Lab.

O T T A W A October 15th, 1943.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1515.

Examination of Four Manganese Steel Castings from the Sorel Steel Foundries Limited, Sorel, Quebec.

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Source of Material and Object of Investigation:

On October 1st, 1943, four specimens of manganese steel castings were received, for examination, from the Sorel Steel Foundries Limited, Sorel, Quebec, per J. R. Blais, Sales Department.

In letters dated September 7th and 22nd, 1943, Mr.

(Source of Material and Object of I estigation, cont'd) -

Blais supplied the following information:

1) Re: International Nickel Co. of Canada Ltd. - Manganese Steel Ball Mill Liner.

Heat-treated, but had not been used.

2) Re: Aluminum Co. of Canada Ltd. - Manganese Steel Pulverizer Ring.

This casting was never placed in service.

3) Re: Canadian Carborundum Co. Ltd. - Manganese Steel Crusher Jaw Plate.

This casting broke in service shortly after being installed in the crusher.

4) Re: Law Construction Company - Manganese Steel Crusher Jaw Plate.

This casting and a similar one failed in service after about 50 per cent of normal life.

The above castings will be referred to herein as Castings Nos. 1, 2, 3, and 4, respectively.

Macro-Examination:

The fracture of the ball mill liner (Casting No. 1) was quite coarse. The metal of this casting and that of Castings Nos. 2 and 4 appeared to be quite sound. However, shrinkage cavities were observed in Casting No. 3.

Chemical Analysis:

Drillings taken from each of the four castings were analysed and the following results were obtained:

	Casting No. 1	Casting No. 2	Casting No. 3	Casting No. 4
		- Per cent -		
Carbon -	1.09	1.11	1.06	1.06
Manganese -	11.05	11.65	10.90	10.00
Silicon -	0.33	0.54	0.66	0.71
Sulphur -	0.035	0.054	0.059	0.061
Phosphorus -	0.010	0.006	0.010	0.004
Chromium -	0.25	1.45	0.31	0.27

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Microscopic Examination:

Specimens were cut from each of the four castings, polished, and examined under the microscope in the unetched condition. The metal of Castings Nos. 1, 3, and 4 was found to be fairly clean, while a large inclusion content was noted in the metal of the No. 2 casting. Shrinkage cavities were observed in Casting No. 3. These are illustrated in Figure 1. The steels were next etched in a solution of 2 per cent nitric acid in alcohol and re-examined. Free carbides were observed in large quantities in all the steels except that of No. 2. The nital-etched structures of the steels of the four samples are shown in Figures 2, 3, 4, and 5.

Figure 1.

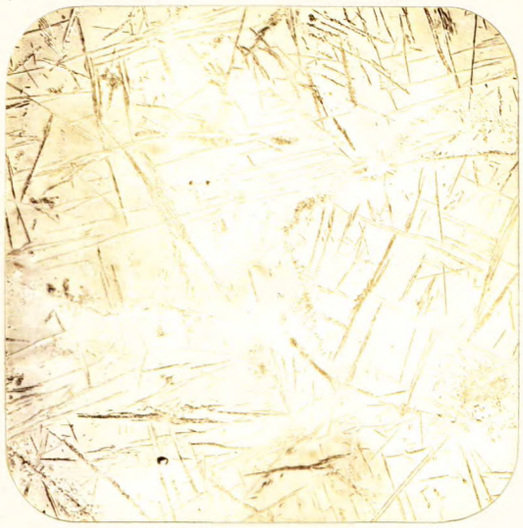
X100, unetched.

CASTING NO. 3.
Note shrinkage cavities.

(Continued on next page)

(Microscopic Examination, cont'd) -

Figure 2.



X100, etched in
2 per cent nital.

CASTING NO. 1.

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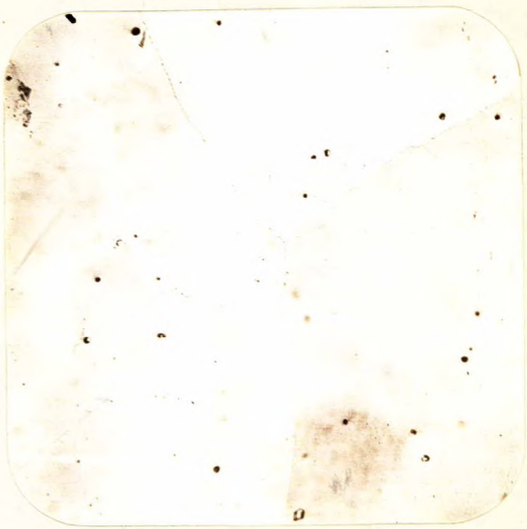
Figure 3.

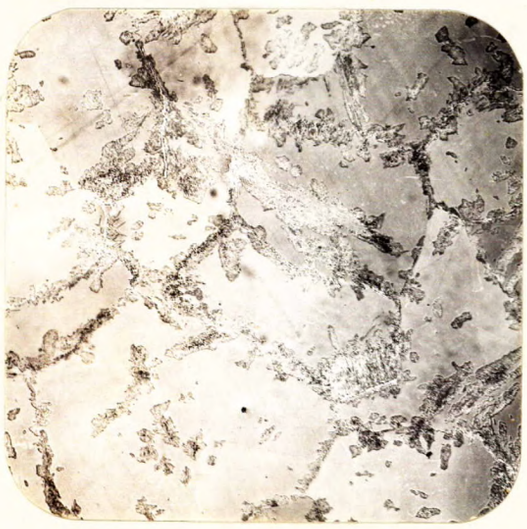


X100, etched in
2 per cent nital.

CASTING NO. 2.

-

Figure 4.



X100, etched in
2 per cent nital.

CASTING NO. 3.

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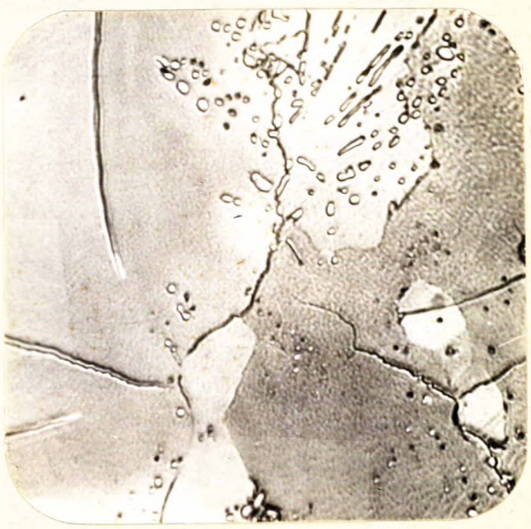
Figure 5.



X100, etched in
2 per cent nital.

CASTING NO. 4.

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Discussion of Results:

The chemical compositions of all the castings were found to be within the limits specified by the A.S.T.M. for austenitic manganese steel, except for the chromium content of Casting No. 2. The chromium content of the other three castings probably originated in the scrap. Although chromium is not usually added to austenitic manganese steels, it is claimed that the addition of 1 to 3 per cent of chromium reduces the amount of cold work required to properly harden this type of steel. If, however, the casting is subjected to severe impact stresses in service there is probably no advantage in adding chromium.

All the castings appeared to have been properly cast, except Casting No. 3 which had a number of shrinkage cavities. A change in casting technique should eliminate this defect.

The presence of such large amounts of free carbides in Castings Nos. 1, 3, and 4 would have a marked embrittling effect and consequently would lead to failure under heavy impact loads. In order to get these carbides in solution the casting must be heated to the proper solution temperature (1900° F.+), and to retain them in solution the casting must be quenched rapidly in cold water. The nature of the carbides in the various castings would indicate that Steel No. 1 has escaped heat treatment and Steel No. 3 has probably been quenched from too low a temperature. Steel No. 4 has been quenched too slowly.

Steel No. 2 had a fairly large inclusion content and a coarse grain structure. This structure results from pouring the steel from too high a temperature. Both of these defects, while not as serious as the free carbide defects, lower the physical properties of the steel.

CONCLUSIONS:

1. The failure of Castings Nos. 3 and 4 can be attributed to the embrittling effect of free carbides. Casting No. 1 would also be expected to fail in a similar fashion.

2. The shrinkage cavities observed in Casting No. 3 are considered a major defect and would be a contributing cause of failure.

3. The presence of free carbides in the steel is due to faulty heat treatment.

4. The high inclusion content and the coarse grain structure of the steel in Casting No. 2 are considered to be minor defects. No other defects could be observed in this casting.

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