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REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1796.

Investigation of Cased Universal Carrier Track Pins.

(Copy No. 10.)

Bureau of Mines
Division of Metallic
Minerals
-
Physical Metallurgy
Research Laboratories

DEPARTMENT
OF
MINES AND RESOURCES

Mines and Geology Branch

O T T A W A February 19, 1945.

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Origin of Material and Object of Investigation:

On February 2, 1945, Mr. O. Peterson of the Commercial Steel Treating Corporation and Mr. H. MacDonald of the Allied Products Corporation, both of Detroit, Michigan, submitted personally to these Laboratories a number of Universal Carrier cased SAE 3115 track pins for examination. They stated that these pins were representative of roughly 250,000 which had been rejected for failure to meet the specified core hardness requirements. It was found that some pins were above the maximum of 32 Rockwell 'C' and others were below the minimum of 24 Rockwell 'C'. A thorough investigation was requested in order to determine the reasons why the pins did not meet the specification requirements.

Core Hardness Determinations:

Hardness readings were made on the face of transverse sections of the pin specimens submitted, using the Rockwell machine.

Pin No.		Hardness, Rockwell 'C'
1	-	36, 37, 37
2	-	33, 34, 33
3	-	37, 38
4	-	9, 9, 9
5	-	16, 15, 15
6	-	14.5, 15, 15
7	-	15, 16, 15

Chemical Analysis:

Drillings were taken from the core of two hard-core pins and two samples of soft-core pins. Because of the small size of the soft-core specimens, it was necessary to use more than one soft-core pin to make up each sample for analysis. The results were:

		HARD CORE		SOFT CORE	
		Pin No. 1	Pin No. 2	Sample No. 1	Sample No. 2
		- Per Cent -			
Carbon	-	0.22	0.20	0.18	0.20
Manganese	-	0.55	0.53	0.56	0.55
Nickel	-	1.39	1.44	1.39	1.39
Chromium	-	0.29	-	-	0.29

McQuaid-Ehn Grain Size:

The regular McQuaid-Ehn grain size test was carried out at 1700° F. for Pins Nos. 2, 4 and 6, resulting as follows:

Pin No. 2 - Average grain size of 4 A.S.T.M.
Pins Nos. 4 and 6 - Average grain size of 5 A.S.T.M.

Photomicrographs were taken of the McQuaid-Ehn specimens. Figure 1 (X500) illustrates the somewhat abnormal appearance of Pin No. 4 (soft core). Figure 2 (X500) shows a relatively normal McQuaid-Ehn structure for soft-cored Pin No. 6. Figure 3 (X500) shows the structure of hard-cored Pin No. 2.

(Continued on next page)

(McQuaid-Ehn Grain Size, cont'd) -

Figure 1.

X500, nital etch.

SOFT-CORED PIN NO. 4.

Somewhat 'abnormal' McQuaid-Ehn structure.

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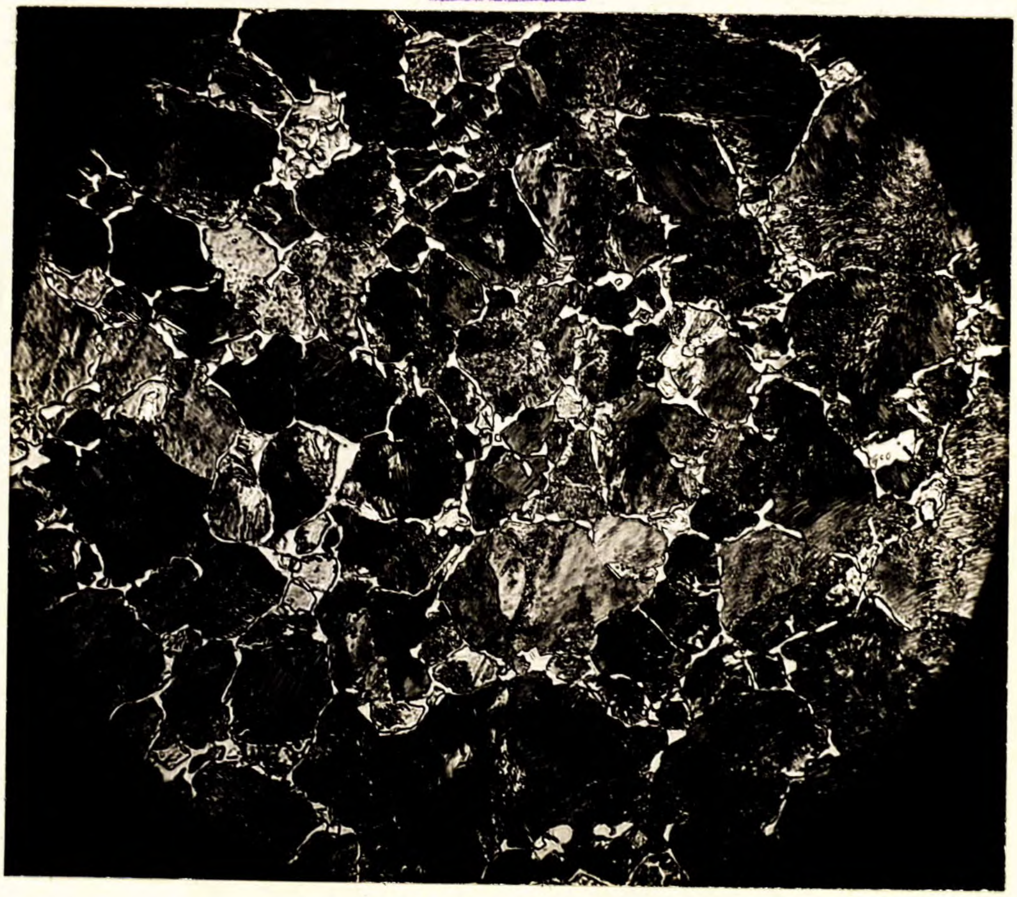
Figure 2.



X500, nital etch.

SOFT-CORED PIN NO. 6.

Relatively normal McQuaid-Ehn structure.

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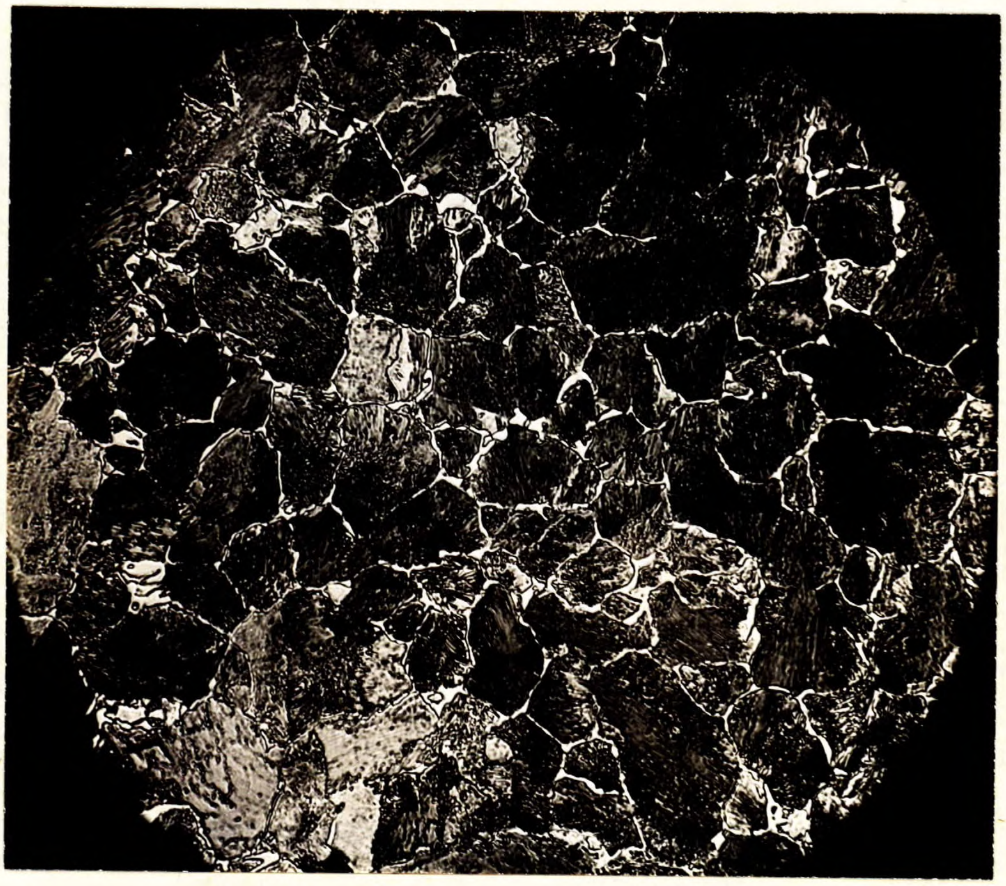
(McQuaid-Ehn Grain Size, cont'd) -

Figure 3.



X500, nital etch.

HARD-CORED PIN NO. 2.

Normal McQuaid-Ehn structure.

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Microscopic Examination:

Transverse microspecimens were cut from one soft-core and one hard-core pin. These were etched in nital and examined under the microscope. Figure 4 (X500) illustrates the core structure obtained for the soft-cored pin. This is largely composed of ferrite with some low-carbon martensite. The core structure of the hard-cored pin is shown in Figure 5 (X500). This is mainly low-carbon martensite with some ferrite.

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Reheat Treatment:

Pin No. 3, which had a core hardness of 37-38 Rockwell 'C', and Pin No. 7, with a core hardness of 15-16, were cut to $1\frac{1}{2}$ inches in length and then immersed in a neutral salt bath at 1580° F. for 5 minutes, after which they were oil-quenched. Transverse sections taken from the centre of the specimens were given a hardness test in the core. The results now were 39 Rockwell 'C' for the hard-cored pin and 31-32 Rockwell 'C' for the originally soft-cored pin. Figures 6 and 7, taken at 500 magnifications, illustrate the structure obtained for the soft-cored and hard-cored pins respectively.

Discussion:

The hardness tests carried out seemed to indicate two series of hardnesses, i.e., those below 17 Rockwell 'C' and those above 33 Rockwell 'C'. Whereas this might appear to indicate the presence of two heats of steel, the chemical analysis does not definitely establish this. It is unfortunate that several different pins had to be used to make up each soft-core sample for analysis. It is suggested that single pins known to be of the soft-core variety be analysed. This might clarify the problem of whether one or two heats of steel are represented.

The structures of the McQuaid-Ehn specimens indicate the presence of some abnormality in one of the soft-cored pins (Pin No. 4, Rockwell 'C' 9). Some parts of this pin appeared normal. Pin No. 6, which had a core hardness of 15 Rockwell 'C', showed a practically normal structure, similar to that of hard-cored Pin No. 2 (Rockwell 'C' 33-34). It is of interest that a pin having the same core hardness as Pin No. 6, when reheat-treated gave a much higher hardness. Although only $1\frac{1}{2}$-inch-sized specimens were reheat-treated, it is felt that

(Discussion, cont'd) -

if a whole pin were to be treated in the same way a substantial increase in the core hardness would result. It therefore appears that some soft-cored pins come from steel which is not totally normal. Others are from normal steel and could, in all probability, be heat-treated to meet the minimum requirement of 24 Rockwell 'C'. If a cyclograph could be set up to separate the soft-cored from the hard-cored pins, reclamation reheat treatment in neutral salt could be carried out. Since the pins are cased, neutral salt or low cyanide (5 per cent) could be used, and short time cycles are recommended in order to avoid diffusion of carbon to the core. It is felt that a large number of the pins could probably then be made to pass Specification O.A. 214.

CONCLUSIONS:

1. Two distinct sets of core hardnesses were obtained on the pins submitted.

2. Soft-cored specimens were too small to be analysed individually; consequently no definite conclusion could be made as to whether one or two heats of steel are represented by the pins.

3. A hard-cored pin had a McQuaid-Ehn grain size of 4. Two soft-cored pins had an average McQuaid-Ehn grain size of 5.

4. One soft-cored pin shows some abnormality whereas others appear to be relatively normal.

5. The core structure of the soft-cored pins is mainly ferrite. The hard cores are mainly low-carbon martensite.

6. A soft-cored pin specimen was reheat-treated to increase the core hardness to twice its former value.

7. It is felt that a number of soft-cored pins could

(Conclusions, cont'd) -

possibly be reheat-treated to meet the O.A. 214 core hardness specification.

Recommendations:

1. Attempts should be made to segregate the soft-cored pins by means of the cyclograph.

2. Known soft-cored pins should be submitted to reheat treatment experiments commercially, to check on whether O.A. 214 can be met.

3. Neutral salt or low-cyanide-concentration salt should be employed and short time cycles used to prevent excessive carbon diffusion into the core.

4. Further chemical analysis should be made to try to establish whether one or two heats of steel are represented.

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SLG:GHB.

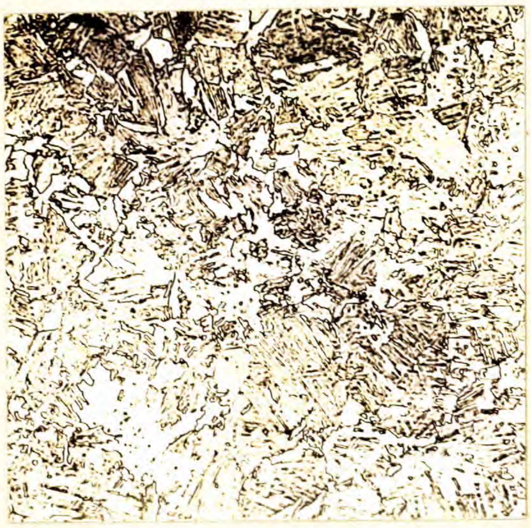
Figure 4.

X500, nital etch.

ORIGINAL SOFT-CORED PIN.
ROCKWELL 'C' 15-16.

Mainly ferrite and some low-carbon martensite.

Figure 5.



X500, nital etch.

ORIGINAL HARD-CORED PIN.
ROCKWELL 'C' 37-38.

Mainly low-carbon martensite and some ferrite.

Figure 6.

X500, nital etch.

SOFT-CORED PIN AFTER REHEAT TREATMENT.
ROCKWELL 'C' 31-32.

Low-carbon martensite and some ferrite.

Figure 7.

X500, nital etch.

HARD-CORED PIN AFTER REHEAT TREATMENT.
ROCKWELL 'C' 39.

Mainly low-carbon martensite and a small amount of ferrite.

SLG:GHB.