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O T T A W A June 14th, 1943.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1429.

Examination of Ram Tank Track Rubbing Plates and Rubbing Pads.

(Copy No. 10 .)

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 Samples:

On May 26th, 1943, Dr. C. W. Drury, Director of Metallurgy, Army Engineering Design Branch, Department of Munitions and Supply, Toronto, Ontario, submitted for examination (Requisition No. 465, AEDB Lots Nos. 607, 608, 609, and 610; Report 13, Test 36) a worn and a new rubbing plate, both made to Drawing No. 187124, and a worn and a new rubbing pad, made to Drawing No. 164236. The drawings of the plates and pads also were received.

Object of Study:

Request was made for the following:

1. Surface hardness and core hardness of the rubbing plates and pads to see if they conform to specifications on the drawings.

2. Suggestions for improving the plates and pads.

3. Comments on whether or not the present method of manufacture is considered satisfactory for the production of plates and pads to resist the wear to which they are subjected.

4. Comparison of the properties of the new and worn parts.

Chemical Analysis:

After annealing the samples, the cases were ground off and drillings for chemical analysis taken. Results were:

	Worn Plate	Worn Pad	New Plate	New Pad
	(Per cent)			
Carbon =	0.35	0.38	0.41	0.38
Manganese =	0.74	0.71	0.76	0.72
Silicon =	0.23	0.32	0.32	0.30
Sulphur =	0.010	0.010	0.010	0.011
Phosphorus =	0.039	0.024	0.024	0.027
Nickel =	1.78	1.79	1.79	1.77
Chromium =	0.70	0.74	0.74	0.73
Molybdenum =	0.25	0.30	0.28	0.30

Physical Examination:

After very lightly polishing the surfaces of the four parts (in places that had not been worn) with emery paper, the following surface hardness reading were obtained:

(Continued on next page)

(Physical Examination, cont'd) -

	Vickers Hardness Number, 10-Kilogram Load	Rockwell Hardness, 'C' Scale
New Plate -	525-542	62.5-66
New Pad -	620-642	63 -65.5
Worn Plate -	272-281	24.5-29
Worn Pad -	606	55 -55

Cross-sections from the new plate and pad were polished and tested for hardness. The hardness values found were as follows:

	Vickers Hardness Number, 10-Kilogram Load
New Plate	
Case -	772-792
Core -	620-657
New Pad	
Case -	752-772
Core -	585-613

Following the same procedure with cross-sections from unworn portions of the used plate and pad, it was found that the cases were too thin to permit a hardness test on their c ss-section, while the cores were as follows:

	Vickers Hardness Number, 10-Kilogram Load
Worn Rubbing Plate -	264-297
Worn Rubbing Pad -	572-599

Microstructure:

Specimens taken from unworn sections of the samples were mounted in steel clamps, polished, and etched in 2 per cent nital. Figures 1 to 4 are photomicrographs, at 1000 diameters, of the case and core of the worn plate and pad. The white fringe at the edge of Figure 1 is probably

nitrides. The white at the outer edge of the worn pad (Figure 3) may be either retained austenite, white martensite, or nitrides.

Figure 4, the core of the worn pad, is typical of the core and case of the new plate and pad, with the exception of their outer edge. The outer edge of the new pad, shown unetched in Figure 5, has material outlining the grains and in globular form at its surface. The same condition was found in the new plate. The surfaces of these new parts have no white constituent such as that shown in Figures 1 and 3.

Since case-depth determinations on the samples as received was difficult, pieces from unworn parts of each of the samples were annealed in lead. After this, the case depths from the carbon gradient point of view (i.e., excluding nitriding) seemed to be approximately as follows:

	Case depth, in inches
New Plate -	0.022
New Pad -	0.020
Worn Plate -	No definite indication of carbon gradient.
Worn Pad -	0.008

Discussion of Results:

All parts were made from SAE 4340 steel.

Since some polishing is necessary before satisfactory Vickers hardness readings can be taken, the surface hardness value reported for the worn plate, in view of its very thin surface constituent, is not accurate. The white constituent at the surface of this sample may indicate that it was nitrided, but at any rate the core was too soft and the case too thin to make the part wear well. The properties of the worn pad, which was not nearly so severely deformed, were much better.

The new plate and pad have cases and cores of the

(Discussion of Results, cont'd) -

requisite hardness. The softness of their extreme surfaces as compared with the interior of their cases is probably explained by the foreign material at these surfaces, since the reaction which caused it may have slightly lowered the hardenability of that area. This condition, which is sometimes very difficult to avoid in carburizing*, apparently does not extent inward from the surface more than 0.002 inch (Figure 5) and so is of very little practical importance. Case depth is certainly not as deep as the 0.030 to 0.040 inch specified on the drawing but, considering the hardness of the core, this is not thought to be important.

CONCLUSIONS:

The new plate and the pad seem to have very satisfactory properties for wear resistance and are, especially in the case of the rubbing plates, great improvements over those formerly made.

It is understood that the specification now provides for a flame-hardening of the parts. This practice would result in the production of a cased zone thicker than in the parts under examination. In view of the high hardness of the core, however, it is not likely that the change in practice will lead to much improvement in wearing properties.

The only possibility of improvement of wear in these parts would appear to be in the use of a different type of material and comparative service tests might well be in order. It is thought that higher carbon material might wear better and that the high carbon, graphitic type steels might be worthy of trial.

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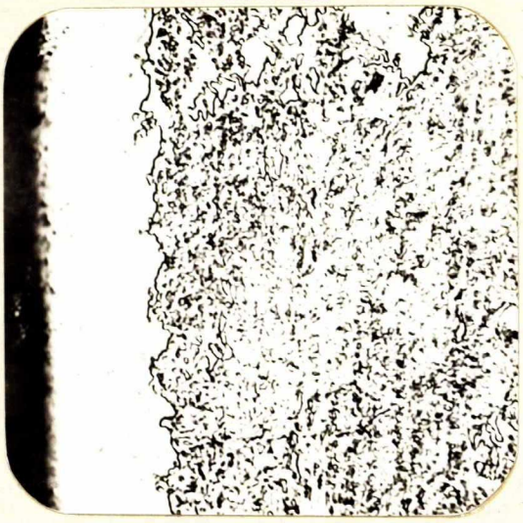
* Supposed Graphite in Carburized NE and SAE Steels, by John Welchner and Roy W. Roush, in METAL PROGRESS, June, 1943.

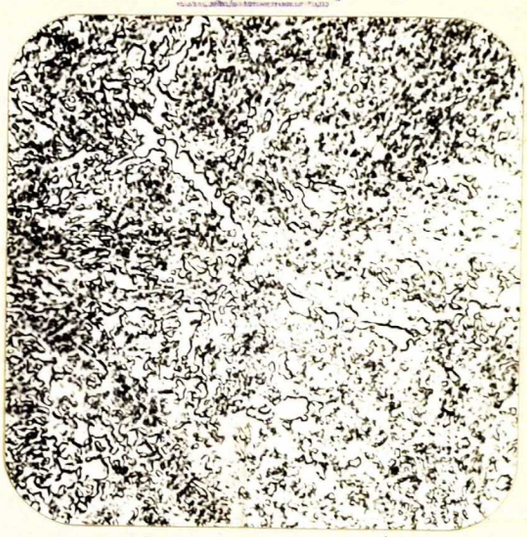
Figure 1.



X1000, nital etch.

EDGE OF WORN PLATE.

Figure 2.



X1000, nital etch.

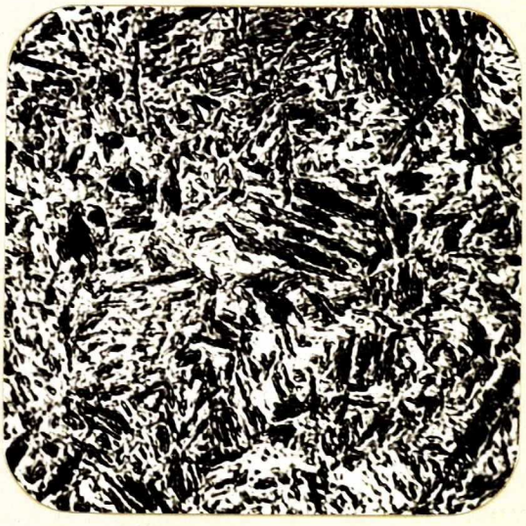
CORE OF WORN PLATE.

Figure 3.

X1000, nital etch.

EDGE OF WORN PAD.

Figure 3.



X1000, nital etch.

CORE OF WORN PAD.

Figure 5.

X1000, unetched.
EDGE OF NEW PAD.

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