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O T T A W A June 2nd, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1657.

Investigation of Oil-Quenched and Water-Quenched SAE 9255 Canadian Dry Track Pins.

(Copy No. 10.)

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Origin of Material and Object of Investigation:

On May 22nd, 1944, four (4) Canadian Dry Pin track pins were received for examination. An accompanying requisition, No. 817, A.E.D.B. Lots Nos. 1067 to 1070, issued by Dr. C. W. Drury, Director of Metallurgy, Army Engineering Design Branch, Department of Munitions and Supply, Toronto, Ontario, stated that:

(a) Lots Nos. 1067 and 1068 had been hardened by water-quenching and then drawn.

(b) Lots Nos. 1069 and 1070 were hardened by oil-quenching and then drawn.

The requisition requested:

1. Examination of each of four pins, to determine compliance with Specification O.A. 227.

2. Microscopic examination to compare the structures.

Chemical Analysis:

Drillings were taken from one water-quenched and one oil-quenched pin for chemical analysis.

	Oil-Quenched Pin	Water-Quenched Pin	SAE 9255 Specification
		- Per Cent -	
Carbon -	0.56	0.55	0.50-0.60
Manganese -	0.82	0.75	0.70-0.90
Silicon -	2.10	2.14	1.80-2.20
Sulphur -	0.015	0.023	0.050 max.
Phosphorus -	0.009	0.010	0.040 max.
Chromium -	0.05	0.07	--
Molybdenum -	Trace.	Trace.	--

Hardness:

Rockwell 'C' hardness readings were taken on the surface of the pins and of the cores. The results were:

	Surface	Core
Oil-Quenched Pin -	46.5	47
" " -	46.5	47
Water-Quenched Pin -	47.0	47
" " -	47.0	47

Transverse microspecimens were cut and polished. Readings were taken on the Vickers hardness machine, using a 10-kg. load. The hardnesses and distances from the surface are shown below:

OIL-QUENCHED PIN -

Distance from surface, inches	V.P.N.
Surface -	470
0.16 -	473
0.32 -	483
0.52 -	483
0.70 -	483
0.90 -	483
1.65 -	483
Core -	478

WATER-QUENCHED PIN -

Surface -	478
0.07 -	473
0.24 -	473
0.37 -	473
0.60 -	478
1.70 -	478
Core -	468

-

Impact Tests:

Impact tests were carried out, using the standard inspection impact machine. The results are shown in Table I. Deflections are given in inches.

TABLE I.

Quench	Deflection after three blows, inches	Deflection after six blows, inches	Remarks
Water -	1.38	-	Failed after 5 blows.
Water -	1.39	2.57	Failed after 7 blows.
Oil -	1.39	2.10	Deflection was 2.55 after 9 blows. It was unbroken after 11 blows, with a deflection of 2.78.
Oil -	1.35	2.47	Failed after 8 blows.

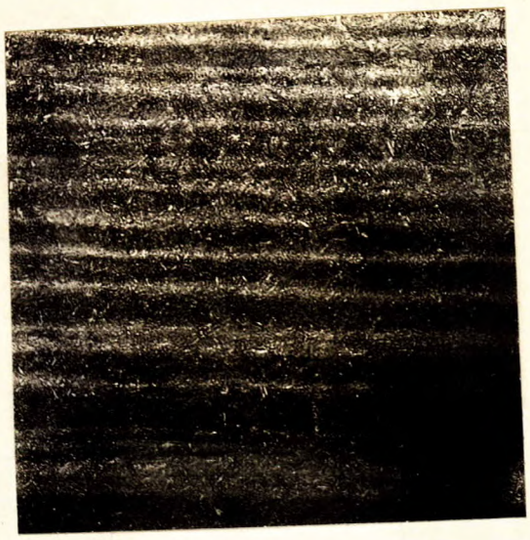
Microscopic Examination:

Transverse and longitudinal specimens were cut from the pins, polished, and examined under the microscope. The unetched specimens showed that the steel was fairly dirty and contained the usual inclusions associated with the heats of SAE 9255 pin steel being produced at the present time. These include titanium nitride, basic magnesium silicate, silica and alumina. The specimens were etched in 2 per cent nital and re-examined under the microscope. Figure 1 (at 250) shows the banded structure that was common to all the pins. Figure 2 (at X1000) illustrates the tempered martensitic structure obtained for the oil-quenched pin. Figure 3 (at X1000) is the tempered martensite structure obtained with the water-quenched pin.

(Continued on next page)

(Microscopic Examination, cont'd) -

Figure 1.



X250, nital etch.

BANDED STRUCTURE.

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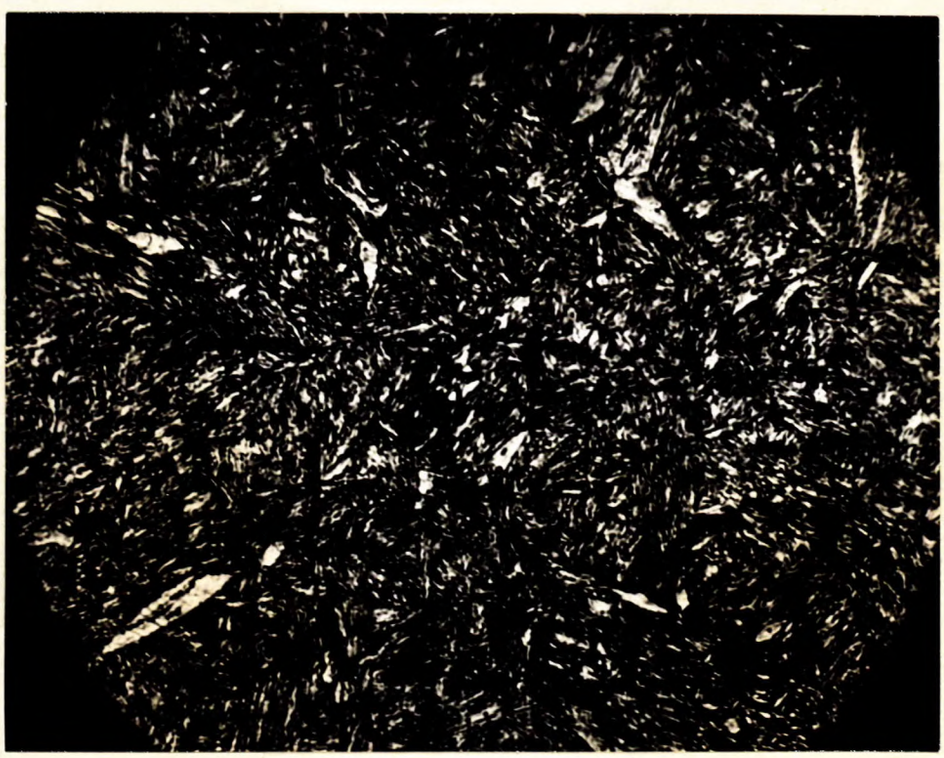
Figure 2.



X1000, nital etch.

TEMPERED MARTENSITE,
OIL-QUENCHED PIN.

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(Microscopic Examination, cont'd) -

Figure 3.

X1000, nital etch.

TEMPERED MARTENSITE,
WATER-QUENCHED PIN.

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Discussion:

The similarity in analysis shows that all pins were produced from the same heat of SAE 9255 steel.

O.A. 227 specifies:

Surface and core hardness - 45 ± Rockwell 'C'.

Impact - Must pass 3 successive blows.

Bend deflection - A minimum bend deflection of 1.2 inches must be obtained after the pin has taken three impact blows.

The surface and core hardness of all the pins examined came within the specification. A transverse hardness survey shows little or no decarburization at the surface.

All pins passed the impact requirements and also the bend deflection. On further impacts, however, the oil-quenched pins were able to withstand more blows than those which were water-quenched.

Notwithstanding the presence of banding and inclusions in all of the pins examined, reasonably good impact results were obtained. It is known, however, that banding is detrimental to impact and, consequently, erratic results would be obtained if a large number of pins of this material were tested.

The structures obtained for both the oil- and water-quenched pins were similar; namely, tempered martensite.

CONCLUSIONS:

1. The pins were produced from the same heat of SAE 9255 steel.

2. Surface and core hardnesses of the pins were within the specification limits.

3. Little or no decarburization is evident.

4. All pins passed the minimum impact and bend

(Conclusions, cont'd) -

deflection requirements of the specification.

5. The oil-quenched pins required more impact blows to fail them than did the water-quenched pins.

6. Banding and inclusions are present in all of the pins.

7. The structures of the oil-quenched and water-quenched pins are both tempered martensite.

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SLG:GHB.