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O T T A W A January 24, 1945.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1779.

Examination of Fractured Composite Tail Tubes of a Piat Bomb.

(Copy No. 10.)

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Origin of Sample and Object of Investigation:

On January 3, 1945, under Requisition No. O.T. 4318, Mr. J. M. Gilmartin, I.O.(M), for Inspector of Materials, Inspection Board of United Kingdom and Canada, Ottawa, Ontario, submitted for metallurgical examination a Piat bomb (Lot No. 531) which had failed in proof firing test.

Material:

The inner and outer tubes of these Piat bombs were stated to have been made to Specification IN. B. No. 59A, Based on R/188.B., Approved 15th July, 1944. Due to lack of material it was not possible to carry out a full range of tests given in this specification.

Macroscopic Examination:

The nature of the side burst fracture of the composite tail tubes of the Piat bomb after proof firing is illustrated in Figure 1.

Figure 1.

SAMPLE AS RECEIVED.

(Approximately 1/3 actual size).

Chemical Analysis:

The results of chemical analysis of the inner and outer tubes, together with the specified compositions, are given in Table I.

TABLE I. - Chemical Analysis.

	INNER TUBE		OUTER TUBE	
	Specified	Found	Specified	Found
	- Per Cent -			
Carbon -	0.05-0.15	0.10	0.28-0.40	0.33
Manganese -	0.50 max.	0.44	0.30-0.70	0.53
Silicon -	0.10 "	Trace.	0.25 max.	0.16
Phosphorus -	0.05 "	0.017	0.05 "	0.014
Sulphur -	0.05 "	0.043	0.05 "	0.034

Mechanical Tests:

Microtensile specimens were prepared in duplicate from the inner and outer tubes and tested in the Hounsfield

(Mechanical Tests, cont'd) -

tensometer. The following results were obtained:

TABLE II.

Tubing tested		Ultimate stress, p.s.i.	Yield stress, p.s.i.	Elongation, per cent in 0.40 inch	Expansion test
Inner (Found)	-	46,600	33,300	32.5	
" (")	-	50,000	45,800	32.5	Passed.
" (Specified)	-	44,800-56,000	-	30.0*	
Outer (Found)	-	75,800	46,100	32.5	
" (")	-	75,000	50,000	32.5	N.d.
" (Specified)	-	-	38,080-56,000	30.0	

* Per cent in 2 inches.

N.d. = Not determined.

Hardness Tests:

The hardness of the tubes was determined by the Vickers method, using a 10-kilogram load. The values obtained at the fracture in the unaffected zone are listed in Table III.

TABLE III. - Vickers Hardness Number.

		At fracture	In unaffected zone
Inner tube	-	170	122
Outer tube	-	180	152

Microscopic Examination:

Sections of the inner and outer tubes were cut from the fractured and unaffected zones, mounted, polished, and examined under the microscope in the unetched condition. The steels were found to be fairly clean. However, several fairly large silicate inclusions were observed in the steel of the inner tube. Figure 2 is a photomicrograph, at X500 magnification, showing one of these inclusions. The unetched and nital-etched structures of the inner and outer tube are shown, at X100 magnification, in Figures 3, 4, 5, and 6.

(Continued on next page)

(Microscopic Examination, cont'd) -

Figure 2.

X500, unetched.

SHOWING SILICATE INCLUSIONS IN INNER TUBE.

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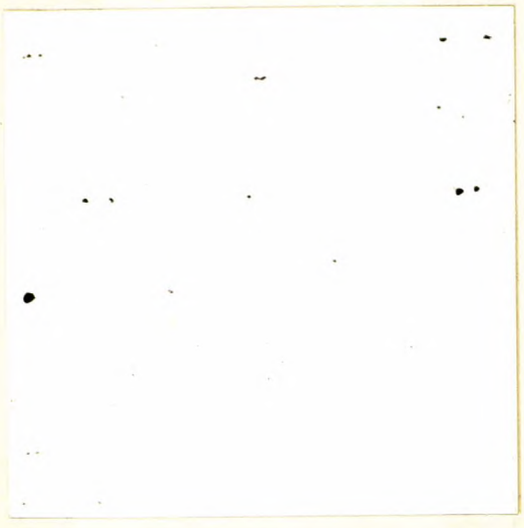
Figure 3.



X100, unetched.

INNER TUBE.

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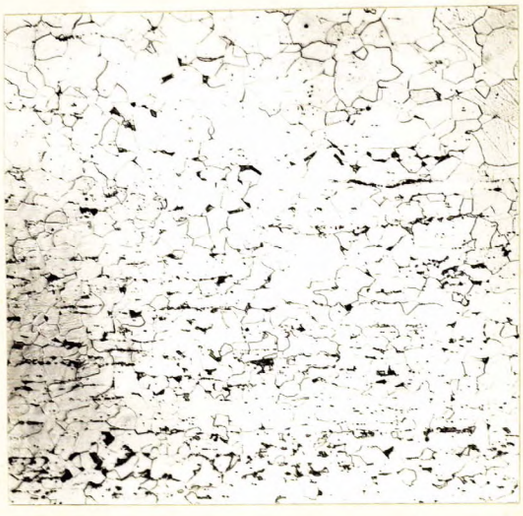
Figure 4.



X100, etched in
2 per cent nital.

INNER TUBE.

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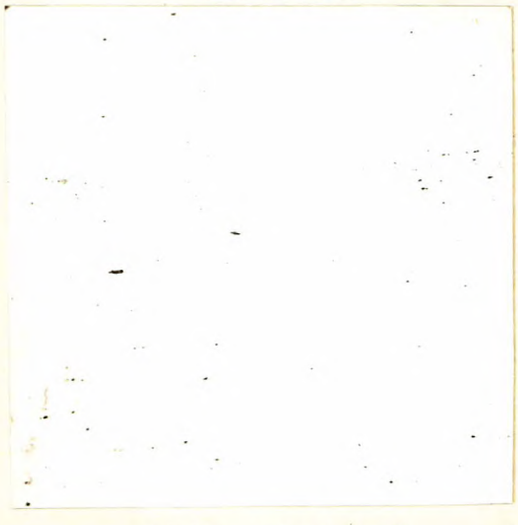
Figure 5.



X100, unetched.

OUTER TUBE.

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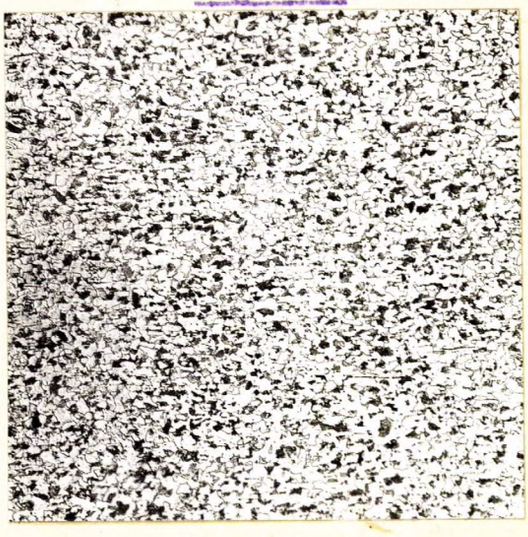
Figure 6.



X100, etched in
2 per cent nital.

OUTER TUBE.

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Discussion of Results; Conclusions:

The chemical compositions of the inner and outer tubes were found to be within the limits specified in Specification IN-B-59A.

The results obtained on mechanical tests carried out on duplicate microtensile test specimens machined from the inner and outer tubes conformed to the specification. There was not enough material available to carry out expansion and compression tests on the outer tube.

The steel used in the manufacture of these tubes was found to be fairly clean. Several fairly large inclusions were observed in the inner tube. It is not felt that these inclusions would materially affect the tensile properties in the longitudinal direction. However, their presence would lower the transverse properties of the tubing. The microstructure of both tubes is typical of normalized low-carbon steel of similar composition. While too much reliance cannot be placed in microtensile specimens, the results obtained would seem to indicate that failure cannot be attributed to poor mechanical properties. It is also considered unlikely that failure was due to the presence of silicate inclusions such as were observed in the inner tubing. From the results of this investigation it is concluded that failure was due to mechanical rather than metallurgical causes.

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