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O T T A W A November 26th, 1943.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1543.

Examination of Two Canadian Dry Pin Track Pins.

(Copy No. 12)

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 November 15th, 1943, two samples of broken pins were submitted by Col. H. G. Hoare, Director of Inspection (Mechanization), Inspection Board of United Kingdom and Canada, Ottawa, Ontario. In an accompanying letter (File No. 4/10/D/RAM/9), signed by Major C. W. Jones, A.D.I.(M), these samples were outlined as follows:

No. 1: Head end - from No. 3 bath, Nov. 6, 10% cyanide, for a period of 19½ minutes at 1575° F., then subject to a 800° F. draw for 1 hour. Reported to have a hardness value of Rockwell 'C' 48-49.

Under bend test this pin broke at a 0.7" deflection and a load of 8,160 pounds.

No. 2: Lot 44, No. 1 bath, no date, 6.7% cyanide, for a period of 20 minutes at 1575° F., and drawn at 765° for 1½ hours. Reported to have a hardness value of Rockwell 'C' 48-48.5.

Under bend test this pin withstood a load of 9,600 pounds with a 2.4" deflection.

It was requested that a complete metallurgical examination of these pins be made in order to determine, if possible, the reason for their different bend test properties.

Chemical Analysis:

	Sample No. 1	Sample No. 2
	- Per cent -	
Carbon -	0.61	0.57
Manganese -	0.73	0.87
Silicon -	2.14	2.04
Nickel -	0.02	0.07
Chromium -	0.07	0.01
Molybdenum -	0.08	Trace.

Hardness Survey:

	Hardness, Rockwell 'C'	
	Surface	Core
Sample No. 1 -	50-51	50-51.5
" No. 2 -	50-52	51-52

Values as found at Cockshutt Plow Co.:

No. 1 - Rockwell 'C' 48-49
No. 2 - " " 48-48.5

Transverse hardness gradients were made, using the Vickers hardness testing machine with a 10-kilogram load.

No.	VICKERS HARDNESS NUMBER													
	Surface	Distance from surface, in inches												
		0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10	0.15	0.20	0.25
1	530	530	530	530	530	530	530	530	530	530	530	530	530	530
	- Equivalent to Rockwell 'C' 51. -													
2	540	540	542	542	542	560	560	560	560	542	542	542	560	560
	- Equivalent to Rockwell 'C' 52. -													

Grain Size Examination:

Due to the difficulty of carburizing silicon-manganese steel, the grain size could not be determined by the usual McQuaid-Ehn test. The following procedure was used:

Samples were heated in a strong decarburizing atmosphere for 2 hours at 1700° F., then cooled to room temperature through a period of 3 hours. Backing the area of heavy decarburization there is a zone of mixed ferrite bordering the grains composed of pearlite. This made possible an easy estimation of the grain size.

Both pins had a grain size of 6.

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Microscopic Examination:

Transverse and longitudinal sections were cut from each pin. Unetched, the metal in all sections was clean and free from inclusions.

Figures 1 to 4 are photomicrographs, at X1000 magnification, showing the metal structure, the specimens having been etched with 2 per cent nital. All structures shown are typically tempered martensite. There was no evidence of decarburization or casing.

Discussion:

Chemical analysis indicates that the two pins are from different heats of metal. Hardness values found are higher than those found at Cockshutt Plow Company, and both surface and core hardness are at the top limit of the present specification (i.e., 45-51 Rockwell 'C').

Transverse hardness gradients show that the pins are neither decarburized nor cased. This is further substantiated by microscopic examination. Fineness of grain size and absence of inclusions indicate uniformity in the raw material.

The tempered martensite microstructure is typical of quenched-and-drawn S.A.E. 9255 steel. The absence of decarburization or carburization at the surface indicates good salt bath control.

Failure to withstand bending stress may be due to some effect (such as embrittlement) at the surface which reduces its resistance to tension. It is possible that a brittle surface layer of high nitrogen content (which would not be recognizable under the microscope) may be developed in the cyanide bath during heat treatment.

This could have been detected by analysis of step cut

(Discussion, cont'd) -

samples from the surface. Unfortunately, there was not sufficient sample supplied to carry out an examination for nitrogen embrittlement.

CONCLUSION:

In the absence of any definite evidence to account for the difference in physical properties, it is suggested that the superior properties of one pin may be due to the fact that a longer drawing time was used in its heat treatment.

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IHM:GHB.

Figure 1.

X1000, etched in
2 per cent nital.

PIN NO. 1,
TRANSVERSE SECTION.

Figure 2.

X1000, etched in
2 per cent nital.

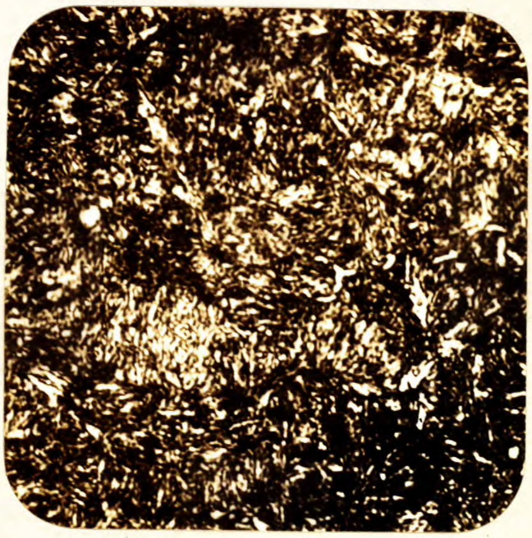
PIN NO. 1,
LONGITUDINAL SECTION.

Figure 3.

X1000, etched in
2 per cent nital.

PIN NO. 2,
TRANSVERSE SECTION.

Figure 4.



X1000, etched in
2 per cent nital.

PIN NO. 2,
LONGITUDINAL SECTION.

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