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OTTAWA September 2nd, 1943.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1488.

Examination of Defective Brass Fuze Bodies.

(Copy No. 10.)

Bureau of Mines
Division of Metallic
Minerals
-
Ore Dressing
and Metallurgical
Laboratories

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
Mines and Geology Branch

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Origin of Problem and Object of Investigation:

Under Materials Division Analysis Requisition No. O.T. 4000, dated May 31st, 1943, the Inspector General, Inspection Board of the United Kingdom and Canada, Ottawa, Ontario, requested the examination of three No. 199 Fuze bodies which showed cracks on the bottom of the base cavity. These defects had been revealed after machining of the material.

It was stated that the fuze bodies were machined by the Northern Electric Company Limited, Montreal, Quebec, from forgings produced at Mueller Limited, Sarnia, Ontario. The forgings were made from extruded brass bars supplied by

(Origin of Problem and Object of Investigation, cont'd) -

the Anaconda American Brass Limited, Montreal Strip Mill. The chemical composition of the extruded bars was given as follows:

		Per cent
Copper	-	58.0
Lead	-	1.7
Iron	-	0.02
Zinc	-	Remainder.

It was requested that an examination of the fuze bodies be carried out to determine the cause of the cracking.

Additional information was given in a letter, dated July 1st, 1943, containing details of the forging practice at Mueller's. It was stated that brass rods (B.S. Spec. 218), 2-3/16 inches in diameter, are cut to billets, length 1-11/16 inches, by a metal-cutting band saw. These billets are then placed on an endless metal open-work belt which is moved through the furnace for approximately 30 minutes, at a temperature of 1300 to 1400° F. The furnaces are heated with gas and the temperature is controlled by electric pyrometers. The hot billets are then put in a press which completes the forging of the fuze bodies in one operation. The forgings are allowed to cool gradually at room temperature. After they are sufficiently cool the flash is removed on a shearing press, which completes the forging and clean-up process.

Additional samples of a Fuze No. 199 Body forging and a piece of extruded brass bar of the actual size used for the forging were received on July 3rd, 1943.

-

Description of Samples:

Figures 1 and 2 show two of the submitted fuze bodies, revealing the circumferential cracks in the fuze body cavity.

Figure 1.

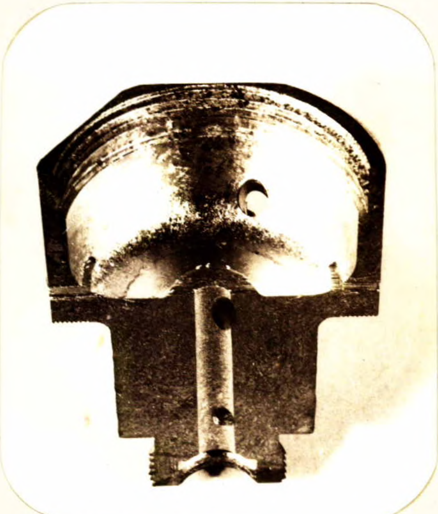
Figure 2.

SAMPLES AS RECEIVED.

(Approximately actual size).

Figure 3 shows the crack on a section of one of the fuze bodies after deep-etching and cutting off the elongated boss which extended into the fuze body cavity.

Figure 3.



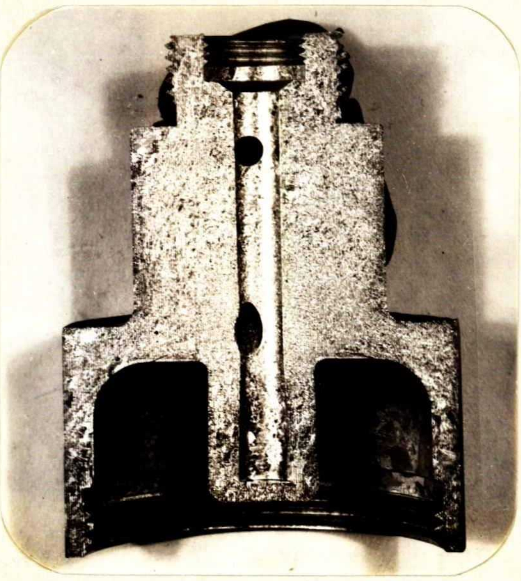
APPEARANCE OF THE CRACK AFTER DEEP-ETCHING.

(Approximately $\frac{3}{4}$ size).

(Description of Samples, cont'd) -

Figure 4 shows the longitudinal section of the machined fuze body, revealing the character and direction of the crack.

Figure 4.



LONGITUDINAL SECTION OF MACHINED FUZE BODY.

(Approximately actual size).

Chemical Analysis:

		Fuze Body	B.S.S. 218:1940
		- Per cent -	
Copper	-	58.65	56.5 - 60.0
Zinc	-	39.57	Remainder.
Lead	-	1.80	1.0 - 2.5
Iron	-	0.02	(Total impurities:
Tin	-	None detected.	(Max. 0.75
Aluminium	-	" "	
Nickel	-	" "	
Manganese	-	" "	
Antimony	-	" "	

Macroscopic Examination:

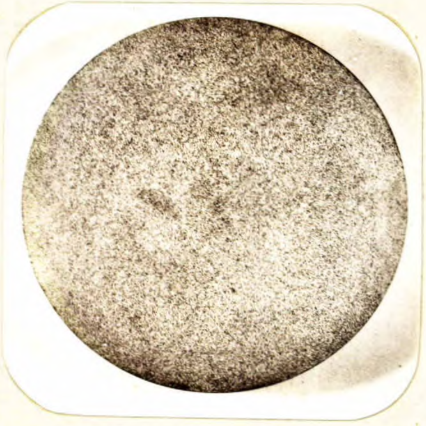
Figures 5 to 8 show the macrostructures of the examined samples after etching in a solution of 40 per cent HNO_3 conc. + 20 per cent HCl conc. + 40 per cent H_2O.

Figures 5 and 6 show respectively the cross-section

(Macroscopic Examination, cont'd) -

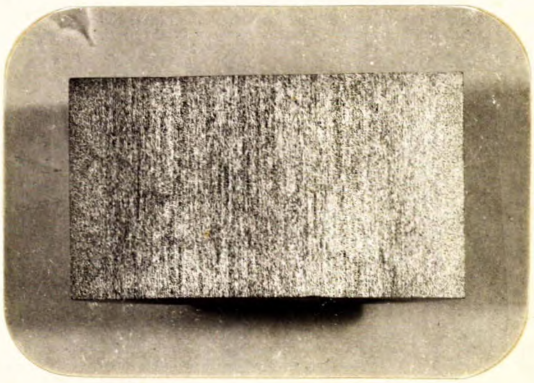
and the longitudinal section through the axis of the extruded brass rod. No metallurgical defects (segregation, inclusions, cracks, etc.) were observed, other than the directionality of the grains, normal in extruded products.

Figure 5.



ETCHED CROSS-SECTION
OF EXTRUDED BAR.
(Approximately 7/8 size).

Figure 6.

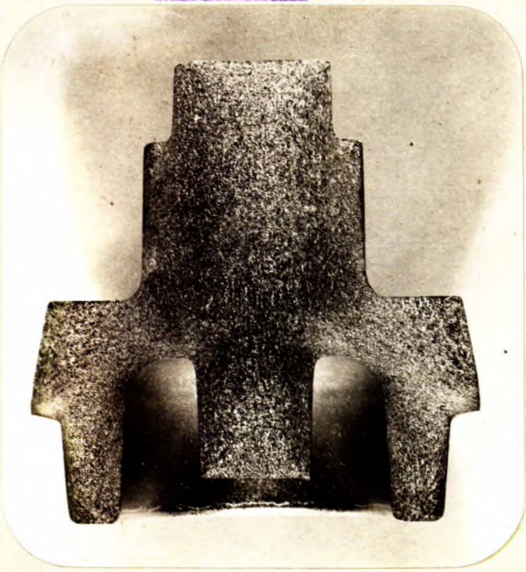


ETCHED LONGITUDINAL SECTION
OF EXTRUDED BAR.
(Approximately 7/8 size).

Figure 7 shows the macrostructure of the longitudinal section of the brass forging. Differences in grain size and flow lines are due to the forging operation.

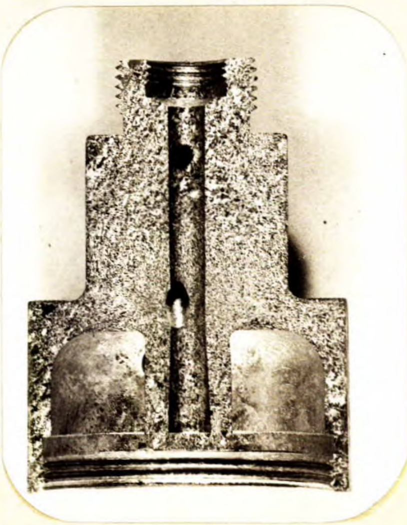
Figure 8 shows the macrostructure of the longitudinal section of a finished, machined fuze body.

Figure 7.



MACROSTRUCTURE OF BRASS FORGING.
(Approximately 7/8 size).

Figure 8.



MACROSTRUCTURE OF FUZE BODY.
(Approximately 7/8 size).

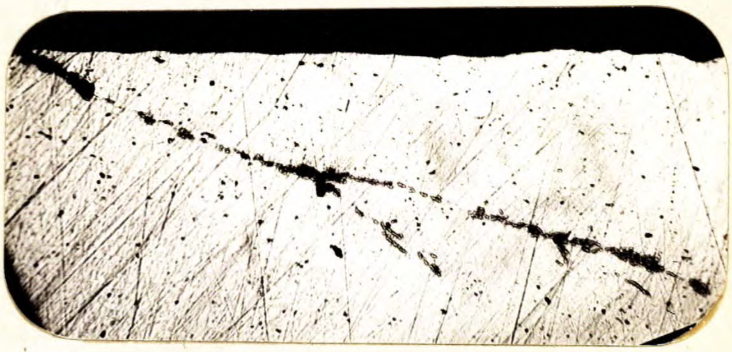
Microscopic Examination:

Figures 9 and 10 show the crack on a longitudinal section of the fuze body (see Figures 4 and 8).

Figure 9.

X25, unetched.

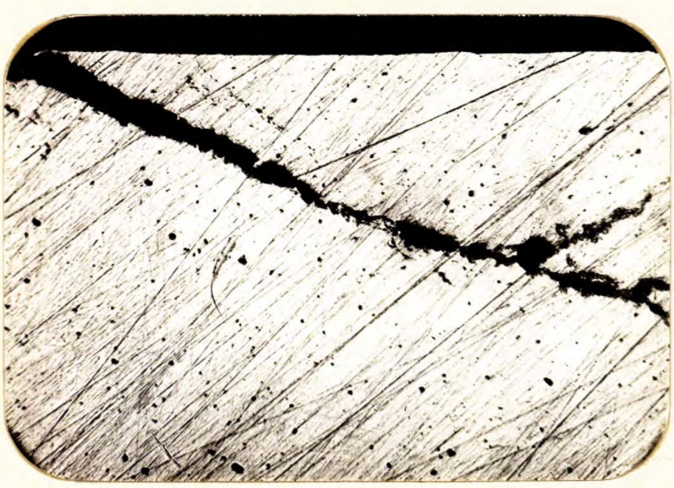
Figure 10.



X100, unetched.

Figure 11 and 12 show a larger magnification of the crack in Figure 9, revealing its character and its inclusions of oxides.

Figure 11.



X100, unetched.

Figure 12.

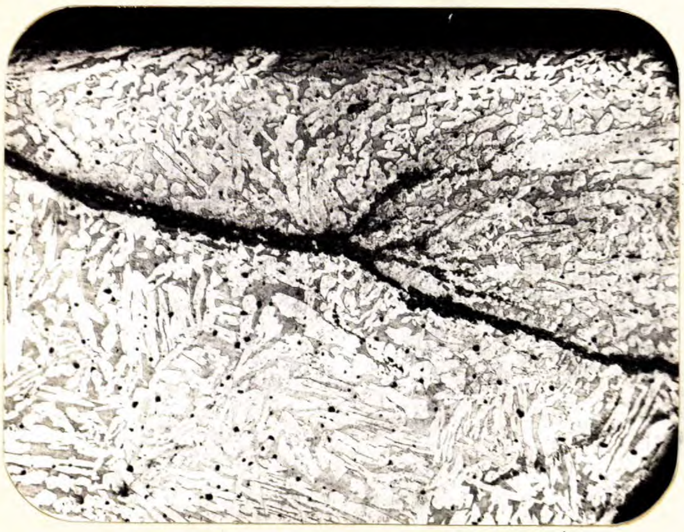
X100, unetched.

Figures 13 and 14 show the microstructure of the material around the crack shown in Figures 9, 11, and 12.

(Continued on next page)

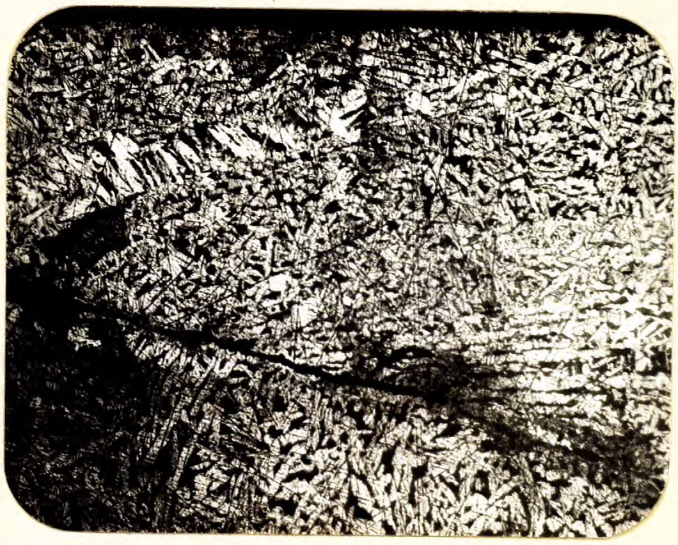
(Microscopic Examination, cont'd) -

Figure 13.



X100, NH_4OH etch.

Figure 14.



X100, $K_2Cr_2O_7$ etch.

MICROSTRUCTURE AROUND THE CRACK.

Discussion of Results:

Chemical analysis shows that the material conforms closely to British Standard Specification No. 218:1940.

The metallographic examination of the submitted piece of extruded brass bar and of the rough brass forging showed sound material. No metallurgical defects were detected.

The character of the cracks and the apparent inclusions of oxides, visible on the whole length of the cracks, indicate that this failure was encountered in the forging operation, probably as a result of improper forging conditions. The crack seems to be a form of "fire-cracking" and could be caused by faulty heat distribution or by internal stresses at the juncture of the two different directions of flow in the forging. Leaded alpha-beta brasses are especially susceptible to fire-cracking. The lead addition, of course, materially improves machinability.

A very similar case of circumferential cracking in

(Discussion of Results, cont'd) -

a hot brass pressing is reported in an article in Metal Industry,* in which comment on this failure is given as follows:

> "...it can be seen that this is a type of stamping defect, caused by faulty stamping conditions with which most manufacturers of hot brass pressing will be familiar."
>
> "...the zone of smaller crystals is occasioned by the increased pressure at this point caused by the junction of two different directions of flow, and the crack is most probably a form of season cracking** due to the internal stresses present at this juncture, and definitely not due to defective or unreliable extruded bar stock."
>
> "This type of defect is infrequently met with in hot brass stampings and can readily be avoided by careful attention to stamping conditions."

CONCLUSION:

The circumferential cracks on the brass fuze bodies were probably due to improper forging conditions.

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JWM:GHB.

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* E. Wood - "Non-ferrous Metals in Modern Aero Engines." - Metal Industry, Vol. 60, No. 3 (January 16, 1942) pp. 34-35, and commented upon by J. Rae, Jr., in No. 9 (February 27, 1942), p. 164.

** It should be, rather, "fire-cracking".