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OTTAWA June 8th, 1944.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1661.

Investigation of German Half-Track
Troop Carrier Track Pin.

(Copy No. 13.)

Bureau of Mines
Division of Metallic
Minerals
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Physical Metallurgy
Research Laboratories

CANADA
DEPARTMENT
OF
MINES AND RESOURCES

Mines and Geology Branch

O T T A W A   June 8th, 1944.

R E P O R T

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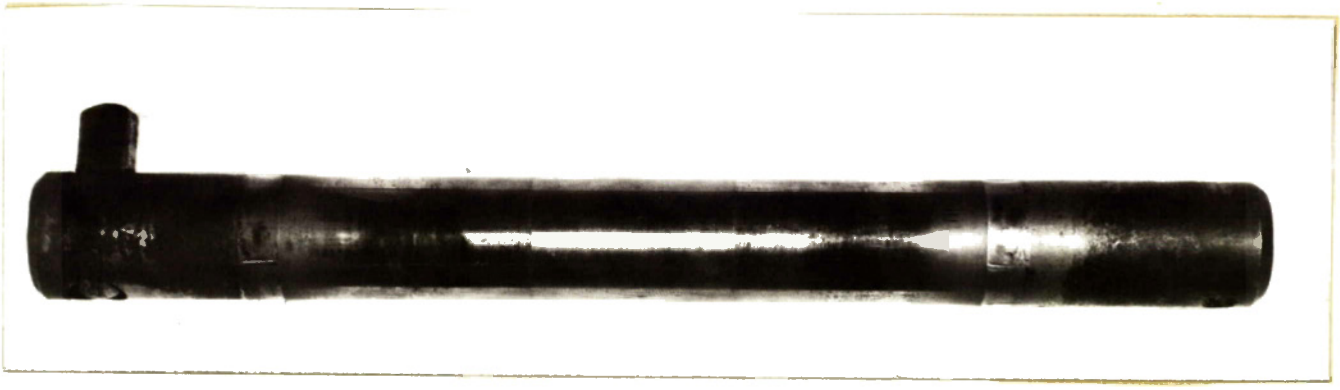
Origin of Material and Object of Investigation:

On May 20th, 1944, the Division of Metallurgy, Army Engineering Design Branch, Department of Munitions and Supply, Ottawa, Ontario, submitted a German Half-Track Troop Carrier track pin for examination. An accompanying requisition, No. 647 (A.E.D.B. Lot No. 539, Report No. 13, Test No. 61), requested that a complete metallurgical investigation be carried out.

Macro-Examination:

The diameter of the pin was 0.866 inch. The length was 8¼ inches. Figure 1 illustrates the pin as received.

Figure 1.



PIN AS RECEIVED.

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Chemical Analysis:

Drillings were taken from the core and analysed chemically. The results were:

		As Found	SAE 6135 Specification
		- Per	Cent -
Carbon	-	0.38	0.30-0.40
Manganese	-	0.94	0.60-0.90
Silicon	-	0.38	0.15-0.30
Sulphur	-	0.060	0.050 max.
Phosphorus	-	0.032	0.040 max.
Nickel	-	Trace.	-
Chromium	-	1.56	0.80-1.10
Molybdenum	-	0.02	-
Vanadium	-	0.10	0.15 min.
Copper	-	0.20	-

Hardness:

A transverse specimen was cut from the pin. Hardness readings were taken across the face at varying distances from the surface, the Vickers hardness tester and a 10-kilogram load being used. The results were:

(Continued on next page)

(Hardness, cont'd) -

Depth from the surface, in inches		HARDNESS V.P.N.	Equivalent* Rockwell 'C'
Core	-	503	48.5
1.20	-	536	51.0
0.95	-	525	50.0
0.75	-	525	50.0
0.55	-	536	51.0
0.39	-	530	50.5
0.19	-	519	49.5
Surface	-	566	52.5

* Taken from Scott-Gray conversion chart.

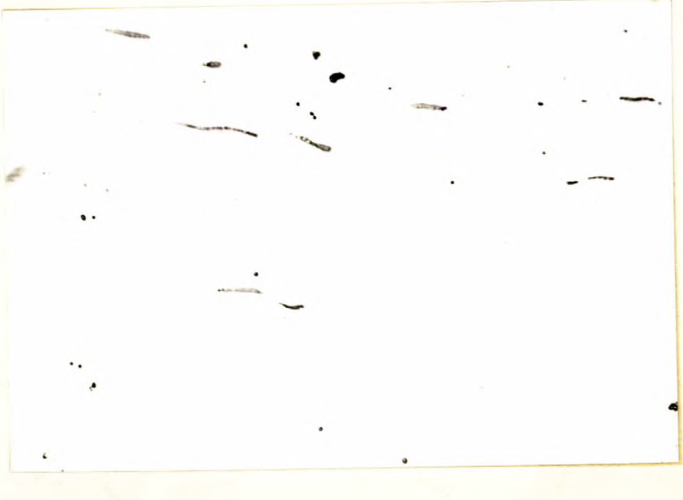
Grain Size:

The McQuaid-Ehn grain size was determined. It was found to be 5-7.

Microscopic Examination:

Transverse and longitudinal specimens were cut from the pin. These were polished and then examined under the microscope. Figure 2 (X500) illustrates the distribution of inclusions in a longitudinal specimen. These inclusions were identified as FeMnS (elongated in the direction of rolling), sometimes duplexed with FeMnO. Other inclusions were of the alumina FeO Al_2O_3 variety. The specimens were etched in 2 per cent nital. Figure 3 (X250) shows the structure at the surface of the pin. Figure 4 (X1000) illustrates the tempered martensite structure of the core of the pin.

Figure 2.



X500, unetched.
DISTRIBUTION OF INCLUSIONS.

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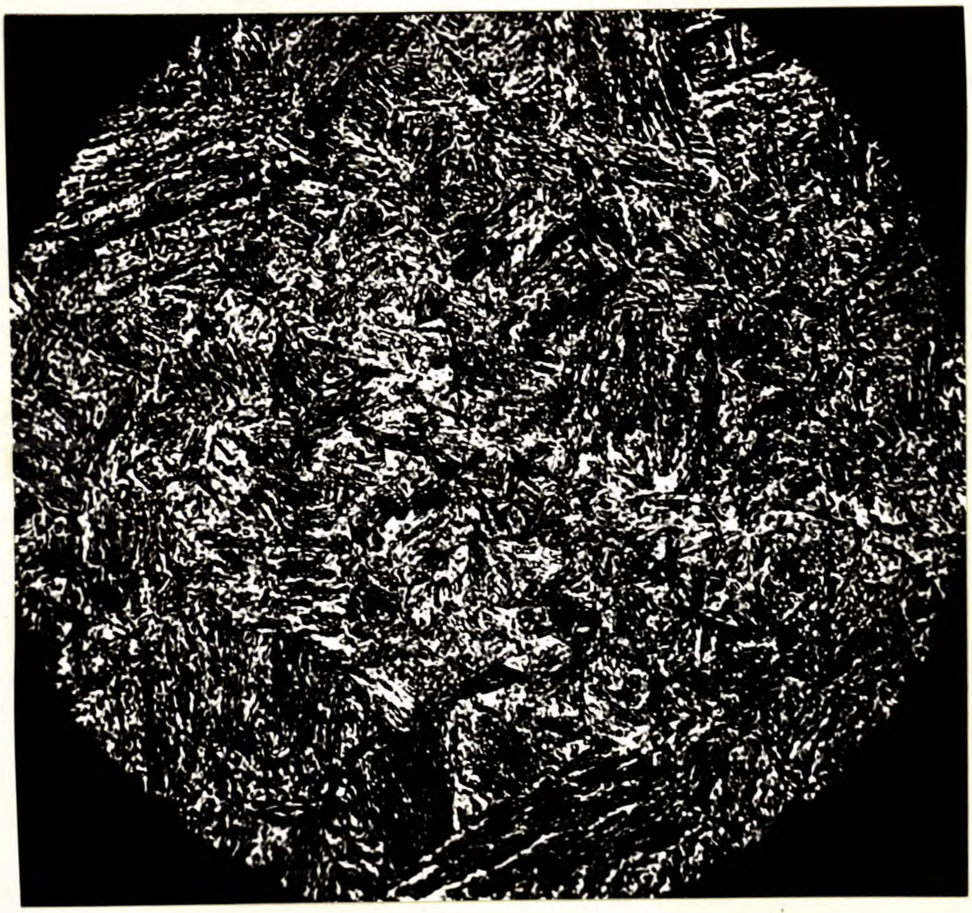
Figure 3.

X250, nital etch.

STRUCTURE AT THE SURFACE OF THE PIN.

Figure 4.



X1000, nital etch.

TEMPERED MARTENSITE STRUCTURE OF THE CORE.

Discussion:

The chemical analysis of the pin shows that the Germans are using a chrome-vanadium spring steel. The hardness survey indicates that this has been homogeneously hardened. The usual heat treatment for a steel of this type is:

Oil-quench from 1600° F. and
draw at 600 to 700° F.

Usually the steel contains about 0.50 per cent carbon and one would expect this higher-carbon-content steel to give better service in this application owing to the better wear resistance.

In Canada, silico-manganese SAE 9255 spring steel is being employed as pin material for the Canadian Dry Pin track. This spring steel does not contain any "strategic" alloy elements. At the time of production of the half-track troop carrier from which this pin was taken, the Germans could not have been short of chromium or vanadium. It is extremely unlikely, if they had been short, that they would have used a spring steel containing these two alloys when lower-alloy spring steels hardened and drawn give the same excellent results in the field.

The steel used for fabrication of the pin examined was in a rather dirty condition, sulphides, FeMnO, FeO Al_2O_3 and alumina inclusions being evident throughout. In addition to the alumina inclusions, the fine austenitic grain size shows that the steel was aluminium-killed. The tempered martensite pin structure indicates that the pin has received the conventional quench-and-draw heat treatment. No decarburization was seen on any part of the pin. If the original pin had been decarburized this could not have been detected, however, as it would have worn away in service. The slightly increased surface hardness obtained with the Vickers machine is probably due to a work-hardening effect.

CONCLUSIONS:

1. The Germans are using chrome-vanadium spring steel for pins on their half track troop carrier. A slightly higher carbon steel, of otherwise the same composition, would be expected to give better results.

2. The pin is homogeneous, in the hardened-and-drawn condition.

3. The steel is dirty and a number of inclusions are readily identified.

4. The steel is fine-grained (5-7) and has been aluminium-killed.

5. The structure of the pin is tempered martensite, indicating that the pin has received a conventional heat treatment.

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