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O T T A W A February 10th, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1161.

(Subsequent to Investigation No. 1151, dated January 22nd, 1942.)

Continuation of Examination of Welds in 75 mm. Smoke Shell Cases.

(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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ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1161.

(Subsequent to Investigation No.
1151, dated January 22nd, 1942.)

—

Continuation of Examination of
Welds in 75 mm. Smoke Shell Cases.

Origin of Material and Object of Investigation:

On January 30th, 1942, under Requisition No. O.T. 53, a further quantity of nine 75 mm. smoke shell cases were received from The Inspection Board of the United Kingdom and Canada, 58 Lyon Street, Ottawa, Ontario. These cases were supplied in order to continue the investigation initiated by Mr. H. H. Scotland's letter of January 7th, 1942, (No. 1161, Examination of Weld Between Mild Steel

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

Base and Tubular Body of 75 mm. Smoke Shell Cases, dated January 22nd, 1942).

Three of the cases, marked "N", were stress-relieved at 734° F.; three others, marked "A", were normalized at 1650° F.; and three received no treatment at all. The purpose of this investigation was to determine more completely the extent of the variation in the penetration of the weld.

Macroscopic Examination:

An external examination revealed that a condition such as that shown in Figure 1 existed. The case on the left shows what is apparently eccentric turning. If this were true one would expect to find the weld largely cut away here. However, the micrometer failed to reveal eccentricity beyond that found in a normal case, i.e., like that on the right in Figure 1.

The cases were then sectioned into four quarters and the dimension "W" as shown in Figure 2 determined. This is tabulated in Table 1.

Table I.

Penetration of Weld at Joint of Base and Tubular Body.

(Dimensions given in inches).

Case No.	Position Around Circumference			
	12 o'clock	3 o'clock	6 o'clock	9 o'clock
1.	0.03	0.012	0.0	0.03
2.	0.04	0.035	0.02	0.03
3.	0.06	0.04	0.015	0.05
1A.	0.04	0.035	0.04	0.04
2A.	0.03	0.04	0.04	0.04
3A.	0.02	0.05	0.02	0.04
1N.	0.03	0.04	0.04	0.02
2N.	0.03	0.03	0.02	0.035
3N.	0.05	0.03	0.02	0.05

Maximum W = 0.06
Minimum W = 0.00
Average W = 0.033

(Continued on next page)

(Macroscopic Examination, cont'd) -

The thickness of the tube wall at the weld was checked and the results are given in Table II:

Table II.

Thickness of Tube Wall at Some of the Welds.

Case No.	Position	Thickness
2.	6 o'clock	0.064 in.
3.	12 o'clock	0.064 in.
1N.	3 o'clock	0.064 in.

Physical Tests:

Bend Tests -

Three strips (each about 3/8 inch wide) were prepared, one from an untreated case, one from a stress-relieved case, and one from a normalized case. These strips were bent carefully in a manner shown in Figure 3. The behaviour of the weld metal was observed through a low-powered microscope. The bending was stopped when visible cracks started developing. The results are given in Table III:

Table III.

Bend Tests.

Case	Penetration of weld, in inches	Degree of bend	Remarks
Untreated	0.03	$12\frac{1}{2}^{\circ}$	Complete failure.
Stress-relieved	0.025	$29\frac{1}{2}^{\circ}$	Partial failure.
Normalized	0.02	$40\frac{1}{2}^{\circ}$	Partial failure.

(Continued on next page)

(Physical Tests, cont'd) -

Tensile Tests -

Tensile test pieces, as shown in Figure 4, were also prepared. These were about 3/8 inch wide. Results are shown in Table IV:

Table IV. - Tensile Tests.

Test No.	1.	2.	3.
Specimen No.	Untreated.	A.	N.
Width of test piece, in inches	0.330	0.305	0.295
Thickness of tube wall, in inches	0.066	0.063	0.059
Area in tube wall, sq. in.	0.218	0.0191	0.0170
Thickness of weld, in inches	0.032	0.039	0.043
Area in weld, sq. in.	0.0106	0.0118	0.0127
Ultimate load, pounds	1,164	946	825
Stress in tube wall, p.s.i.	53,395	49,528	47,941
Stress in weld, p.s.i.	109,811	80,180	64,133
Load on weld, pounds per linear inch	3,528	3,122	2,800
Position of fracture	In tube.	In tube.	In tube.

Discussion of Results:

From the examinations conducted, it is evident that there is a wide variation in the depth of the weld. This variation would appear to originate in the welding operation, since from an examination of Tables I and II the tube wall thickness at the weld appears to be independent

(Discussion of Results, cont'd) -

of the apparent penetration of the weld. If irregularities existed in the machining practice, thin tube walls and thin welds would coincide.

The bend tests would seem to indicate that the stress-relieving treatment at 734° F. has quite a marked toughening effect.

About all the tensile tests seem to indicate is that when the welding is properly done the joint is strong enough. There were only three small flaws found in the welding in the shell cases examined.

Conclusions:

1. There is a variation in the depth of penetration of the weld. This variation would appear to originate in the welding practice.

2. The stress-relieving treatment has a decided toughening effect on the weld metal.

Recommendations:

The exact conditions to which this projectile is exposed in service are not known to the writer. From its general appearance it would appear to be fired from a mortar of some kind. If this is the case we would like to submit two suggestions for consideration:

1. It is suggested that a good shrink fit of the tube to the forged base would be sufficient for the purpose.

2. Should the requirements of this projectile permit of shrink fit of the tube to the base, it is also

(Recommendations, cont'd) -

suggested that high-test cast iron might replace the forged steel base. An iron made in accordance with A.S.T.M. Specifications A-48-36, C.I. 45, should be satisfactory.

These changes in manufacturing technique would have the following merits:

1. Cheaper fabrication due to shrink fit, also faster.
2. Faster machining of base because of better machinability of good high-test iron.
3. Release of forging capacity and steel for other purposes.

The only probable difficulty that the writer could foresee in a shrink fit would be the necessarily close machining tolerances.

Should the above suggestions not be acceptable, owing to service conditions, and present means of fabrication maintained, it is recommended that the weld penetrate to at least one-third of the thickness of the tube.

A bend test as a routine control should be helpful. If untreated, a bend of 10° should be possible. If stress-relieved at 734° F., a bend of 25° should be possible. The full normalizing treatment would not be necessary.

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Figure 1.

Photograph showing apparent eccentricity of machining.

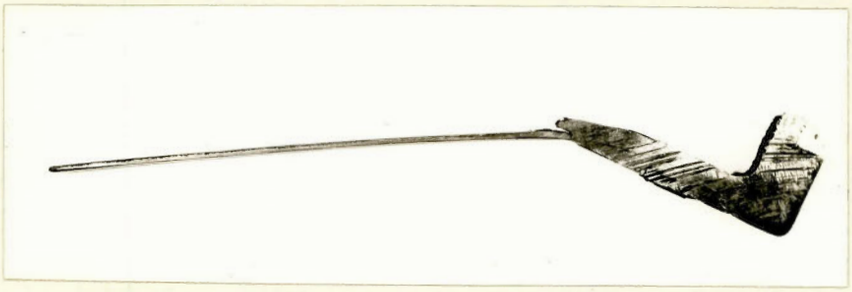
(Approximately 1/3 size).

Figure 2.

A close-up of the welded joint, showing the extent of the weld, dimension "W".

(Approximately X4 magnification).

Figure 3.



Photograph showing type of bend test.
(Approximately 1/2 size).

Figure 4.

Photograph of tensile specimen used.
(Approximately 1/2 size).

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