File

DEPARTMENT OF MINES AND RESOURCES

BUREAU OF MINES

CANADA

Ottawa, November 1, 1946.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2129.

Metallurgical Examination of 20-mm. A/P Shells, to Determine Cause of Difficulty Encountered in Hardening.

(Copy No. 8.)

O T T A W A November 1, 1946.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 2129.

Metallurgical Examination of 20-mm. A/P Shells, to Determine Cause of Difficulty Encountered in Hardening.

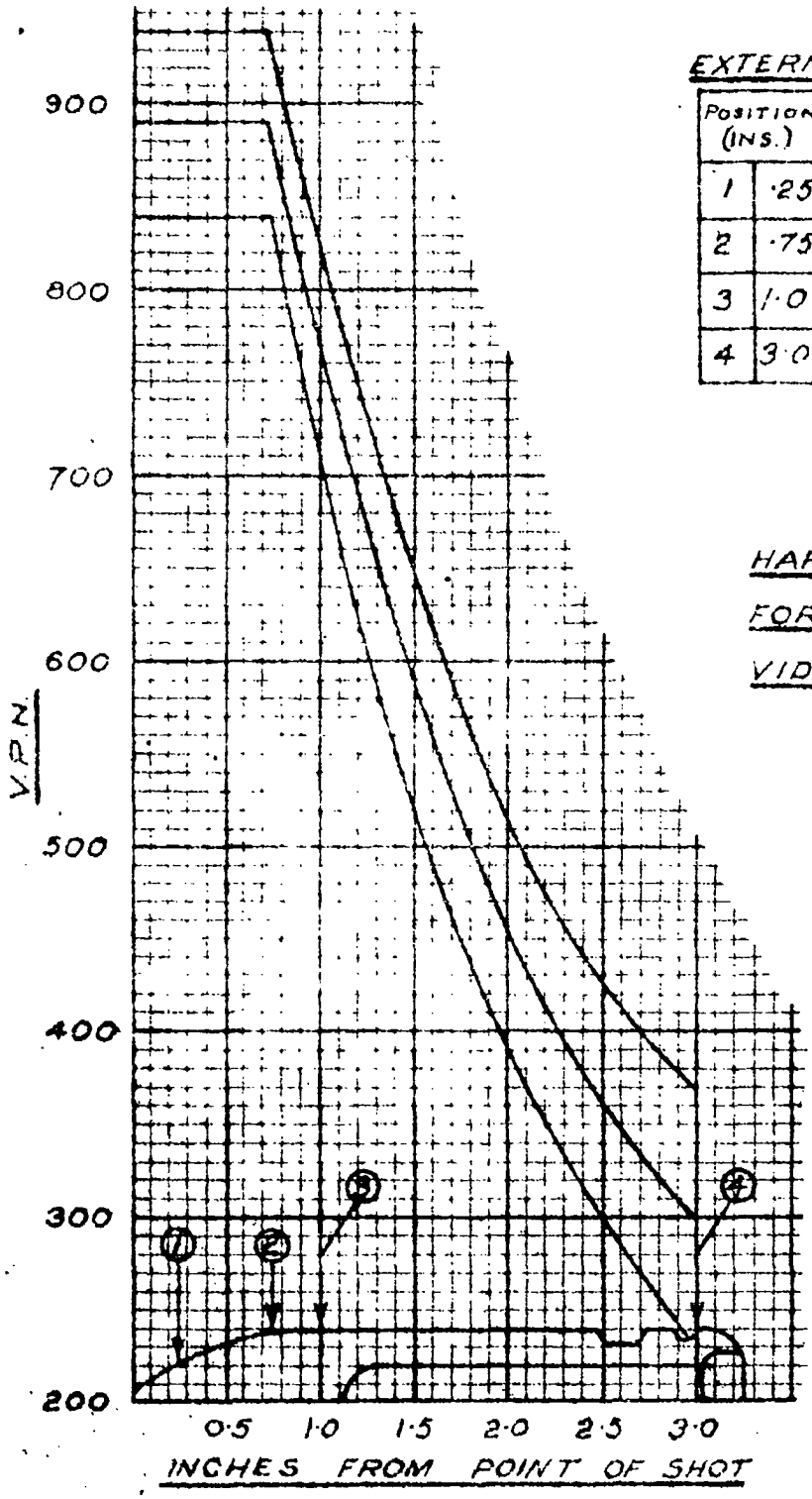
==========

Origin of Material and Object of Investigation:

On September 20, 1946, fifty (50) 20-mm. armour-piercing shells were received by these Laboratories for examination and heat treatment. In a letter (File CARDE 30-184) received on September 14 from Mr. J. W. MacNaughton, for Chief Superintendent, Canadian Armament Research and Development Establishment, Department of National Defence (Army), P.O. Box 1427, Quebec, Quebec, it was stated that forty-two of these had been heat-treated but the hardness values obtained were below the specified requirements. Eight of the shells had not been heat treated.

It was requested that these Laboratories determine the reason for the difficulty of hardening these shells and also determine the heat treatment which would give the proper hardness gradient.

(Figure 1 comprises Page 2.)
(Text continues on Page 3.)



EXTERNAL HARDNESS V P.N.

Position (Ins.)		MIN.	TARGET	MAX.
1	·25	840	890	940
2	·75	840	890	940
3	1·0	710	775	835
4	3·0	230	300	375

HARDNESS GRADIENTS
FOR 20 m/m AP/T SHOT
VIDE O.B. PROC 25086

HARDNESS CURVE

THE HARDNESS AT THE ·75" POSITION MUST BE MAINTAINED HIGH, AND AS CLOSE AS POSSIBLE TO THAT AT THE ·25" POSITION. THE HARDNESS GRADIENT BETWEEN THE ·75" AND THE 1·0" POSITIONS SHOULD BE AT LEAST AS STEEP AS THE TARGET CURVE.

S.L. 19/3/46
R.D.H. 3/4/46

20% HARDNESS GRADIENTS

D/184/A/1

Chemical Analysis:

Drillings were taken from a shell for chemical analysis. The following results were obtained:

		Per Cent
Carbon	-	0.53
Manganese	-	0.83
Silicon	-	0.28
Sulphur	-	0.022
Nickel	-	0.46
Chromium	-	1.01
Molybdenum	-	0.27
Vanadium	-	Nil.

Hardness Tests:

A heat-treated shell was wet-ground longitudinally until half the metal had been removed. Hardness tests were then made on the ground face, using the Vickers machine and a 10-kg. load. The results were:

Distance from the Nose, in inches		Vickers Pyramid Number
0.75	-	642
0.65	-	690
0.52	-	690
0.29	-	690
0.24	-	743
0.17	-	734
0.11	-	707
0.08	-	638
0.012	-	657
0.004	-	560

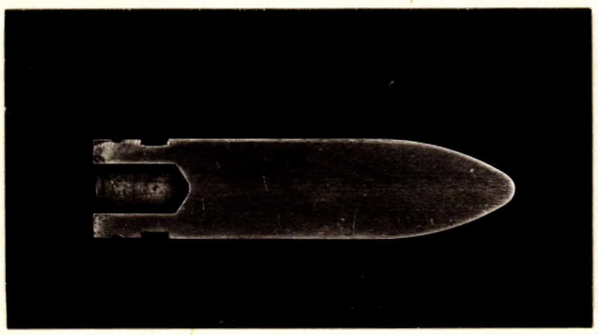
Decarburization:

An unheat-treated shell was wet-ground so that half the metal was removed. This ground face was then polished and etched in 2 per cent nital. Figure 2 illustrates the results obtained:

(Figure 2 follows, on Page 4.)

(Decarburization, cont'd) -

Figure 2.



Etched in 2 per cent nital.

Note white etching layer around the outside.

(Approximately 2/3 actual size.)

-

To check the extent of this decarburized layer, 0.005-inch layers were successively machined from the outside of an unheat-treated shell and analysed for carbon content. The following results were obtained:

Inches from the Surface		Carbon Content, Per Cent
0.005	-	0.21
0.010	-	0.34
0.015	-	0.35
0.020	-	0.45
0.025	-	0.45
0.030	-	0.46
0.035	-	0.48
0.040	-	0.53
Centre	-	0.53

Discussion:

Low hardness results were obtained due to a decarburized layer on the outside of the unheat-treated shell. The depth of this layer will vary from shell to shell. The shell examined by carbon determination showed a decarburized layer of 0.035 inch in depth. It is probable that in the heat treatment for the drop forging operation decarburization was extremely severe and the subsequent machining was not deep enough to entirely remove the lower-carbon material.

(Continued on next page)

(Discussion, cont'd) -

It would not be possible to heat-treat the shells in this condition to give the hardness gradient requirements. It is recommended that new shells be obtained. These should be taken from (a) a batch which have not been decarburized to such an extent prior to machining, and (b) a batch in which the machining operation has removed all the decarburization. If difficulty is found in heat-treating these shells, these Laboratories should be consulted again, in order to establish the proper heat treatment cycle. It should also be mentioned that these shells should be heat treated in a neutral atmosphere for the hardening operation.

Conclusions:

1. A decarburized layer was present in all the shells examined, both prior to and after heat treatment.

2. The shell which was carefully examined by carbon determination was decarburized 0.035 inch.

3. Inability to obtain the proper hardness is due to this decarburization.

Recommendation:

A new batch of shells should be obtained, making sure that machining has eliminated all the decarburized material. Should trouble be encountered in obtaining the proper hardness gradient, these Laboratories should be consulted to establish the proper heat treatment conditions.

oooooooooooo
oooooooo
oo

SLG:LB.