O T T A W A February 10th, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1158.

Examination of Cracked Manganese Steel
Tractor Pad Casting.

(Copy No. 6 .)

BUREAU OF MINES
DIVISION OF METALLIC MINERALS

ORE DRESSING AND
METALLURGICAL LABORATORIES

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

O T T A W A February 10th, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1158.

Examination of Cracked Manganese Steel
Tractor Pad Casting.

Origin of Material and Object of Investigation:

On January 30th, 1942, a piece of a tractor pad casting showing cracks was received from Mr. W. S. White, Superintendent, Sorel Steel Foundries Limited, Sorel, Quebec. A chemical analysis and investigation to determine, if possible, the cause of the cracks was requested.

Macro-Examination:

Figure 1 is a picture of the cracked piece, showing the location of the cracks. Note that these cracks are in the ribs, in the neighbourhood of the heavier mass of metal at the end.

Chemical Analysis:

Chemical analysis showed that the metal was not carbon steel but manganese steel.

The analysis is given below and compared with A.S.T.M. Specification A 128-33 for Manganese Steel:

	Sorel Casting, per cent	A.S.T.M. Spec. A 128-33, per cent
Carbon	0.90	1.0 - 1.4
Manganese	11.08	10.0 Min.
Silicon	0.92	---
Phosphorus	0.065	0.10 Max.
Sulphur	0.006	0.05 Max.

Physical Examination:

Vickers hardness values were obtained. The average Vickers hardness value was 188, which corresponds to a Brinell value of 187.

In the immediate vicinity of the very wide cracks this hardness went up to as high as 397.

Micro-Examination:

Figure 2 is a photomicrograph at 200 diameters, etched in picral, showing the general structure of the metal and also a small crack occurring on a grain boundary. This particular view is from a location at the base of one of the ribs.

Figure 3 is a photomicrograph at 200 diameters, etched in picral, showing the condition of the metal in the vicinity of the very wide cracks. Note that the austenite has started to decompose.

-

Discussion:

Chemical analysis indicates that the carbon may be on the low side. However, if reference is made to Metals Handbook, 1939 edition, page 567, figure 1, it will be evident that this analysis falls within the normal austenitic range. This should not therefore be a source of trouble.

Physical testing indicates that the hardness is correct. This, coupled with microscopic examination, indicates that the quenching temperature and the soaking period are correct. Note the austenitic structure in Figure 2.

The fact that the metal in the immediate vicinity of the large cracks is much harder and there is evidence of decomposition of the austenite would indicate that the cracks reached their present state during quenching. This assumption would not be valid if this casting had been in service.

The small crack shown in Figure 2 may be an example of how these cracks originate. These small cracks have two possible sources of origin: either in the casting process or in the heating prior to quenching.

The design is one that might be expected to be subject to high casting stresses where these cracks occurred. Since this metal is very brittle in the "as cast" condition, it would tend to be sensitive to stresses caused by this type of design.

If the hot strength of the moulding sand were too high, this would also favour the creation of excessive casting stresses.

If the casting were placed in a hot furnace, or heated very quickly to the quenching temperature, internal stresses would be induced. The metal in the interior would be subjected to tensile stresses. This condition could result in small intergranular cracks such as those shown

(Discussion, cont'd) -

in Figure 2.

It is also possible that the method of introduction into the quenching bath may have some bearing on this condition. It is advisable, whenever possible, to quench flat castings edgewise. This will minimize quenching strains.

Conclusions:

1. Furnace practice, as indicated by chemical analysis and cleanliness of metal, is good.

2. The visible cracks developed to their present condition during quenching.

Recommendations:

1. The rate of heating in the heat-treatment furnace should be investigated. Too fast heating may be the source of trouble.

2. The design of the casting should be investigated, with a view to the possibility of making metal sections more uniform.

3. The possibility of minimizing casting stresses by means of gating or the use of chills should be investigated.

4. The hot strength of the moulding sand should be determined. If too high, this could cause trouble.

5. The method of quenching (flat or on edge) should be noted. Edgewise quenching, where possible, is recommended.

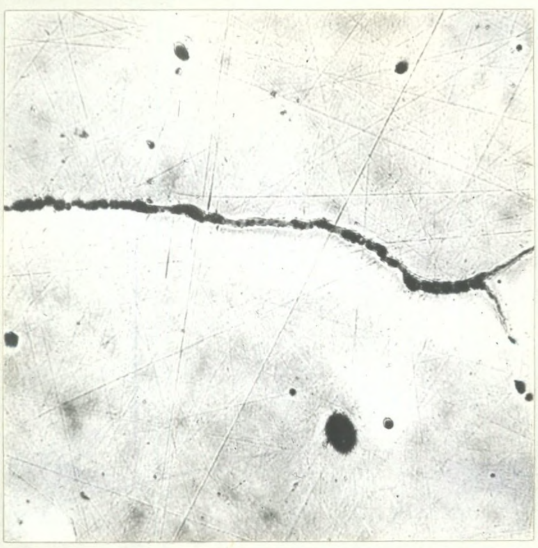
ooooooooooooooo
oooooooo
oo

HVK:GHB.

Figure 1.

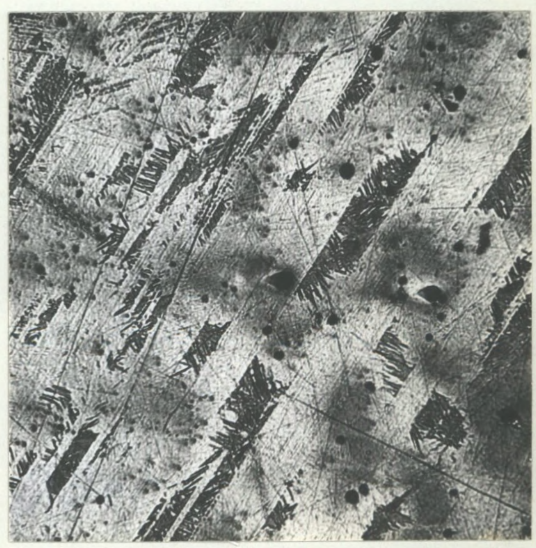
CRACKED PIECE,
AS RECEIVED.
(approximately ½ size).

Figure 2.



X200, picral etch.
GENERAL STRUCTURE OF METAL.
(Note small crack on
grain boundary.)

Figure 3.



X200, picral etch.
CONDITION OF METAL IN
VICINITY OF WIDE CRACKS.

HVK:GHB.

==========