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O T T A W A      December 1st, 1944.

R E P O R T  
of the  
ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1752.

Metallurgical Examination of Flange  
Discs for Smoke Generators.

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Origin of Material and Object of Investigation:

On November 6th, 1944, two flange discs (see Figures 1 and 2) for smoke generators were submitted, under Analysis Requisition No. O.T. 4299, by Mr. H. H. Scotland, Inspector of Materials, for Controller General, The Inspection Board of the United Kingdom and Canada, Ottawa, Ontario. The covering request letter, dated November 6th, 1944, contained the following remarks:

"Please test as follows:

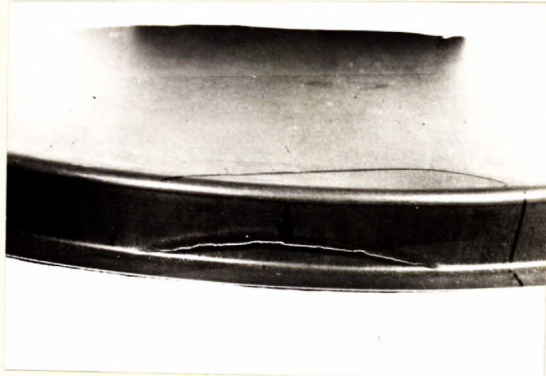
(1) Analysis.

(2) Please give an expression of opinion as to the cause of marks ringed in red. Are they imperfections in the steel itself, and will they be detrimental to the purpose for which the discs are used?"

Macro-Examination:

Figures 1 and 2 are macrophotographs showing the cracklike imperfection in Disc A and the "blister"-like imperfection in Disc B, respectively.

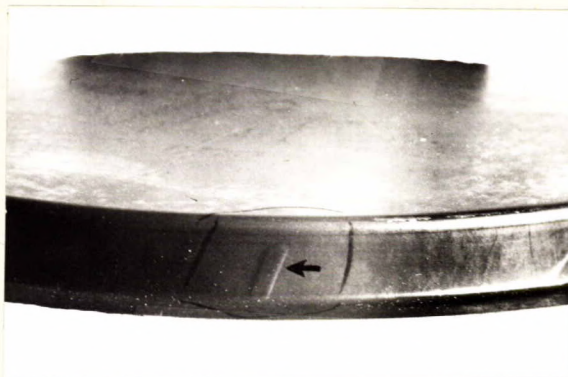
Figure 1.



DISC A.

Showing open cracklike imperfection.

Figure 2.



DISC B.

Showing closed "blister"-like imperfection.

A sample of the sheet steel was etched in 50 per cent hydrochloric acid at 170° F. in order to determine whether it was rimming steel or not. This test revealed a typical rimming steel structure.

Chemical Analysis:

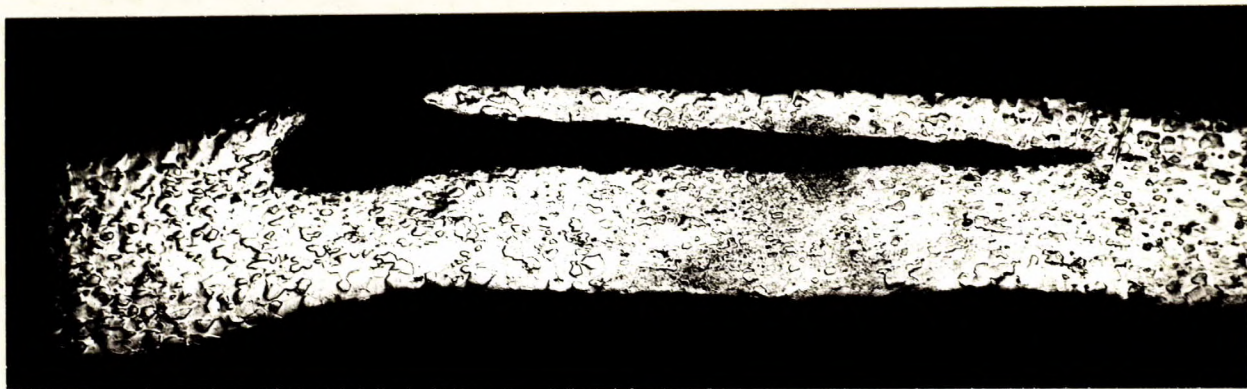
The following is the chemical analysis of material cut from Sample B:

	<u>Per Cent</u>
Carbon	- 0.04
Manganese	- 0.20
Silicon	- Trace.
Sulphur	- 0.033
Phosphorus	- 0.001

Microscopic Examination:

Figures 3 and 4, taken at X50 and X30 magnifications respectively, show the exact nature of the imperfections found in Discs A and B. Figure 5 is a photomicrograph, at X125 magnification, of a section taken from Disc B, further illustrating the imperfection in the steel.

Figure 3.



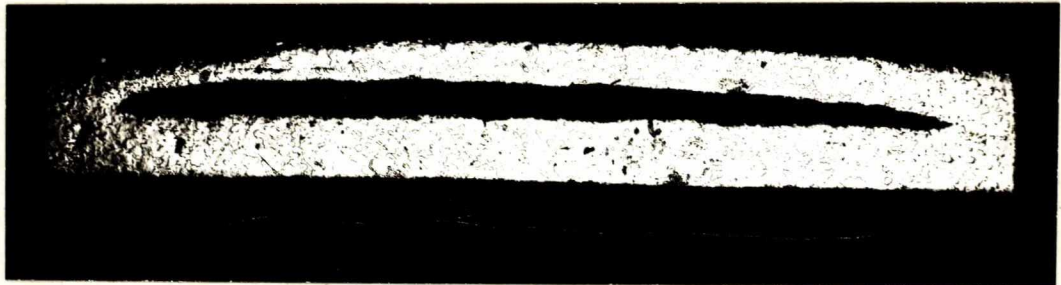
X50, nital etch.

SHOWING NATURE OF IMPERFECTION  
FOUND IN DISC A.

(Continued on next page)

(Microscopic Examination, cont'd) -

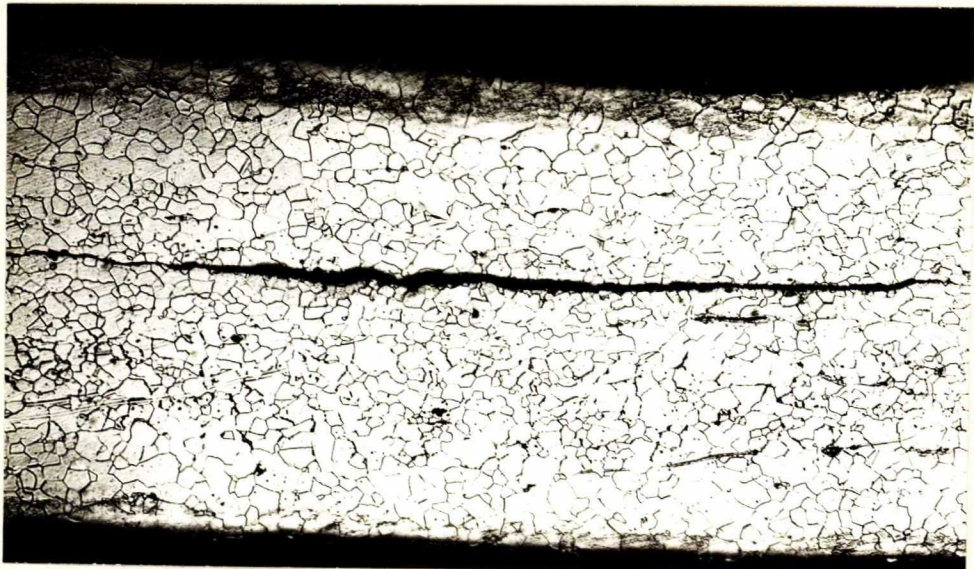
Figure 4.



X30, nital etch.

SHOWING THE IMPERFECTION IN  
THE STEEL OF DISC B.

Figure 5.



X125, nital etch.

INTERNAL IMPERFECTION IN DISC B.

Discussion:

The results of chemical analysis and macro-etching show that the steel employed in the manufacture of the discs is rimming steel. This opinion is based upon the low carbon and silicon content as indicated by the chemical analysis and

(Discussion, cont'd) -

upon the typical rimming steel structure as revealed by the macro-etching.

It is obvious, from the photomicrographs shown in Figures 3, 4 and 5, that the imperfections in the finished discs are due to defects in the steel. These defects are caused by gas bubbles left in the steel as a result of faulty rimming technique during the solidification period.

The type of imperfection encountered in Disc A (see Figure 1), i.e. one which appears like a crack, results from the opening of the blister at the surface of the sheet (see Figure 3). The "blister" type of imperfection found in Disc B (Figure 2) is the result of an internal gas void which has not come to the surface (see Figure 4). The void shown in Figure 5 is similar to that shown in Figure 4, but in this case it has been flattened out during the rolling operation.

These defects are, of course, of a serious nature, since they very greatly weaken the tensile properties of the sheet. Hence, sheet containing these defects could not be used for vital parts. However, if the flange discs do not have to withstand excessive pressure it may be permissible to use these parts.

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#### Conclusions and Recommendations:

1. The imperfections in the discs are due to defects in the steel caused by improper rimming technique during the solidification of the ingot.

2. The defects seriously reduce the strength of the sheets, but the parts may be used provided that strength of the material is not a prime factor.

3. It is suggested that a review be made of the conditions under which the discs are employed, in order to

(Conclusions and Recommendations, cont'd) -

determine whether parts containing such imperfections may  
or may not be used.

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