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DEPARTMENT OF MINES AND RESOURCES

BUREAU OF MINES

CANADA

Ottawa, December 23, 1946.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2157.

Investigation of Two Manganese Steel Grate Specimens.

(Copy No. 4.)

Bureau of Mines

Mineral Dressing and
Metallurgy Division

CANADA

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OF
MINES AND RESOURCES

Mines and Geology Branch

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Origin of Material and Object of Investigation:

On December 10, 1946, two pieces of manganese steel were received for metallurgical examination from The William Kennedy & Sons, Limited, Owen Sound, Ontario. In a letter dated December 5, 1946, Mr. A. McMeekin, Metallurgist, indicated that one specimen was marked "S" and the other "K". He stated that the "S" specimen was from a grate that gave 30 per cent more service than that from which the "K" specimen was taken. The chemical analyses of the two grates, as obtained at the plant, were stated to be as follows:

	Carbon, per cent	Manganese, per cent	Silicon, per cent	Chromium, per cent	Nickel, per cent
"S"	1.02	12.7	0.47	0.26	0.30
"K"	1.12	12.5	0.75	0.19	0.25

Hardness Tests:

Brinell hardness tests were made on each specimen. The results were:

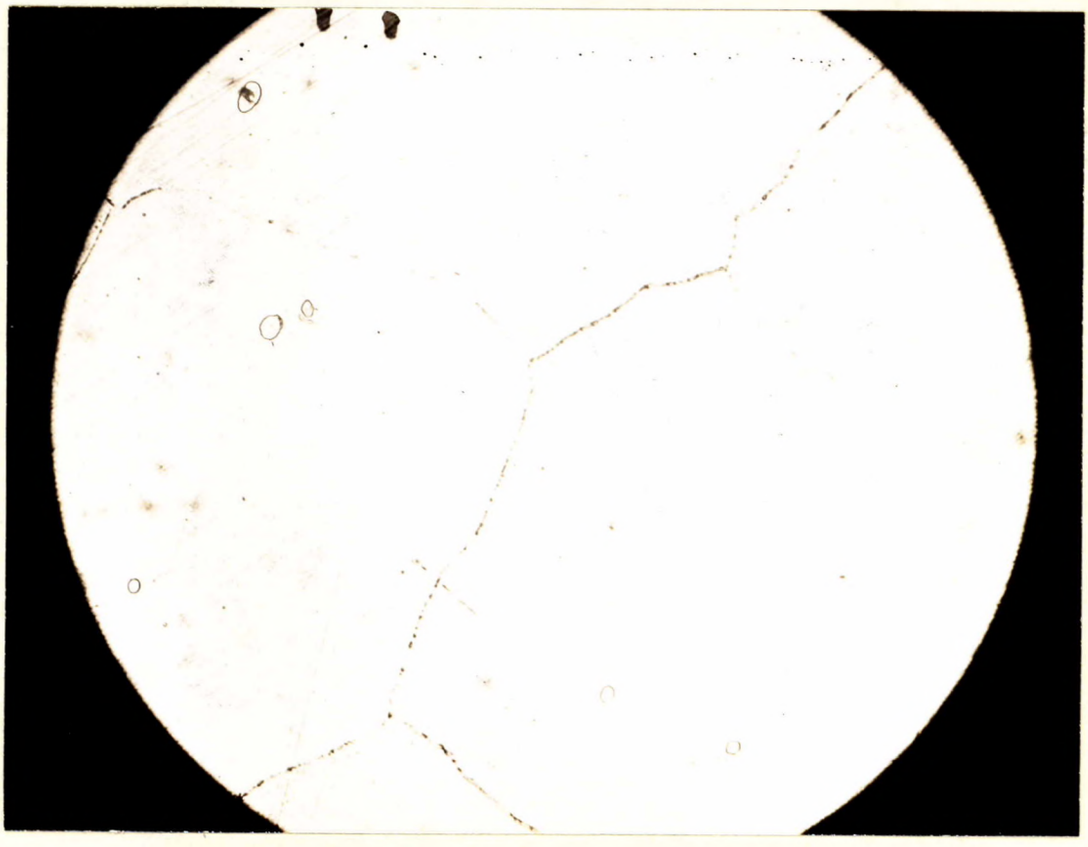
"S" = 217
"K" = 241

Microscopic Examination:

Specimens were cut and polished from each of the samples submitted, and then were examined under the microscope after an etch with 2 per cent nital.

Figure 1, taken at X500 magnification, illustrates the structure of the "S" specimen. It will be noted that a normal austenitic structure has been obtained. Some sulphide inclusions are also present. Figure 2 (X500), of specimen "K", shows undissolved carbides present in the austenite.

Figure 1.



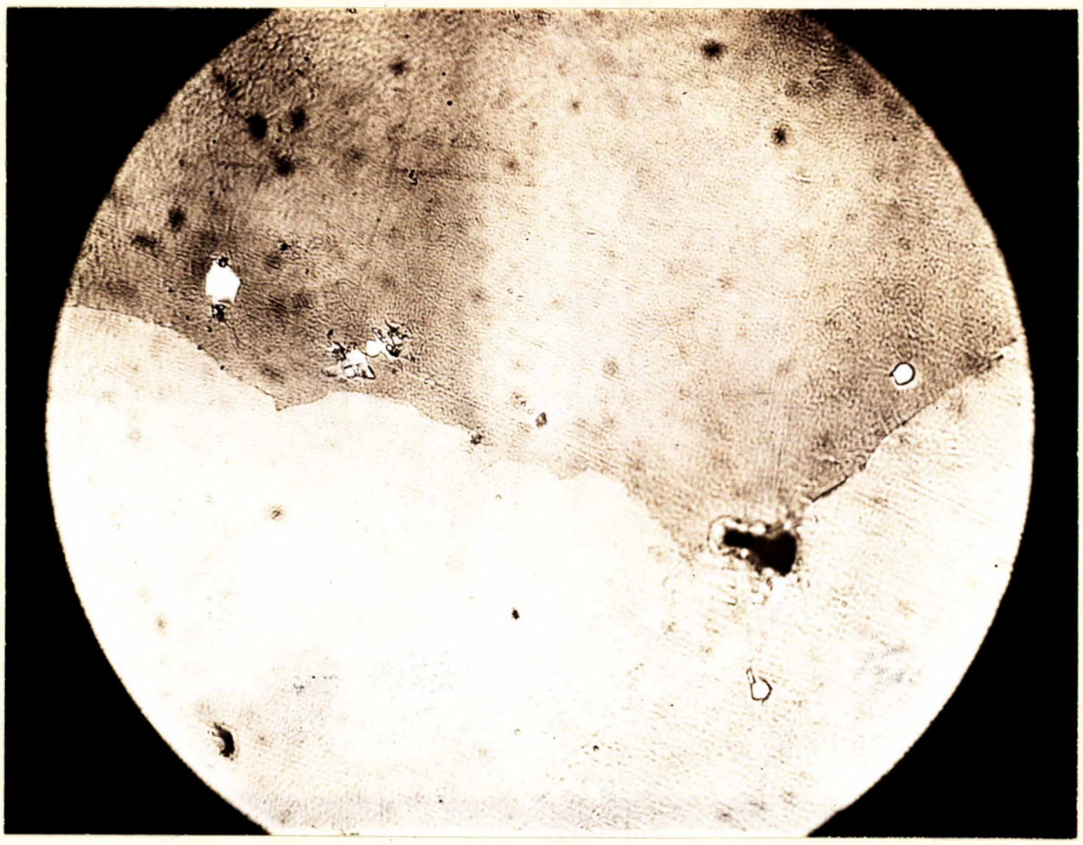
X500, nital etch.

MICROSTRUCTURE OF "S" SPECIMEN.

Normal austenite structure with sulphide inclusions.

(Microscopic Examination, cont'd) -

Figure 2.



X500, nital etch.

MICROSTRUCTURE OF "K" SPECIMEN.

Note free carbides (white constituent).

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Discussion:

The chemical analysis, as reported, is normal for austenitic manganese steel.

The Brinell hardness of this type of steel usually runs from 180 to 220. The hardness of the "K" specimen is 241, which is somewhat high. A number of plants control their heat treatment by Brinell tests. If the hardnesses fall within the range 180 to 220 Brinell they assume that the heat treatment has been satisfactory; if outside of this range (provided the chemical analysis is satisfactory), they

(Discussion, cont'd) -

assume that an unsatisfactory heat treatment has been given to the castings and usually reheat-treat them.

The microscopic examination illustrates that a variation in heat treatment must have occurred for the two grates. Sample "K" has carbides out of solution, whereas sample "S" has all the carbides in solution, an indication of good heat treatment. This would account for the unsatisfactory service obtained with grate "K". It is recommended that the following phases of the heat treatment be checked:

(1) Temperature of the actual castings in the furnace.

(2) Time at temperature.

(3) Quenching conditions.

The temperature of the castings does not always coincide with the temperature of the furnace. Indeed, it has been found that a variation of 150 to 200° F. difference sometimes exists. This can be determined by placing a chromel-alumel thermocouple in the load at various points, attaching the leads to a standard potentiometer, and comparing readings on the potentiometer with those on the furnace meter.

Conclusions:

1. The reported analysis is normal for austenitic manganese steel.

2. The Brinell hardness of specimen "K" (241) is higher than the usual range (180 to 220) for manganese steel.

3. Microscopic examination shows the presence of free carbides in specimen "K", indicating an unsatisfactory heat treatment.

4. Specimen "S" has been properly heat treated,

(Conclusions, cont'd) -

as no carbides are out of solution.

5. The improper heat treatment accounts for the unsatisfactory performance of grate "K" in service.

Recommendation:

A check-up on all the heat treatment conditions should be made. The institution of a Brinell test to act as a control is strongly recommended.

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