File.

FILE COPY

OTTAWA October 16th, 1944.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1722.

Examination of Fractured Composite
Tail Tubes of a Piat Bomb.

(Copy No. 10.)

Bureau of Mines
Division of Metallic
Minerals
-
Physical Metallurgy
Research Laborarottes

CANADA
DEPARTMENT
OF
MINES AND RESOURCES

Mines and Geology Branch

OTTAWA October 16th, 1944.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1722.

Examination of Fractured Composite Tail Tubes of a Piat Bomb.

==========

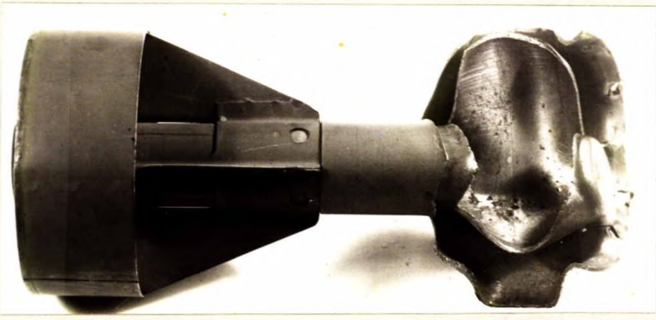
Origin of Sample and Object of Investigation:

On September 27th, 1944, under Requisition No. O.T. 4235, one (1) Piat bomb which had burst in firing test was received from the Inspection Board of the United Kingdom and Canada, 70 Lyon Street, Ottawa, Ontario. In an accompanying letter, dated September 27th, File No. 12/4/1, Investigation No. 96, it was requested that a metallurgical examination, similar to that described as Investigation No. 1711 (Analysis Requisition No. O.T. 4279), be carried out on the material in order to determine, if possible, the cause of failure. It was also stated that it was understood that the outer tube of the tail unit had been normalized by the Tocco process and, in view of work previously carried out by these Laboratories (see Report of Investigation No. 1681, dated July 18th, 1944), may not have had a completely normalized microstructure.

Macro-Examination:

Figure 1 is a photograph illustrating the nature of the side burst of the composite tail tubes of the Piat bomb after proof firing.

Figure 1.



PHOTOGRAPH SHOWING SIDE BURST OF PIAT BOMB COMPOSITE TAIL TUBE.

(Approximately ½ 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 below:

TABLE I. - Chemical Analysis.

		INNER TUBE		OUTER TUBE	
		Specified	Found	Specified	Found
Carbon	-	0.05-0.15	0.05	0.28-0.40	0.31
Manganese	-	0.50 max.	0.36	0.30-0.70	0.68
Silicon	-	0.10 "	Trace.	0.25 max.	0.16
Phosphorus	-	0.05 "	0.008	0.05 "	0.013
Sulphur	-	0.05 "	0.042	0.05 "	0.034

-

Mechanical Tests:

Microtensile specimens were prepared from the outer and inner tubes and tested in the Hounsfield tensometer. The following results were obtained:

TABLE II. - Tensile Tests.

Tubing Tested		Ultimate stress, p.s.i.	Yield stress, p.s.i.	Elongation, per cent in 0.40 in.	Expansion Test
Inner (found)	-	47,100	36,900	37.5	Passed.
Inner (specified)	-	44,800-56,000	--	30.0*	
Outer (found)	-	76,600	62,500	30.0	N.D.
Outer (specified)	-	--	38,080-56,000**	30.0*	

N.D. = Not determined.

* Per cent in 2 inches.

** This may be exceeded, provided the other mechanical properties meet the requirements of the specification.

Note: Provided that the operation of flaring the end of the outer tube is carried out after normalizing in the final heat treatment, the upper limit for the yield point may be ignored and the maximum compression strength raised to 42 tons per square inch.

Hardness Tests:

The hardness of the tubes was determined by the Vickers method, using a 10-kilogram load. The following Vickers hardness numbers were obtained:

		Vickers Hardness Numbers	
		At Fracture	Unaffected Zone
Inner Tube	-	152	133
Outer Tube	-	240	205

Microscopic Examination:

Sections of the outer and inner tubes were mounted in lucite, given a metallographic polish, and examined under the microscope in the unetched condition. The steel of the inner tube was found to be fairly clean, while a fairly large

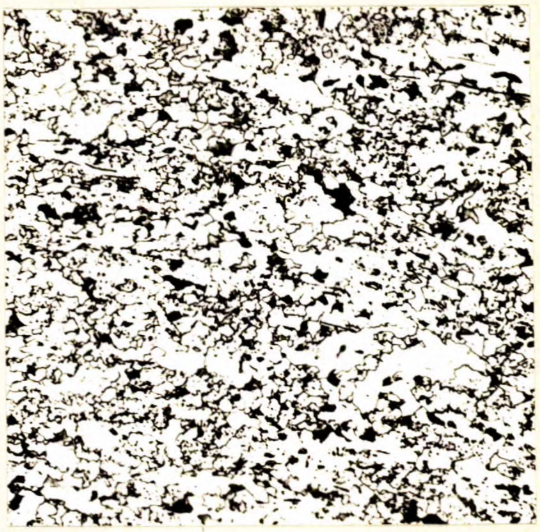
(Microscopic Examination, cont'd) -

number of elongated inclusions (chiefly sulphides) were observed in the steel of the outer tube. After an etch in 2 per cent nital, the steels were re-examined. The nital-etched structures of the tubes are shown in Figures 2, 3 and 4. The outer surface of the inner tube (shown in Figure 2) was slightly decarburized, but no decarburization was noted on the inner surface of this tube. The structure is typical of that of a normalized low carbon steel. Figures 3 and 4 are photomicrographs, at X250 and X1000 magnifications respectively, showing the outer tube. It will be noted that while some pearlite is present the carbides are mainly in the spheroidized condition.

Figure 2.

X100, etched in
2 per cent nital.
INNER TUBE.

Figure 3.

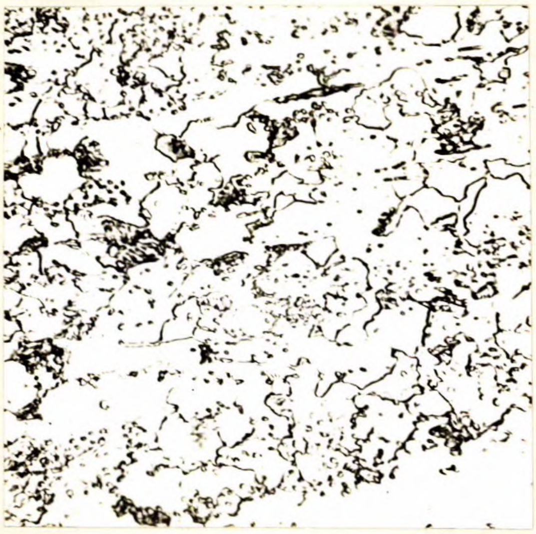


X250, etched in
2 per cent nital.
OUTER TUBE.

(Continued on next page)

(Microscopic Examination, cont'd) -

Figure 4.



X1000, etched in
2 per cent nital.

OUTER TUBE.

-

Discussion of Results; Conclusions:

The composition of the steel used in the manufacture of these tubes conformed to the requirements of Specification IN.B.59A.

Because of the small amount of material available it was not found possible to carry out a full range of mechanical tests. The results obtained on mechanical tests carried out on the inner tube conformed to the specification. The yield stress of the outer tube was above the upper limit specified. This, however, can be ignored, provided the compression strength does not exceed 42 tons per square inch. As stated above, it was not possible to carry out this test, due to lack of sample.

The steel used in the manufacture of the outer tube was not particularly clean. However, the type of inclusion observed is not considered a serious defect. The steel of the inner tube was fairly clean. The microstructure of this latter

(Discussion of Results, Conclusions, cont'd) -

tube was also considered to be satisfactory, except for a slight decarburization and grain growth on the outer surface. The microstructure of the outer tube showed that the steel was not completely normalized, the carbides being largely in the spheroidized condition. This would indicate that the steel had not been held long enough at the normalizing temperature to effect complete solubility of these spheroidized carbides. However, failure of the tube is not attributed to this incomplete normalizing, as the pearlite-spheroidized carbide-ferrite material should have approximately the same properties as the pearlite-ferrite, properly normalized material. As for this fairly low carbon steel, the properties would be largely determined by the continuous phase, which is ferrite in both cases. This is confirmed by the mechanical tests, although too much reliance should not be placed on small specimens. It is thought, then, that if the possibility of incorrect design can be eliminated, failure in the present instance can be attributed to mechanical rather than to metallurgical causes.

ooooooooooo
ooooo
o

NBB:GHB.