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EXAMINATION OF TWO DEFECTIVE MANGANESE STEEL CASTINGS

by

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PHYSICAL METALLURGY DIVISION

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SUMMARY

The trouble encountered with the two manganese steel castings was less than normal wear life and cracking. The poor wear life could be explained by lower than normal manganese contents and insufficient shock impact service to fully work-harden the castings. Cracking was due to the presence of grain boundary carbides, found in both samples.

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INTRODUCTION

On August 6, 1958, two pieces of manganese steel mantles, numbered 1 and 2, were received at the Physical Metallurgy Division. The covering letter from Mr. R. Desilets, Chief Metallurgist, Sorel Steel Foundries Ltd., dated July 2, 1958, stated that the specimen marked "1" was returned by their customer because of rapid wear and also the development of nine vertical cracks. It was requested that the cause of this failure be determined. It was also stated in the letter that it was realised that the composition was not correct and this could explain the rapid wear.

The sample marked "2" was returned for the same reasons as "1". Cracking was confined, however, to about one-third of the whole surface.

CHEMICAL ANALYSES

Drillings were obtained from both samples for chemical analyses. These results, as well as those supplied by Sorel Steel Foundries Ltd., are listed below in Table 1.

TABLE 1

Analyses of the Two Samples

Element	Sample "1" (%)		Sample "2" (%)	
	Mines Branch	Sorel	Mines Branch	Sorel
C	1.07	1.04	1.23	1.08
Mn	10.83	9.8	11.50	
Si	0.59	0.60	0.87	
S	0.011		0.011	
P	0.040		0.065	
Cr	0.60		0.32	

HARDNESS TESTS

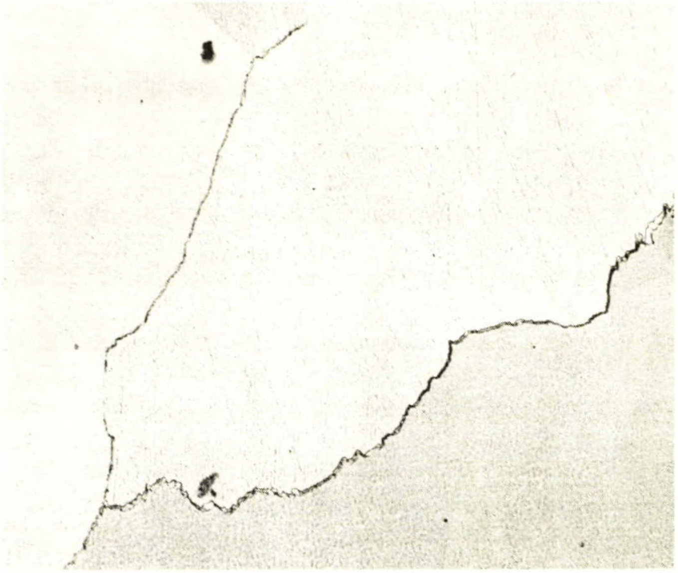
Micro hardness surveys were made on suitably prepared specimens from each sample, using a Tukon hardness tester equipped with a Knoop indenter under a 1000 g. load. These surveys showed that neither piece had been fully work-hardened in service. The worked surface of sample #1 was Rockwell 'C' 42, while that of sample #2 was Rockwell 'C' 39. These were converted from the Tukon hardness readings obtained.

METALLOGRAPHIC EXAMINATION

Examination of suitably prepared specimens under a microscope showed that sample #1 had a reasonably fine grain size (Figure 1), but, when viewed at higher magnification, numerous areas were found where a continuous film of fine grain boundary carbide could be resolved (Figure 2). Sample #2 was found to be quite coarse-grained and contained a heavier grain boundary carbide precipitate, as well as small isolated islands of carbide within the grains but near the grain boundaries. Figure 3 illustrates these last remarks.

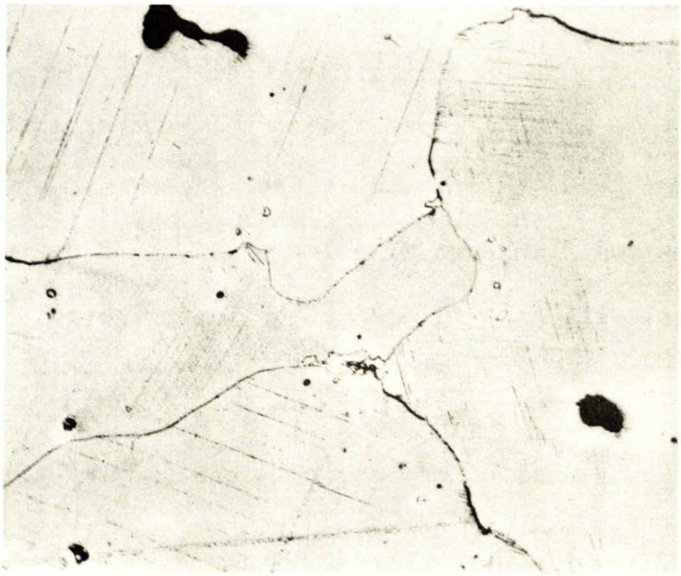
Mag. X100 Etched in 6% nital

Figure 1. - Microstructure of sample #1 showing relatively small grain size.



Mag. X500 Etched in 6% nital

Figure 2. - Higher magnification view of sample #1, showing presence of fine continuous film of grain boundary carbide.



Mag. X100 Etched in 6% nital

Figure 3. - Photomicrograph of field in sample #2, showing relatively large grain size, grain boundary carbides, and small isolated islands of carbides in the grains.

DISCUSSION

The correlation between the Mines Branch analyses and those supplied by Sorel Steel Foundries is not good for either the manganese content in sample #1 or the carbon content in sample #2. However, the properties of both samples, although within specification limits, could be improved by higher manganese contents. Chromium additions of the order of 1½% may also prove beneficial in increasing the wear life.

Other than analysis, there is one other reason for rapid wear life. This is the fact that neither sample had received sufficient shock impact service to become fully work-hardened. The reason for this is not known, but may be due to the type of ore being processed.

The cracking found in both castings is most probably due to the presence of grain boundary carbides. The brittle nature of the carbides could allow for the rapid initiation and propagation of cracks. The only remedy for this is a proper heat treatment. Either a higher austenitizing temperature or a longer soak at the temperature will have to be used. If chromium additions are also increased, then suitable changes in heat treatment will have to be further investigated.

CONCLUSIONS

(1) Rapid wear was due to unsatisfactory compositions and insufficient shock impact service to fully work-harden the castings.

(2) Cracking was due to the presence of grain boundary carbides.

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