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ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1574.

Investigation of SAE 9255 Bar Stock for Decarburization.

(Copy No. 12.)

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Abstract

Samples from 15 pieces of bar stock for use in the Canadian Dry Pin were examined for decarburization. Two were found to be decarburized, hardness tests and microscopic examination after a definite heat treatment being used to reveal surface condition. It was pointed out that this decarburization, especially for a manufacturer heat-treating in neutral salt, was at the best a disadvantage and at the worst a severe defect. A constant check on bar stock production was recommended.

Origin of Material and Object of Investigation:

On December 23rd, 1943, fifteen (15) pieces of SAE 9255 bar stock used for the Canadian Dry Pin were received for examination. At the same time, Dr. C. W. Drury, Director of Metallurgy, Army Engineering Design Branch, Department of Munitions and Supply, Toronto, Ontario, submitted a covering requisition, No. 756, AEDB Lot No. 851, Report 22-C, Test 13, which requested that the depth of the decarburization be determined for each

(Origin of Material and Object of Investigation, cont'd) -

piece, with the object of checking on the efficiency of the centreless-grinding operation. Unfortunately, no heat numbers were given for the various pins submitted; consequently it was not possible to tie up the findings with any particular time of manufacturing operation.

General:

Depth of decarburization can be determined in three main ways:

(a) Hardness test.
(b) Photomicrographic.
(c) Analysis of consecutive cuts.

In this investigation, (a) and (b) have been used. Method (c) is the most accurate but requires considerable time for a large number of samples. It was felt that results obtained from the first two methods of examination would be sufficiently accurate for the purpose involved.

Hardness Tests:

Transverse sections were cut from all of the fifteen pieces and hardness readings were taken across the face of each section, using the Vickers machine and the 10-kilogram load. Table I gives the results obtained at definite distances from the surface. These are obtained from charts such as shown in Figure 1 which gives the curves obtained for the pieces numbered 4, 7, and 9.

(Table I and Figure 1
(both appear on Page 3.)

(Hardness Tests, cont'd) -

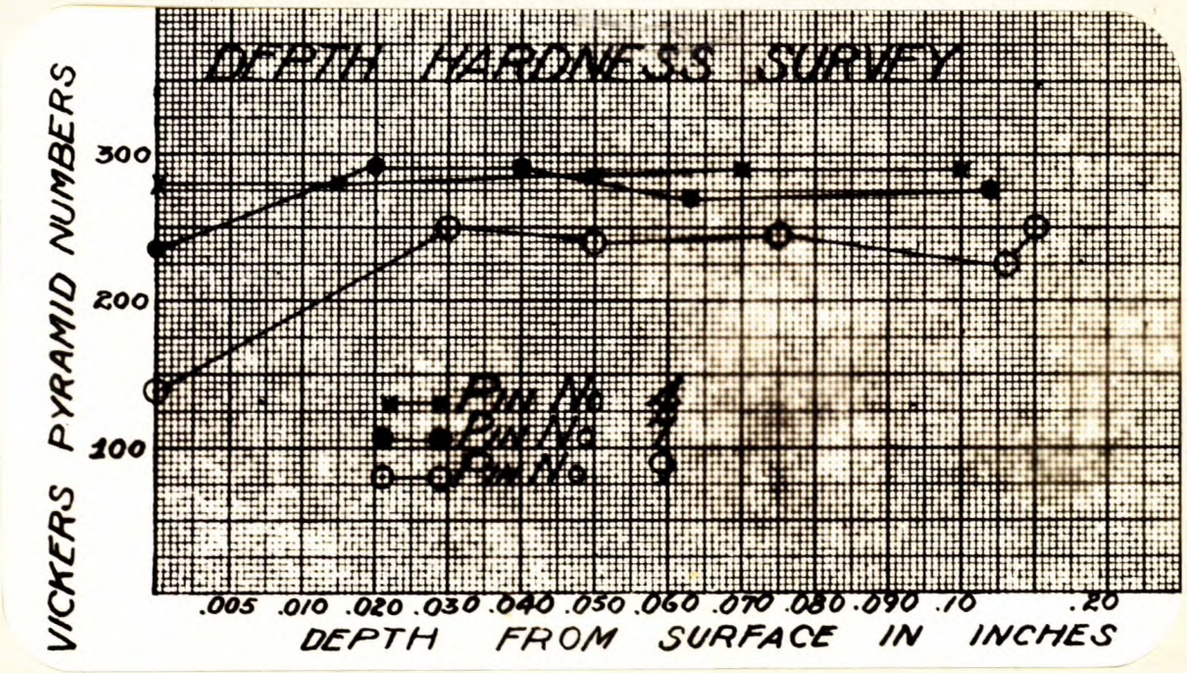
TABLE I.

Vickers Hardness Numbers, 10-kg. Load.

Sample No.	At the surface	At depths, in inches, from the surface					
		0.005	0.010	0.025	0.050	0.075	0.10
1	276	274	272	272	276	272	270
2	270	270	270	269	273	272	270
3	289	284	280	275	273	272	270
4	279	278	278	281	287	287	287
5	306	285	264	245	251	256	255
6	270	270	270	268	268	266	266
7*	236	251	270	283	280	270	275
8	281	280	280	282	268	260	252
9*	142	168	195	237	241	245	230
10	304	298	292	288	282	270	258
11	292	284	276	264	256	252	252
12	240	240	240	242	250	256	247
13	262	255	247	235	235	235	228
14	287	283	275	266	265	265	265
15	262	255	248	237	237	241	245

* Samples Nos. 7 and 9 are decarburized at the surface.

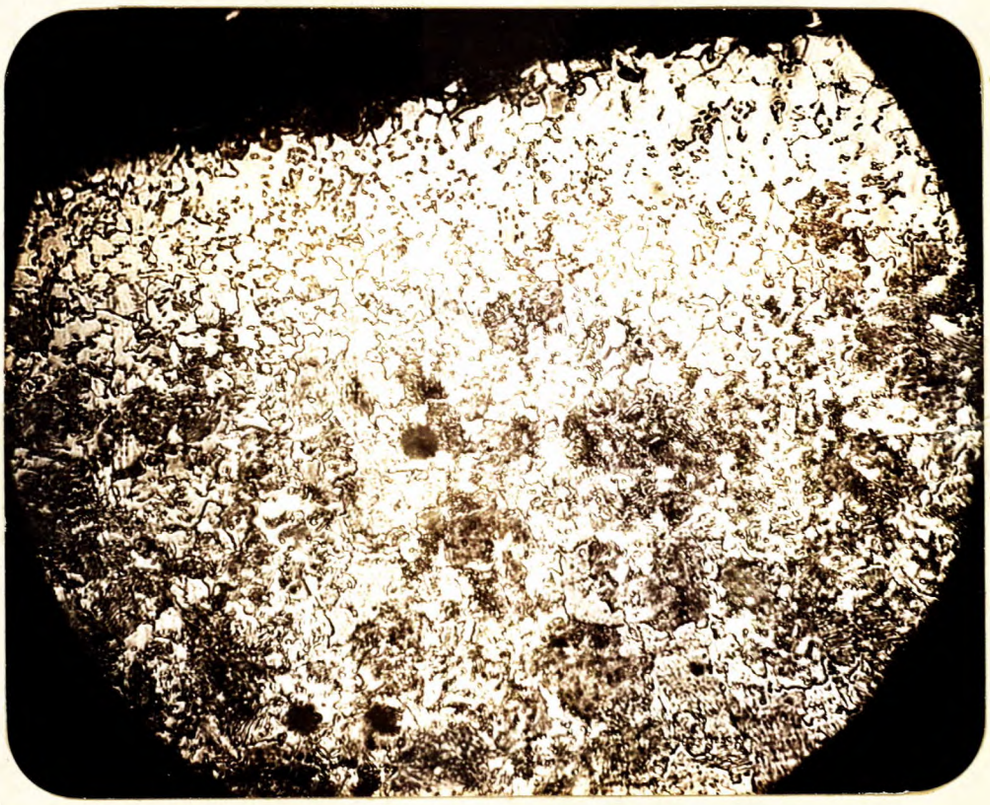
Figure 1.



Microscopic Examination:

Pins Nos. 7 and 9 were examined microscopically for decarburization. A transverse section was cut from each pin and heated in lead for five minutes at 1575° F., then cooled in the lead pot for ½ hour to 1200° F. This was done to facilitate visual examination of the decarburized zone, difficult to perceive in a sphercidized structure. The specimens were polished and etched in 2 per cent nital. Figures 2 and 3, taken at X500 at the surface of pins numbered 7 and 9 respectively, indicate the presence of 0.003-inch decarburization in both specimens.

Figure 2.



X500, nital etch.

PIN NO. 7.

(Microscopic Examination, cont'd) -

Figure 3.

X500, nital etch.

PIN NO. 9.

Discussion:

The use of hardness testing by itself as an estimation for depth of decarburization is not very accurate. This is especially true where the decarburization is only a few thousandths of an inch. Using the Vickers machine and a 10-kg. load, not enough impressions can be made close to the surface to give a true picture, e.g., Pin No. 9 in Figure 1 appears to be decarburized 0.030 inch. In this report the hardness surveys were made in order to find qualitatively which pins appeared to be decarburized. The photomicrographs indicate that Pins Nos. 7 and 9 are decarburized to about the same maximum depth. However, decarburization was more uniform in

(Discussion, cont'd) -

Sample No. 9.

Microscopic examination of the surface, however, showed that whereas in Pin No. 9 the decarburization was fairly uniform around the whole diameter this was not the case for Pin No. 7. The decarburization was spotty for this pin, the photomicrograph representing the maximum observed.

The presence of decarburization in the bar stock after centreless grinding would make it difficult for the heat-treating manufacturer to meet the pin hardness requirements for surface and core, if neutral salt were being used to heat the pins to the quenching temperature. A producer using a controlled-atmosphere furnace, however, could make adjustments to bring back the carbon content at the surface to approximately that at the core of the pins. The pins would then have relatively uniform hardness throughout after the quenching operation. This would not hold for the neutral salt type of production.

Heats should be kept separate and constant checks made for decarburization. This, for the neutral salt producer, would avoid the expense of heat treating before discovering the impossibility of obtaining the surface and core hardnesses specified.

CONCLUSIONS:

1. Use of the Vickers machine with a 10-kg. load will not give results sufficiently accurate for quantitative estimation of shallow decarburized layers.

2. Visual examination under the microscope indicates 0.003-inch decarburization uniformly around the circumference

(Conclusions, cont'd) -

of Pin No. 9 and an 0.003-inch maximum for Pin No. 7.

3. Decarburization will cause difficulty in meeting surface and core hardness requirements, for a manufacturer using neutral salt as a heat treating medium.

Recommendation:

Heats of steel should be kept separate and checked for efficiency of the centreless-grinding operation periodically.

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