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R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1758.

Metallurgical Examination of Two Steering End Ball Sockets.

(Copy No. 10.)

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Origin of Material and Object of Investigation:

On November 24th, 1944, the Controller General of the Inspection Board of the United Kingdom and Canada, Ottawa, Canada, submitted two (2) steering end ball sockets. It was reported that these parts had been removed from a vehicle after a field test of approximately 2,900 miles during which the ball sockets had deformed out of round. Under Analysis Requisition O.T. 4307, a complete metallurgical examination was requested.

Drawings C11Q3392 and C11Q3392-B, submitted with the sockets, gave the following material specifications:

(1) Chemical Analysis - (see Table I).

(2) Heat treatment: Quench in caustic solution from 1520° F. (Brinell 477-550), inspect 100 per cent. Draw at 1100° F. for approximately 3 hours to Brinell 207 to 229.

Chemical Analysis:

TABLE I.

	As Found No. 1	As Found No. 2	Specified Analysis
	- Per Cent -		
Carbon -	0.43	0.42	0.38-0.45
Manganese -	0.92	0.92	0.70-0.90
Silicon -	0.22	0.19	0.15-0.40
Phosphorus -	0.015	0.014	0.050 max.
Sulphur -	0.010	0.012	0.050 max.
Copper -	Nil.	Nil.	0.50-0.60
Molybdenum -	0.20	0.22	-

Hardness:

	Brinell Hardness (3,000-kg. load)
No. 1 -	201
No. 2 -	197

Mechanical Properties:

Two (2) tensile specimens (0.282-in. diameter) were prepared from each casting. The mechanical properties are shown in Table II.

TABLE II.

Casting	Maximum stress, p.s.i.	Yield strength, p.s.i.	Elongation, per cent in 1 inch	Reduction in area, per cent
No. 1	93,000	72,000	22	25.8
No. 1	92,000	67,000	22	30.6
No. 2	90,000	68,700	20	30.0
No. 2	93,400	70,000	20	57.1

Microscopic Examination:

Examination of specimens from both castings disclosed a uniform microstructure of tempered martensite with a marked dendritic pattern. See Figure 2.

Discussion:

The chemical composition of the castings is not in complete agreement with the specified analysis. However, the addition of 0.20 per cent molybdenum is considered to more than compensate for the absence of 0.50 to 0.60 per cent copper. Mechanical tests and microscopic examination show that the sockets were quenched and drawn. The Brinell hardness is slightly below specification.

The ball socket joints deformed in service because the yield strength of the material was not sufficient to resist the stresses imposed. Either they were overstressed or the yield strength, corresponding to the lower range of the specified hardness, was too low to withstand service requirements. If the failure was not caused by overstressing, then the yield point (and, therefore, the hardness) must be increased to obtain satisfactory performance. This must be done despite all consideration of the effect of higher hardness on machinability.

The specification covering these parts is not considered satisfactory, because the only control over yield strength is a specified hardness range. The required yield strength should be specified, because variance in heat treatment can produce lower yield strengths for the same hardness value.

Conclusions:

1. The Brinell hardnesses, 197 and 201, are slightly below specification.

2. Better resistance to deformation will be obtained by increasing the yield strength of the material.

3. Specifications covering the ball socket joints should contain a specified minimum yield strength as well as a hardness range.

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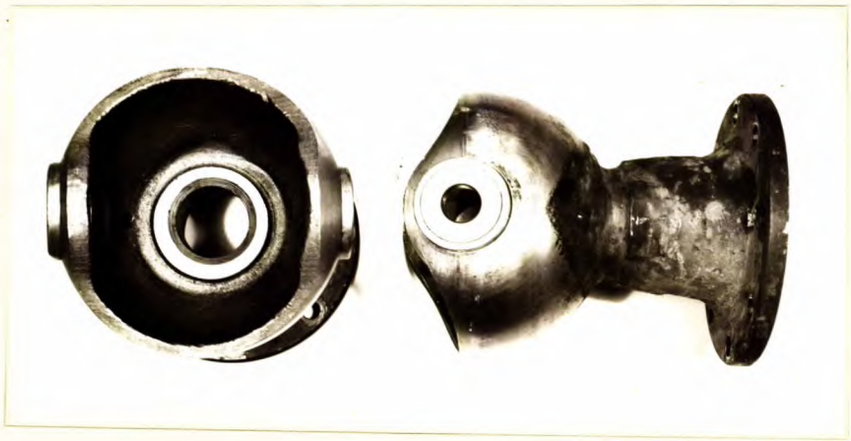
Figure 1.



STEERING END BALL SOCKETS.

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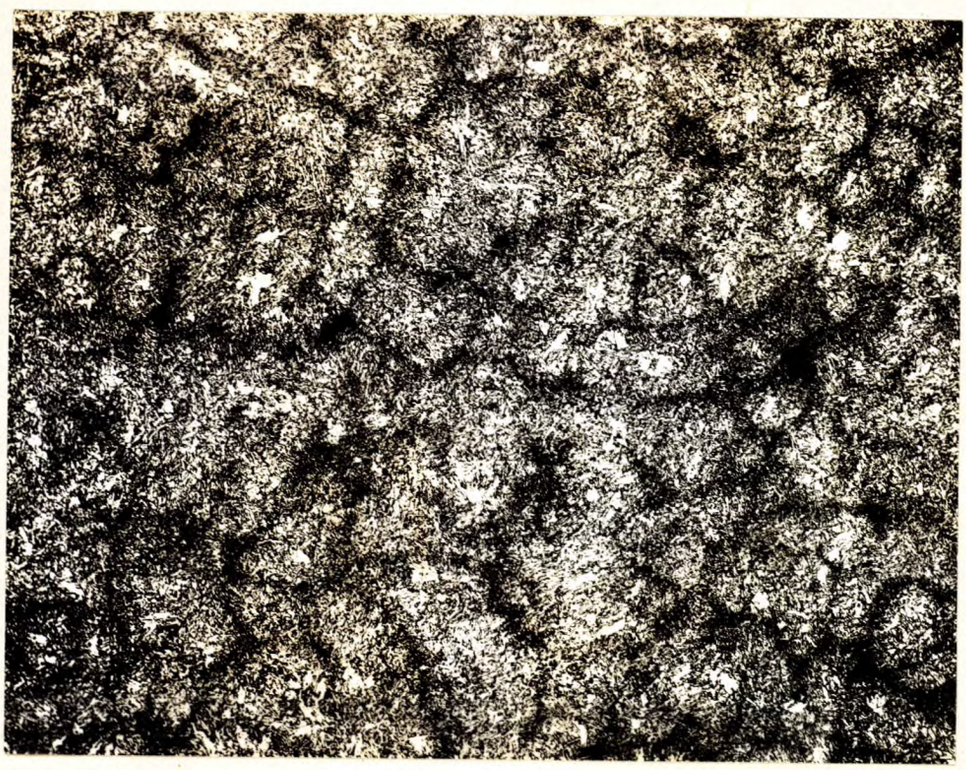
Figure 2.



X100, etched in 2 per cent nital.

MICROSTRUCTURE.

Tempered martensite with
marked dendritic pattern.

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