NOTICE: When government or other drawings, specifications or other data are used for any purpose other than in connection with a definitely related government procurement operation, the U. S. Government thereby incurs no responsibility, nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use or sell any patented invention that may in any way be related thereto.
LABORATORIES DIVISION
INFORMAL REPORT

PROJECT TITLE: METALLURGICAL EVALUATION OF EXPERIMENTAL PINION, FINAL DRIVE GEAR

Report No. 3423 (Final)  Date: 21 January 1956
Laboratory Work Order No. 1579

DETROIT ARSENAL
CENTER LINE, MICHIGAN
PROJECT TITLE: METALLURGICAL EVALUATION OF EXPERIMENTAL PINION, FINAL DRIVE GEAR

Report No. 3423 (Final)  Date: 21 January 1956

Prepared by: John Vettraino
Initiation Date of Project: 11 March 1955
Laboratory Work Order No. 1579
PROJECT TITLE: METALLURGICAL EVALUATION OF EXPERIMENTAL PINION, FINAL DRIVE GEAR

OBJECT:

To evaluate the metallurgical characteristics of an experimental pinion gear.

REMARKS:

The microstructure, case depth, and hardness of this pinion were comparable with production fabricated gears and pinions.

MATERIAL SUBMITTED:

Experimental pinion, Ordnance No. 7385298, fabricated from 94517 Boron steel, designated as 4B.

RESULTS AND DISCUSSION:

Hardness tests were conducted on representative areas of the pinion. The results are:

<table>
<thead>
<tr>
<th>Location</th>
<th>Rockwell &quot;C&quot; Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface, crown of tooth</td>
<td>58-59</td>
</tr>
<tr>
<td>Case, pitch line</td>
<td>37-38</td>
</tr>
<tr>
<td>Core, root area</td>
<td>31-32</td>
</tr>
</tbody>
</table>

A microhardness traverse was run through the carburized case at the pitch line and at the root. The results are:
## Pitch Line - 500 g Load - Knoop Indenter

<table>
<thead>
<tr>
<th>Depth, Inches</th>
<th>Knoop No.</th>
<th>Equivalent Rc</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.001</td>
<td>810</td>
<td>63.5</td>
</tr>
<tr>
<td>0.002</td>
<td>786</td>
<td>62</td>
</tr>
<tr>
<td>0.003</td>
<td>786</td>
<td>62</td>
</tr>
<tr>
<td>0.004</td>
<td>765</td>
<td>61</td>
</tr>
<tr>
<td>0.010</td>
<td>760</td>
<td>61</td>
</tr>
<tr>
<td>0.020</td>
<td>745</td>
<td>60.5</td>
</tr>
<tr>
<td>0.030</td>
<td>732</td>
<td>60</td>
</tr>
<tr>
<td>0.040</td>
<td>732</td>
<td>60</td>
</tr>
<tr>
<td>0.050</td>
<td>700</td>
<td>56</td>
</tr>
<tr>
<td>0.060</td>
<td>693</td>
<td>53.5</td>
</tr>
<tr>
<td>0.070</td>
<td>693</td>
<td>53.5</td>
</tr>
<tr>
<td>0.080</td>
<td>675</td>
<td>52</td>
</tr>
<tr>
<td>0.085</td>
<td>668</td>
<td>51.5</td>
</tr>
<tr>
<td>0.090</td>
<td>517</td>
<td>48.5</td>
</tr>
</tbody>
</table>

Effective case depth = 0.080 inches  
Total case depth = 0.105 inches

## Root Line Traverse - 500 g Load - Knoop Indenter

<table>
<thead>
<tr>
<th>Depth, Inches</th>
<th>Knoop No.</th>
<th>Equivalent Rc</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.001</td>
<td>786</td>
<td>63</td>
</tr>
<tr>
<td>0.002</td>
<td>760</td>
<td>61</td>
</tr>
<tr>
<td>0.003</td>
<td>760</td>
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<tr>
<td>0.004</td>
<td>760</td>
<td>61</td>
</tr>
<tr>
<td>0.010</td>
<td>745</td>
<td>60.5</td>
</tr>
<tr>
<td>0.020</td>
<td>745</td>
<td>60.5</td>
</tr>
<tr>
<td>0.030</td>
<td>724</td>
<td>59.5</td>
</tr>
<tr>
<td>0.040</td>
<td>724</td>
<td>59.5</td>
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<tr>
<td>0.050</td>
<td>691</td>
<td>58</td>
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</tr>
<tr>
<td>0.081</td>
<td>617</td>
<td>48.5</td>
</tr>
<tr>
<td>0.089</td>
<td>517</td>
<td>48.5</td>
</tr>
</tbody>
</table>

Effective case depth = 0.081 inches  
Total case depth (estimated) = 0.100 inches
Microscopic examination of specimens taken from the carburized case of the pinion revealed a microstructure consisting of tempered martensite with finely dispersed, small spheroidal carbides (Figure 1). The core microstructure consists of coarse grained, tempered martensite and small areas of finely dispersed ferrite (Figure 2).

Written by:

J. Vetraino

Reviewed by:

R. A. Fulk
Chief, Materials Laboratory

Approved by:

George A. Tuttle
Major, Ordnance Corps
OIC, Laboratories Division
DETOIT ARSENAL
Laboratories Division

TECHNICAL REPORT DISTRIBUTION

Report No. 3423 (Final)

PROJECT TITLE: METALLURGICAL EVALUATION OF EXPERIMENTAL PINION, FINAL DRIVE GEAR

Chief, Materials Branch, Research and Development Division (2)
OIC, Laboratories Division (2)
Chief, Materials Laboratory, Laboratories Division (1)
Office of the Civilian Executive
ATTENTION: Technical Library (1)
INCLUSION SHEET

Report No. 3423 (Final)

Project Directive, dated 11 March 1955

Inclusion 1

Figure 1, Neg. No. A1372, Gear, Final Drive Pinion, 7385298. Representative Case Microstructure

Inclusion 2

Figure 2, Neg. No. A1373, Gear, Final Drive Pinion, 7385298. Representative Core Microstructure

Inclusion 2
OBJECTIVE: To evaluate the metallurgical properties of an experimental final drive pinion.

MATERIAL SUBMITTED: One (1) final drive pinion (stamped #28) representative of a lot of ten (10) pinions manufactured in accordance with Ordnance Drawing 7385298 with the exception that 94817 boron steel was employed in place of the specified alloy steel.

PROCEDURE:

1. Physical test:
   - Hardness: Conduct complete hardness survey as follows:
     a. Rockwell "C" survey on surface of teeth.
     b. Microhardness of carburized case.
     c. Rockwell "C" hardness of core section measured at pitch line.

2. Metallographic: A microscopic examination of the carburized case and core including the following:
   - Case depth estimation, both total and effective, taken at pitch and root area; total case being defined as the distance (measured perpendicularly) from the surface of the case down through the carbon enrichment and effective case depth being defined as the distance (measured perpendicularly) from the surface of the hardened case to a point of hardness equivalent to Rockwell C-50.
   - Microstructure evaluation of case and core sections with representative photomicrographs at 500X of case.
   - Microstructure evaluation of any conditions deviating from normal, with representative photomicrographs at 500X.

3. It is requested that two (2) memorandum reports be prepared and forwarded to Materials Br, Research & Development Division. For further information, contact Mr. I. Binder, extension 23-240.

INITIATED BY:  
I. Binder
Project Engineer: I. Binder

REVIEWED BY:  
E. Macklewicz, Act'g Chief Metals Section

APPROVED BY:  
Jeb P. Jones, Chief Materials Br, R&D

Inclosure 1
Figure 1

Gear, Final Drive Pinion, 7385298. Representative Case Microstructure. Etchant: 2% Nital, 500X Magnification.

Figure 2

Gear, Final Drive Pinion, 7385298. Representative Core Microstructure. Etchant: 2% Nital, 250X Magnification