually associated with fatigue failures. Figure 1 shows the surfaces of two pins.

Two of the pins broke at a point approximately three inches from the rivetting tip. Figure 2 shows a failed pin placed alongside the unbroken pin for comparison. The surface on the latter pin has been gouged circularly at one point by some imperfection in the link eye-hole. The third pin failed $5\frac{1}{2}$ inches from the tip.

Figure 1.

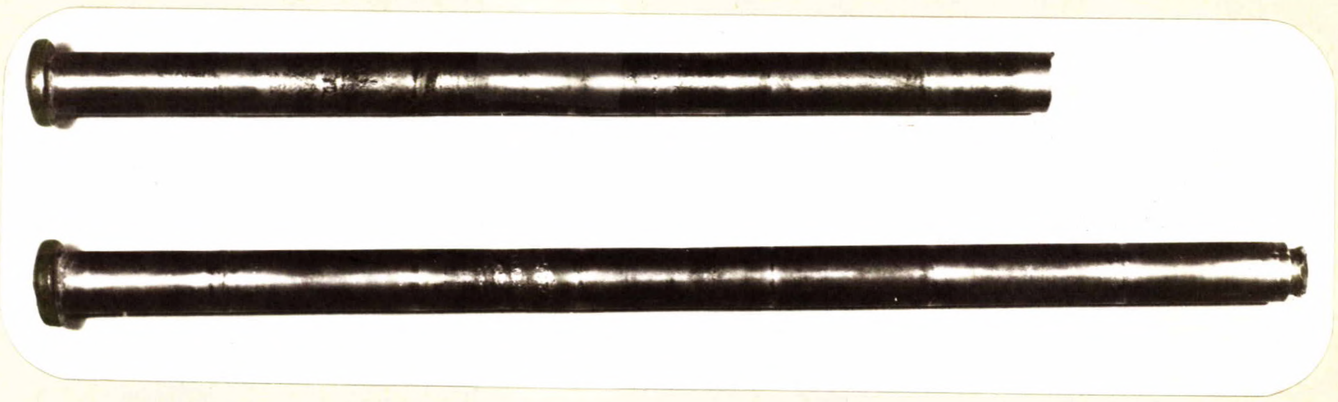


FRACTURED SURFACES OF FAILED PINS.
Note duplex structure.

(Continued on next page)

(Macro-Examination, cont'd) -

Figure 2.



Wear Data:

Measurements were taken of the wear on the four pins. Two readings were made, with a micrometer, at each selected point on the pin. These were at right angles to each other. The following diagram indicates the relative positions at which the pins were measured:

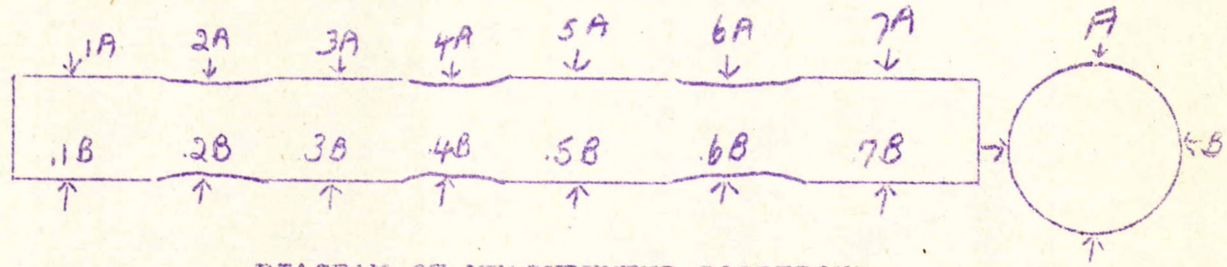


DIAGRAM OF MEASUREMENT POSITIONS.

The first column in Table I designates the shoe number from which the pin was taken.

(Continued on next page)

(Wear Data, cont'd) -

TABLE I.

Wear Measurements, in inches.

SHOE NO.	1A	1B	2A	2B	3A	3B	4A	4B
12	0.808	0.811	0.797	0.797	0.798	0.795	0.794	0.790
29	0.810	0.811	0.811	0.806	0.791	0.797	0.809	0.809
54	0.804	0.805	0.807	0.807	0.789	0.786	0.804	0.804
63	0.805	0.806	0.808	0.804	0.802	0.802	0.796	0.796

(Cont'd)

Shoe No.	5A	5B	6A	6B	7A	7B	Mean* Wear	Max.** Wear
12	0.806	0.806	0.805	0.803	0.811	0.811	0.013	0.025
29	0.800	0.799	0.801	0.802	-	-	0.012	0.024
54	0.803	0.802	0.806	0.806	-	-	0.013	0.029
63	-	-	-	-	-	-	0.012	0.019

* Mean wear = 0.815 minus mean diameter.

** Maximum wear = 0.815 minus smallest diameter.

Hardness:

Rockwell 'C' hardness readings were taken on the surface, 1/16 inch below the surface, and in the core of the pins. Table II outlines the results obtained:

TABLE II. - Hardness.

Shoe No.	Surface Hardness	1/16 inch from surface	Core
12	39.5-41	42	40-42
29	40-41	42-43	44
54	41.5-42.5	41-42	42-43
63	42	41.5-43	44-44.5

Depth-Hardness Survey:

A transverse section was cut from one of the broken pins and a hardness survey was made across the face, using the Vickers hardness machine and a 10-kg. load.

(Continued on next page)

(Depth-Hardness Survey, cont'd) -

V.H.N.		Distance from the surface, in inches
405	-	0.276
405	-	0.189
409	-	0.118
421	-	0.079
421	-	0.055
425	-	0.043
425	-	0.024
425	-	0.020
425-437	-	Surface.

Microscopic Examination:

A transverse section was cut from one of the broken pins. It was polished and etched in 2 per cent nital. Figure 3, taken at X1000 magnification, illustrates the structure obtained.

Figure 3.

X1000, nital etch.

STRUCTURE OF CORE.

Tempered Martensite.

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Discussion:

By running the track backward (grouser meeting the ground first after coming off the sprocket), more reversals of stress have been induced on the pins, causing fatigue failure. This is denoted by the duplex fracture observed on the broken

(Discussion, cont'd) -

pins. These pins have been drawn to Rockwell 'C' 40-44, which is below the specified hardness of Rockwell 'C' 45-51. At the lower hardness the pins are more subject to fatigue failure than at the higher hardness, since fatigue resistance is directly proportional to hardness.

The hardness of these pins was lowered in order to raise the impact resistance. Previous failures on normal running track suggested that breakages were occurring due to impact. The lack of any pin failure on the left track up to 1,500 miles indicates that for track running in the normal manner (grouser is the trailing part of the link) a lower hardness pin is desirable.

It should be pointed out, however, that IF fatigue is the only cause for pin failure in the right track running backward this can be improved by using higher hardness pins, i.e., within the specified hardness range, 45 to 51 Rockwell 'C'. This would increase the life of the pins and also result in greater wear resistance.

The mean wear of the four pins examined is 0.0091 inch per 1,000 miles (using 1,375 miles as average distance for all four pins). This compares very favourably with the mean wear per 1,000 miles obtained for pins which had gone approximately 3,000 miles. Our Investigation No. 1544 (December 1st, 1943), indicates a wear of 0.012 inch per 1,000 on headless pins which had not been centreless-ground but recarburized by cyanide to the specified surface or core hardness of 45-51 Rockwell 'C'. Investigation No. 1470 (May 8th, 1943), on headed pins also not centreless-ground but cyanided, showed that for pins which have gone 2,486 miles the mean wear per 1,000 miles was 0.0064 inch. It can be seen that the wear on the pins examined herein is normal for the

(Discussion, cont'd) -

hardness (R. 'C' 40-44) to which they were drawn.

Table II shows that the cores are somewhat harder than the surfaces. This may be due to either (a) slight decarburization of the surface or (b) insufficient length of time in the draw furnace.

The microstructure obtained is tempered martensite.

CONCLUSIONS:

1. The pins failed due to fatigue.

2. Reversing the track from general assembly practice induces greater fatigue stresses on the pins.

3. Lowering the hardness range from Rockwell 'C' 45-51 to Rockwell 'C' 40-44 has produced a pin with more resistance to impact, as shown by the absence of failures on the standard assembled track, up to 1,500 miles.

4. Normal assembly practice appears to produce:

(a) High impact stress,
(b) low fatigue stress.

Reversed assembly produces:

(a) High fatigue stress.

The impact stress has not been determined in the field.

5. Core hardnesses are somewhat higher than surface hardnesses.

6. An 0.0091-inch wear has occurred per 1,000 miles.

Recommendations:

1. It would be of interest to run a track with higher-hardness pins in the reversed manner. This would increase the fatigue life of the pins. It would also determine whether the

(Recommendations, cont'd) -

impact stresses are lessened by running the track in this manner.

2. For cyanided pins, a lower hardness than the specified Rockwell 'C' 51 maximum is recommended.

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