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O T T A W A November 5th, 1940.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 911.

Report on Track Links from the International Harvester Company Limited, Hamilton, Ontario.

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 Material:

Tests were made on five Universal Machine Gun Carrier track links sent by the International Harvester Company Limited, Hamilton, Ontario, and coming from the first trial heat in the new furnace in their Malleable Foundry. These links were received here on October 25th, 1940.

Results:

The five track links were submitted to bend tests (bending between 8-inch centres) and hardness tests (Vickers method). The results were as follows:

Link No.	Maximum load, lb.	BEND, IN DEGREES At 6,000 lb.	BEND, IN DEGREES At 10,000 lb.	BEND, IN DEGREES On broken parts.	Core hardness, (30-kg. load), Vickers.	Surface hardness, (5-kg. load), Vickers.
1 (As received).	8,200	2.8		8.5	170-200	170
2 (cyanided).	10,800	0.3	1.8	3.0	295	524
3 (cyanided).	10,800	0.2	1.8	4.0	...	524
4 (cyanided).	11,000	0.3	1.9	3.5	...	508
5 (cyanided).	11,500	0.3	2.0	5.5	242	502

Notes:

1. Link No. 1 was tested as received, without any further treatment.

2. Links Nos. 2, 3, 4, and 5 were treated as follows:

   (a) 50 minutes total time (i.e., 30 minutes after bath temperature has been attained) in 50 per cent cyanide bath at 1750° F.
   (b) Slow cooling in air.
   (c) Heating 30 minutes in cyanide at 1425° F. and quenching in oil.
   (d) Drawing for one hour at 350° F.

3. Inspection of Links Nos. 1, 2 and 3 revealed cracks in the castings near the central portion of the main bearing, as shown in Figure 1.

(Continued on next page)

(Notes on Results, cont'd) -

4. Links Nos. 1 and 2 had large shrinkage cavities at that same point, as can also be seen in Figure 1.

Chemical Analysis:

A sample taken from one of the castings analysed as follows:

Carbon	-	2.15 per cent
Manganese	-	0.60 "
Silicon	-	0.81 "
Sulphur	-	0.058 "
Phosphorus	-	0.142 "

Decarburization:

The photomicrograph (Figure 2) illustrates the degree of decarburization on a section of Link No. 1 as received. On the right hand side is shown the small amount of scale and the whiter ferrite area which lies on a grey zone of pearlite surrounding a few dark temper carbon particles.

The decarburization is as follows:

Zone.	
0 to 0.01 inch:	good decarburized zone.
0.01 to 0.02 inch:	partly decarburized zone.
0.02 to 0.04 inch:	pearlitic zone, very slight decarburization.
0.04 to centre of core:	pearlitic structure surrounding temper carbon particles.

Discussion and Conclusions:

The castings show some cracks and shrinkage holes due to strains set up by the large variation in the cooling speed at different portions of the link in the mould. This is chiefly caused by lack of adequate precaution in the method of gating. As was noticed on links previously submitted to us for examination, gating on the central portion of the link had a tendency to minimize this detrimental effect.

Link No. 5 passed the bend and hardness tests; Links Nos. 2, 3, and 4 are just on the margin. In these latter, the core hardness is too high and should be down to approximately 200 Vickers. The poor results obtained on the bend tests are an indication of insufficient decarburization, due either to too short a time in the furnace or to improper rate of flow and composition® of the decarburizing gases. The structure of the core of the links submitted to us was compared with that of links treated previously in a slow stream of carbon dioxide. The former had a pearlitic background to the temper carbon particles whilst the latter revealed a bull's-eye structure. This particular structure would likely be favoured by a rather fast heating at the start of the cycle followed by a moderately slow cooling at the end of the cycle.

Experiments were conducted on a low manganese

® According to Becker, Journal I. and S., I, 1930 -- I, p. 354, a ratio of $\frac{CO_2}{CO}$ from approximately 0.02 to 0.42 would constitute at equilibrium a decarburizing atmosphere without any danger of oxidizing.

(Discussion and Conclusions, cont'd) -

(0.30 per cent), low silicon (0.59 per cent), low sulphur (0.057 per cent) iron, in which the manganese was in atomic excess over the sulphur, and good results were obtained on an experimental scale even after only 36 hours' exposure to a slow carbon dioxide stream at 1680° F. followed by slow cooling ($\frac{1}{2}$° to 1° per minute). The break occurred under a load of 13,800 pounds with a 9$\frac{1}{2}$° bend on the cyanided link. The core hardnesses varied from 187 to 224 while the case was at approximately 500 Vickers. Although a larger atomic excess of manganese over sulphur promotes the speed of decarburization, there is a higher limit to the permissible amount of manganese; otherwise the manganese content has a tendency to lower the critical range of the core and widen the hardening range--thus giving rise to serious difficulties in the case-hardening treatment. (Cf. Report No. 889, on "Investigational Work on Universal Machine Gun Carrier Malleable Iron Track Links", (page 17), August 29th, 1940.)

On highly decarburized castings, such as those obtained through the use of a solid oxidizing medium (true whiteheart malleable), this higher limit would be approximately 0.50 to 0.70 per cent. However, in the case of slightly decarburized castings such as those under study at present, this higher limit would be reduced to lower value, otherwise hardening of the core would

(Discussion and Conclusions, cont'd) -

likely take place during the case-hardening treatment, with a consequent embrittlement. For this same reason, the silicon content should be as low as is conveniently possible.

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RP:PES.

Figure 1.

(Approximately X 1).
Fracture showing cracks and shrinkage cavities.

Figure 2.

(X 100)

Section showing decarburized area.

RP:PES.