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R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1273.

Investigation of Decarburized and Recarburized Homogeneous SAE 9255 Universal Carrier Track Pins.

(Copy No. 27.)

BUREAU OF MINES
DIVISION OF METALLIC MINERALS

ORE DRESSING AND
METALLURGICAL LABORATORIES

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

OTTAWA July 27th, 1942.

REPORT

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Investigation of Decarburized and Recarburized Homogeneous SAE 9255 Universal Carrier Track Pins.

Origin of Material and Object of Investigation:

A previous investigation (No. 1251, June 1942) carried out in these laboratories gave favourable results for homogeneously hardened SAE 9255 Universal carrier pins. Since rolled bar stock usually has a decarburized surface, it is necessary to eliminate this prior to homogeneous hardening. In the present report the effect of decarburizing and recarburizing SAE 9255 steel is examined. The bar stock was received from Ontario Steel Products Limited, Gananogue, Ontario, on June 27th, 1942.

Chemical Analysis:

		- Per Cent -	
		As Found	Specification SAE 9255
Carbon	-	0.57	0.50-0.60
Manganese	-	0.78	0.60-0.90
Silicon	-	2.36	1.80-2.20
Phosphorus	-	0.016	0.040 max.
Sulphur	-	0.023	0.050 max.

Heat Treatment:

The 0.500 inch bars were cut to 10-inch lengths and machined to 0.437-0.432 inch.

Decarburization:

Decarburization of some bars was effected by an ordinary furnace anneal.

Recarburization:

A few of the decarburized bars were recarburized by treating in a Vapocarb furnace using a carburizing atmosphere. They were quenched from 1525° F. in oil at 110° F. and drawn at 750° F. for 40 minutes.

Hardening:

The decarburized and neutral (bars which have only been machined) pins were then subjected to a homogeneous hardening treatment by heating in a neutral atmosphere in the Vapocarb furnace. They were held for 30 minutes at 1525° F., then quenched in oil at 110° F. and drawn at 750° F. for 40 minutes.

All pins were between 48-52 Rockwell "C" hardness. These values were obtained about 1/16 inch below the surface.

In this report a "neutral" pin is one which has been ground to size and homogeneously hardened in a neutral atmosphere.

Drop Impact Tests:

Drop impact tests were carried out on the pins, both at room temperature and at minus 50° F. The machine used is illustrated in a previous report.[*] At the low temperature the pins were kept in a bath of acetone and dry ice for ½ hour prior to testing. A five-kilogram weight was dropped from successive height intervals of 25 cm. each, until the final height of 300 cm. was reached. Table I lists the angles of bend obtained after each drop of the weight for the three types of pins prepared, namely, neutral, decarburized, and recarburized.

(See Table I, on Page 4)

Bend Tests:

Bend tests were carried out on a similar series of pins. The Amsler Universal testing machine was employed, using a 12-inch radius and 8-inch centres. Charts of increment vs. load were plotted. The elastic limit, permanent bend, and break point were then determined from these charts.

Table II records the results obtained.

(Table II is on Page 5)

Hardness Tests:

Transverse microsections were cut from the pins and hardness tests were taken using the Vickers hardness machine with a 10-kilogram load. Figure 1, on page 6, shows the curves obtained for each of the different types of pins tested.

(Continued on Page 6)

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[*] Report of Investigation No. 1197, April 1942.

Table I.

DROP IMPACT TESTS ON SAE 9255 STEEL PINS.

Temperature	ROOM TEMPERATURE				MINUS 50° F.		
Height of drop, cm. (5-kg. weight)	Neutral	Decarb.	Recarb.	Recarb.	Decarb.	Recarb.	Neutral
Hardness, Rockwell 'C'	51	52	48	50.5	52.5	51.5	52
25	0	0	½	½	1	½	0
50	0	1	1	1¼	1	1	½
75	½	2	1½	2	1¼	1¼	1
100	1	2¼	2½	2½	2	2	2
125	2½	3	3½	3	2¼	2½	3
150	3½	3½	4	5	4	4	4
175	6	5	6	7	6	6	6
200	8	7½	9½	10	8	7	7½
225	10	10	10	10½	9½	9	9
250	10½	10½	13	11	10	9½	10
275	11	11	13½	12½	10½	10	11
300	11	11	14	13	11	11½	12

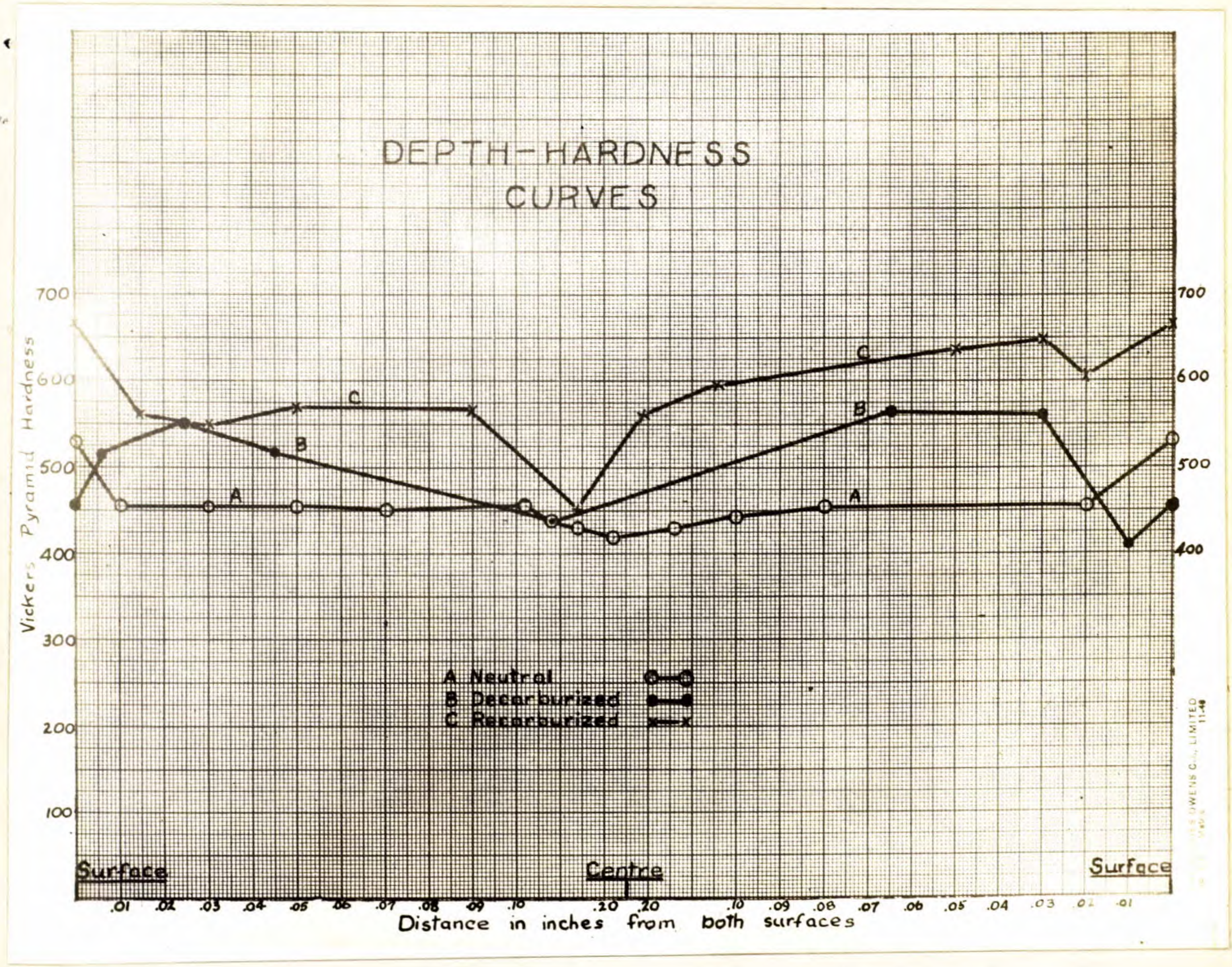
Table II.

BEND TESTS ON SAE 9255 HOMOGENEOUSLY HARDENED TRACK PINS FOR UNIVERSAL CARRIERS.

Heat Treatment	Neutral		Decarburized		Recarburized	
PHYSICAL PROPERTY	Angle	Load, in pounds	Angle	Load, in pounds	Angle	Load, in pounds
Elastic Limit	8°25'	2040	4°	1380	6°28'	1815
Permanent Bend	9°32'	2155	6°21'	1805	7°32'	2115
Break Point (appearance of first crack on case)	11°9'	2200	16°28'	2550	9°53'	2250
Surface Hardness (Rockwell 'C')	52		46		51	

(Hardness Tests, cont'd) -

Figure 1.



Microscopic Examination:

Transverse microsections were cut from the pins and examined under the microscope after being polished and nital-etched. Figure 2, at X1000 magnification, shows the quenched and drawn structure of the neutral pins. Figures 3 and 4, at X1000 magnification, are taken near the surfaces of the pins. Figure 3 illustrates the decarburized structure after the furnace anneal. Figure 4 shows the effect of the elimination of the decarburized area by treating in the carburizing atmosphere--this is the recarburized pin.

Discussion:

The chemical analysis shows that the steel conforms to Specification SAE 9255 with the exception of 0.16 per cent silicon, which is above the upper limit. This extra silicon has not had any noticeable effect upon the results. It is felt, however, that if a heat of steel is obtained which has silicon close to the lower limit, a slight change in hardenability will be observed.

The drop impact tests show that all the pins will withstand 97.5 Kg/m. of impact work without breaking. The recarburized and neutral pins react in a similar way under sudden shock.

The bend test results also show very little difference in the behaviour of the neutral and the recarburized pins. The decarburized pin is more ductile. This is mostly due to the low hardness, namely, Rockwell 'C' 46.

From the drop and bend test results it can be seen that carburizing, in order to eliminate decarburization at the surface, would not have any serious deleterious effects on the pins.

The depth-hardness curves indicate a wide variation in the normal hardness between the three types of pins examined. It is felt that this has been caused by the uneven temperatures obtained in the ordinary draw furnace. A circulated furnace atmosphere would give a more accurate control over the temperature and, consequently, a narrower hardness range would be obtained. At present we are not equipped for this type of work but a furnace is now being installed in which uniform draw conditions can be maintained.

Recarburizing the pins increases the hardness at the surface. This is beneficial from the point of view of

(Discussion, cont'd) -

wear resistance. Since no harmful effects have been produced by this surface skin, it would appear that carburizing in order to eliminate decarburization should be employed in place of centreless grinding.

The photomicrographs in Figures 3 and 4 show that decarburization by the ordinary furnace anneal was great and also that elimination of this by heating in a slightly carburizing atmosphere in the Vapocarb furnace has been satisfactory.

Conclusions:

1. The steel conforms to SAE 9255 with the exception of 0.16 per cent silicon. This has not produced any ill effect on the results.

2. Pins that were purposely heavily decarburized can be satisfactorily recarburized.

3. Recarburized pins react approximately the same to a sudden shock as do machined pins.

4. Recarburized pins give approximately the same results as the machined pins under a bend test.

5. Circulation of furnace atmosphere should be exercised in order to obtain a controlled draw temperature.

6. Carburizing to eliminate decarburization puts a hard skin on the pin. This is a good thing, since increasing the surface hardness should be beneficial for wear resistance.

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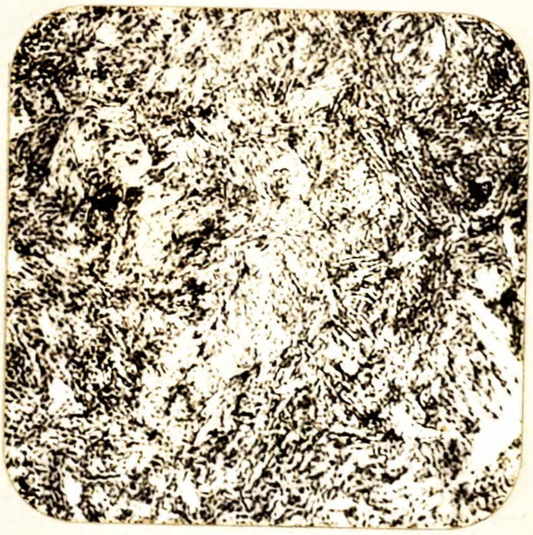
SLG:PES.

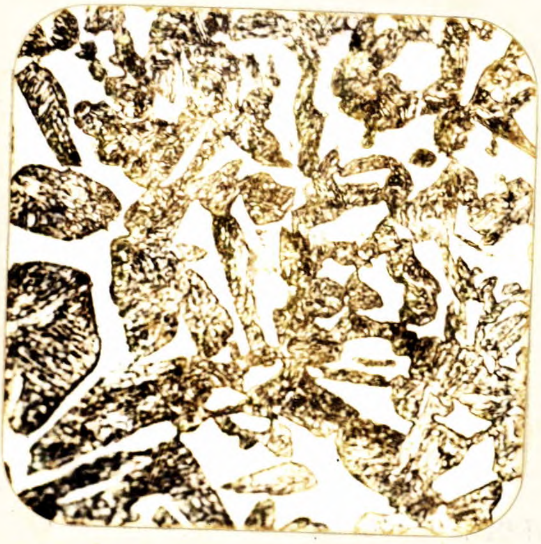
Figure 2.



X1000, nital etch.

"NEUTRAL" PIN.

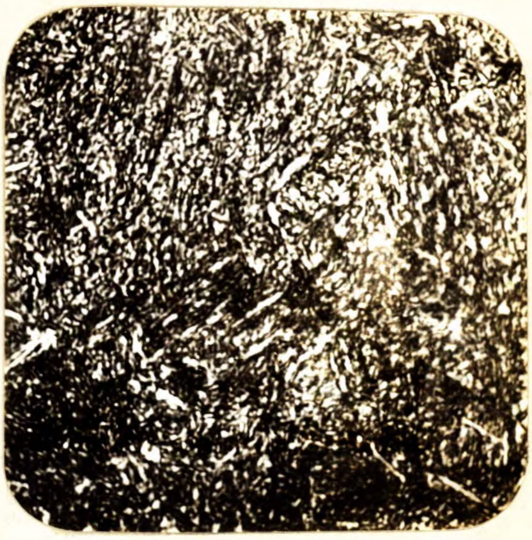
Figure 3.



X1000, nital etch.

DECARBURIZED PIN.

Figure 4.



X1000, nital etch.

RECARBURIZED PIN.

SLG:GHB.