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December 8th, 1941.

## R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1130.

The Use of Ferro-Enamels in Selective  
Carburization.

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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 Material and Nature of Work:

On December 1st, 1941, Messrs. H. D. McLaren and J. K. Hossack, of the FERRO ENAMELS (CANADA) LIMITED, Ottawa, Ontario, sent in a shell gauge for selective carburization using their Heat-Treating Enamel No. 3127.

By a sufficiently prolonged exposure to a carburizing medium at a suitable temperature, a hard surface of high carbon content may be produced on a low-carbon

(Origin of Material and Nature of Work, cont'd) -

steel (case hardening); however, if during the process a portion of the piece thus treated is protected from the carburizing action of the medium, it remains soft and ductile. The selective carburization of certain shell gauges is desirable when because of size or shape the pieces are liable to distortion during the heat treatment. Thus, after quenching a portion of the gauge is retained soft in order to permit straightening if required.

Description of Method:

The portion of the gauge desired soft (central portion of gauge, Figure 1, approximately  $\frac{1}{2}$  size) had been covered with a coating of approximately 1/16 in. thickness of Heat Treating Enamel No. 3127. This special enamel may be applied by simple dipping or, still better, by means of a spray gun. The excess enamel may be removed by brushing. The portion of the gauge desired soft was thoroughly cleaned on one side before the application of the enamel.

To test the protective value of the enamel coating against carburizing, the gauge was given the following treatment (pack carburizing):

1. Heated 8 hours at 1650° F. in "energized" carburizing compound. Cooled slowly in the furnace.
2. Reheated to 1500° F. for 3 hours. Quenched into oil.

During the quenching operation, it was observed that the enamel coating fell off the moment it touched the oil. After the above heat-treatment, the surface which was protected by the enamel appeared bright and was in contrast with the adjacent portions which had been carburized. (See Figure 1).

Hardness Tests:

The Vickers method was used, with various loads. Points 1, 2, 8, and 9 are on the case, outside the bright area; Point 7 is near the edge of this bright surface; while Point 5 is in the centre near the inner sharp edge.

POINT	VICKERS HARDNESS NUMBERS				
	Loads, kilograms -				
	5 kilo-grams	:10 kilo-grams	:30 kilo-grams	: 50 kilo-grams	:100 kilo-grams
1.	701	724	775	779	..
2.	810	810	780	775	..
3.	161	161	161	166	..
4.	165	166	166	174	..
5.	246	256	235	234	227
6.	216	216	216	202	202
7.	310	256	230	244	299
8.	766	762	769	779	..
9.	766	772	775	779	..

Upper edge of gauge: 294 (30-kilogram load).

Discussion of Results and Conclusions:

The various loads used in determining the hardness numbers indicate that the unprotected portions of the gauge submitted to carburization have a case at least 0.035 in. thick. The hardness tests show also that the areas protected by the enamel have remained soft except at the edges, where the hardness numbers indicate that only a slight carburization has progressively taken place at these particular points.

The use of enamel as a protective coating against

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

carburizing was found to have the following advantages corollary to the trial above mentioned:

1. The protective enamel coating is easy to handle.
2. Protection against carburization is good.
3. The protective coating falls off of itself during the quenching.
4. The surface protected by the enamel keeps its shiny appearance even after the heat treatment.
5. The line between the hard and soft portions is sufficiently sharp when proper care is taken in handling the piece which is submitted to selective carburization.

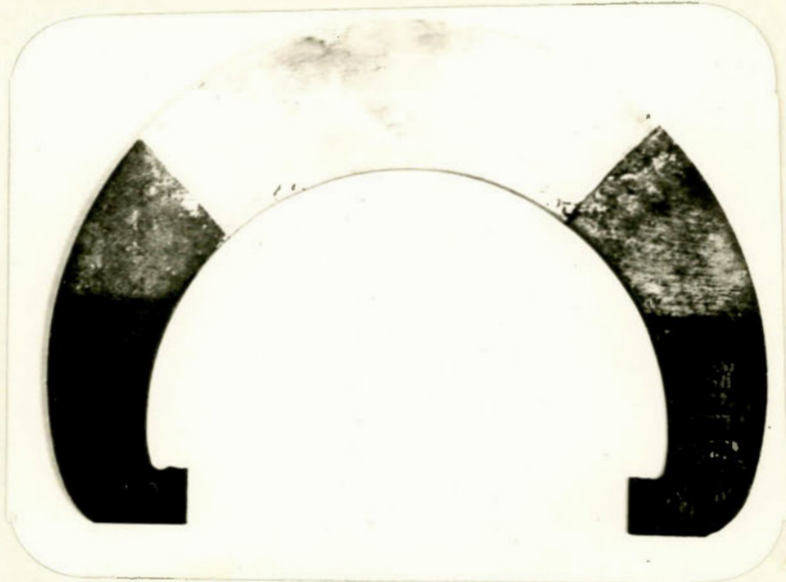
It is therefore concluded that in cases where production does not warrant the expense of installation and operation of a selective electroplating equipment, the use of heat-treating enamel for selective carburization will be found advantageous in several respects, viz., facility of application, facility of handling, and economy.

It is suggested that the heat-treating enamel might also be used with advantage

- (a) for protection against oxidation, in the bright annealing of small articles;
- (b) for protection against nitriding, in selective nitriding; and
- (c) as a protective coating for the low-carbon steel container used for nitriding.

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Figure 1.



(Approximately  $\frac{1}{2}$  natural size)

Showing the bright surface protected from carburization by the enamel.

PHOTOGRAPHED BY THE NATIONAL BUREAU OF STANDARDS  
WASHINGTON, D. C. 20540

A P P E N D I X

Information Note in Connection with  
Report of Investigation No. 1130, "The Use  
of Ferro-Enamels in Selective Carburization."

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THE COMPOSITION OF NO. 3127 ENAMEL  
FOR SELECTIVE CARBURIZATION IS THE PROPERTY  
OF FERRO ENAMELS LIMITED AND IS OBTAINABLE  
FROM:

Ferro Enamels Limited,  
Wombourne,  
Wolverhampton,  
England.

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RP:PES.

