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O T T A W A November 1st, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1728.

Examination of 20-mm. Cartridge Cases.

(Copy No. 10.)

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Origin of Samples and Object of Investigation:

Fifteen 20-mm. cartridge cases (six unfired, six which fired successfully, and three which apparently ruptured during firing) were received on October 12th, 1944, from the Director of Technical Research, Department of National Defence, Naval Service, Ottawa, Ontario. The cases were in two lots with three unfired and three successfully fired cases in each.

In the covering Requisition No. 21, File No. NS 15100-381/44, Vol. 1 (Staff), dated 10th October, request was made for:

(a) A comparative hardness over the profile of the pieces.

(b) Photomicrographs of ruptured cases where fracture is evident.

(c) Photomicrograph of similar section of fired cases.

(d) Photomicrograph of similar section of unfired cases.

Description of Material:

One lot, which was ink-stamped NFCH 44 ZC-341, had a single flash hole (vent) for the primer and the other, ink-stamped 43 ZB-17 PWDR. SPDN 5447 FZ MK 26.1 LOT 667 9-43 NFH, had double flash holes. These cases will be differentiated in this report by referring to the number of flash holes. The case which ruptured, as well as the accompanying two that were creased around the neck, had a single flash hole and no ink stamping. On its base the ruptured shell was marked = M.S. = 1944, while the two others (with creases) had = M.S. = 1944 and I.S. 1944 respectively.

Macro-Examination:

A photograph of representative cases, as received, is given in Figure 1.

Figure 1.

1 2 3 4 5

CASES AS RECEIVED.

No. 1: Case which burst.
Nos. 2 and 3: Cases from same lot as 1. Note crease at neck of each.
No. 4: Case which fired successfully.
No. 5: Unfired case.

(Approximately 3/5 actual size).

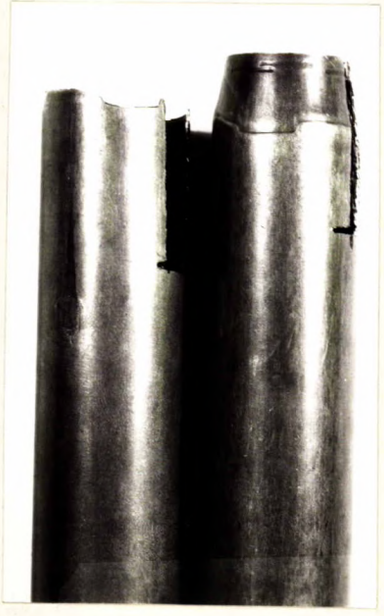
1728.

(Macro-Examination, cont'd) -

By comparing Cases Nos. 4 and 5 (Figure 1), it may be noticed that the neck of the case has expanded on firing.

The outlines of the creases on the necks of Cases Nos. 2 and 3 were found to correspond exactly to the form of the piece detached from Case No. 1. As well, the imprints of the crimping marks on the neck of the detached piece from the No. 1 cartridge case (see Figure 1) were found on Nos. 2 and 3. It was noticed that the rupture in the detached piece, as seen from its imprint in Cases Nos. 2 and 3 (Figure 1), was rather angular and extended farther down the shell in two locations and that these were in line with two of its crimping marks. One of these locations may be seen in Figure 2.

Figure 2.



ANGULAR NATURE OF PART OF FRACTURE.

(Approximately 5/6 actual size).

Samples removed prior to photographing.
Note identical contour of rupture and crease, as well as imprint of crimp mark on shell at right above its own crimp.

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(Macro-Examination, cont'd) -

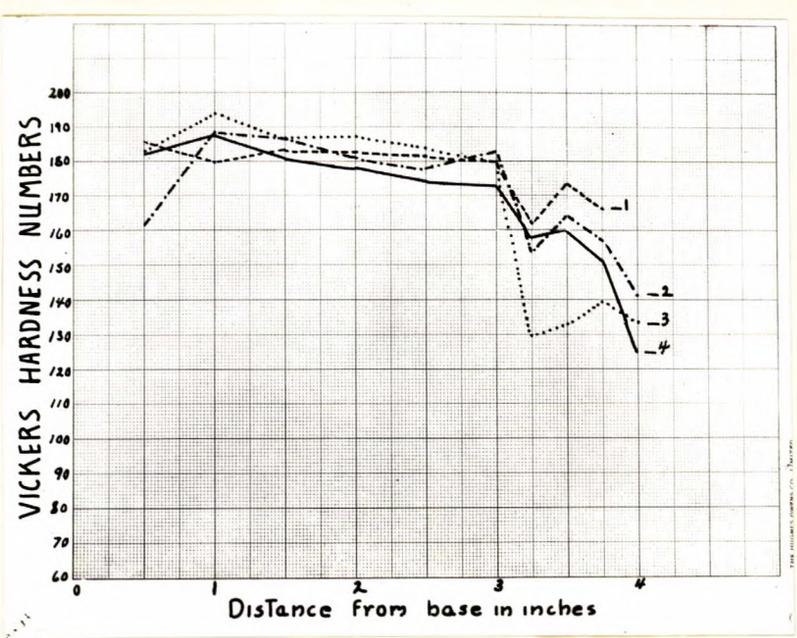
The thickness of the ruptured case near the fracture was found to be very nearly equal around the circumference and to be within the limits specified.

Hardness Tests:

Hardness tests were taken on a Vickers machine, using a 10-kilogram load every one-half inch along the case to three inches from the base and, from then on, a 5-kilogram load every one-quarter inch to within one-quarter inch of the mouth. Because of the difference in load, made necessary by the thickness of the specimen, the complete hardness curves are not truly representative of the cases, but they are comparable.

The results of these tests (the hardness being averaged for the three cases of each lot) are given in Figures 3 and 4.

Figure 3.

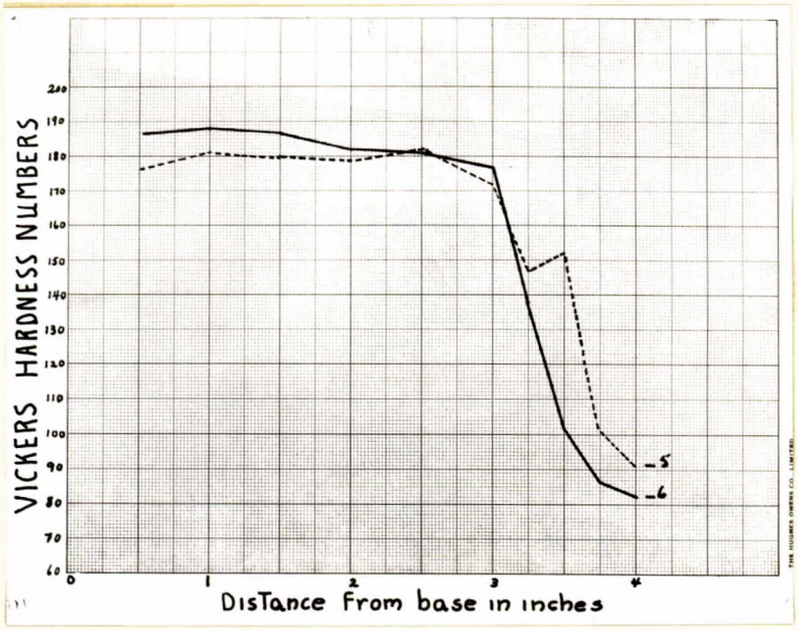


HARDNESS CURVES FOR FIRED CASES.

Curve No. 1. - Case which ruptured, with single flash hole.
" " 2. - Cases, with double flash holes, which fired successfully.
" " 3. - Cases, with single flash hole, which fired successfully.
" " 4. - Cases, with creases near shoulder, single flash hole.

(Hardness Tests, cont'd) -

Figure 4.



HARDNESS CURVES FOR UNFIRED CASES.

Curve No. 5. - Unfired cases with double flash holes.
" " 6. - Unfired cases with single flash holes.

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Microscopic Examination:

A section from the neck and shoulder of each case was mounted in lucite, polished, and etched in a potassium dichromate solution.

Since the average distance of the rupture from the mouth of the case was about one-half inch, cross-sections from this location were selected for the comparative photomicrographs, which are given, at 75 diameters, in Figures 5 to 10 inclusive. The grain size in all cases is very small and practically the same.

In Figure 9 it may be noticed that the ruptured case has necked down considerably at the fracture. In Figure 10 the

(Microscopic Examination, cont'd) -

marking around the neck of a case from the lot in which rupture occurred is seen to be a definite ridge on the outside with a corresponding bulge inside.

Figure 5.

X75.

UNFIRED CASE,
DOUBLE FLASH HOLE.

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Figure 6.

X75.

UNFIRED CASE,
SINGLE FLASH HOLE.

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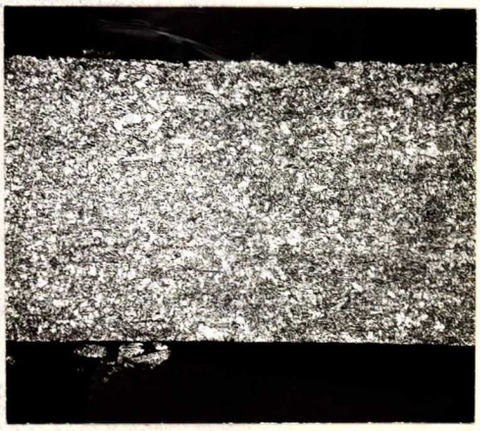
Figure 7.

X75.

FIRED CASE,
DOUBLE FLASH HOLE.

-

Figure 8.



X75.

FIRED CASE,
SINGLE FLASH HOLE.

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(Microscopic Examination, cont'd) -

Figure 9.

X75.

FRACTURE IN
RUPTURED CASE.

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Figure 10.

X75.

FIRED CASE,
CROSS-SECTION THROUGH CREASE
IN NECK (REFER TO CASES
NOS. 2 AND 3, FIGURE 1).
Outer side of case is at top.

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Discussion of Results:

The macro- and micro-examinations show that the markings on the necks of the two cases accompanying the one which ruptured resulted from these cases being fired after the ruptured one and expanding onto the detached piece of it lodged, temporarily, in the front of the chamber. It is evident, then, that only one of the cases submitted ruptured or tended markedly to rupture. From the described and pictured contours of the fracture it would seem that the crimps influenced the stress distribution considerably during failure.

The hardness tests and microscopic examination indicate that the material in the cases is quite uniform in the critical area and that there is no apparent metallurgical

(Discussion of Results, cont'd) -

reason for failure.

The appearance of the fracture (Figure 9) shows that the metal failed by tension stressing beyond its ultimate strength. Since the hardness of this ruptured case in the critical area is not significantly different from that of the others, an unusually low tensile strength certainly would not be expected in the cartridge case. Also, the ductile, necked-down nature of the break rules out brittleness of the brass (caused by stress-corrosion cracking, etc.) as a contributor to failure.

The two points, (a) that the break was caused by overstressing in tension and (b) that the crimping played a role in the stress distribution during failure (an indication that the case still held the projectile during the stressing which caused failure), lead to the conclusion that failure was caused by an unusually abrupt and/or severe forward thrust on the projectile and resultant pull on the neck of the case. It would seem that the gun, cartridge or ballistic factor or factors which caused this, such as excessively fast development of breech pressure, too tight crimping, misalignment, etc., were responsible, rather than a metallurgical deficiency in the case, for the rupture.

Conclusion:

No metallurgical defects which may have contributed to this failure were found.

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LPT:GHB.