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O T T A W A June 3rd, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1237.

Examination of Front Axle Spindle
Connecting Rod (Part #1798785).

(Copy No. 23.)

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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Source of Material and Object of Investigation:

Two front axle spindle connecting rods were submitted for examination on May 25th, 1942, by the Inspection Board of the United Kingdom and Canada, 58 Lyon Street, Ottawa, Ontario, under Analysis Requisition No. O.T. 3003. It was desired to

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

know whether the steel complied with specifications for S.A.E. 6135 steel and also whether the material had received the proper heat treatment. The connecting rod which was bent and painted and the one which was unpainted and straight will be referred to in this report as Steels Nos. 1 and 2, respectively.

Chemical Analysis:

- Per cent -

	Steel No. 1	S.A.E. 6135	Steel No. 2	S.A.E. 3150
Carbon	0.40	0.30 - 0.40	0.52	0.45 - 0.55
Manganese	0.87	0.60 - 0.90	0.85	0.60 - 0.90
Silicon	0.31		0.26	
Phosphorus	0.012	0.040 Max.	0.018	0.040 Max.
Sulphur	0.017	0.050 "	0.017	0.050 "
Chromium	0.99	0.80 - 1.10	0.71	0.45 - 0.75
Nickel	-	-	1.40	1.00 - 1.50
Vanadium	0.16	(0.15 Min. (0.18 Desired	0.01	-
Molybdenum	N.D.@		N.D.@	-

@ N.D. - None detected.

Physical Properties:

Condition	As Received Steel No. 1.	Steel No. 2.
Ultimate strength, p.s.i. -	123,400	169,000
Yield point, p.s.i. -	110,000	-
0.2% proof stress, p.s.i. -	-	152,400
Elongation, % in 2" -	24.0	15.0
Reduction in area, per cent -	58.8	37.6
Brinell@ -	262	341
Izod, foot pounds -	22	8

@ Specified Brinell, 255.

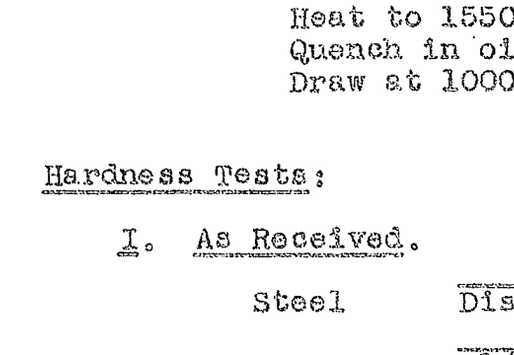
Microscopic Examination:

Figures 1 and 2 are photomicrographs of Steels Nos. 1 and 2, respectively, at X1000 magnification, of specimens etched in a solution of 2 per cent nitric acid in alcohol. The structure of both steels consists of tempered martensite. Steel

(Microscopic Examination, cont'd) -

No. 1 also contains a very little ferrite.

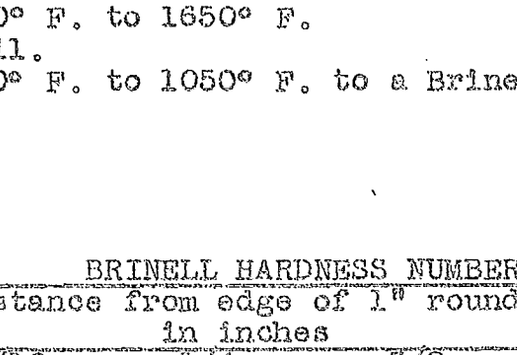
Figure 1.



X1000, etched in 2% nital.

STEEL NO. 1.

Figure 2.



X1000, etched in 2% nital.

STEEL NO. 2.

Heat Treatment:

The specification given on Drawing Part No. 1798785 for the heat treatment of S.A.E. 6135 steel is as follows:

Heat to 1550° F. to 1650° F.
Quench in oil.
Draw at 1000° F. to 1050° F. to a Brinell of 255.

Hardness Tests:

I. As Received.

Steel	BRINELL HARDNESS NUMBERS Distance from edge of 1" round bar, in inches			
	1/10	1/4	3/8	1/2
No. 1. -	264	265	258	262
No. 2. -	341	341	345	342

II. Quenched from 1600° F. and Drawn at 1200° F.

No. 1. -	310	302	314	310
No. 2. -	286	286	282	283

Discussion of Results:

The chemical analysis of the two samples showed that Steel No. 1 had the correct composition for an S.A.E. 6135 steel, and that Steel No. 2 had the composition of an S.A.E. 3150 steel.

Hardness tests indicated that Steel No. 1 had been drawn to the specified hardness range, but that Steel No. 2 did not meet the hardness specification. The small amount of ferrite present in Steel No. 1 is a very minor defect and indicates that the steel was either heated to slightly too low a temperature for quenching or that the quenching was not sufficiently rapid. Although published charts indicate that Steel No. 1 would normally have the correct hardness after being quenched in oil from 1550° to 1650° F. and drawn at 1050° F., heat treating tests carried out in the laboratory showed that the steel would have to be drawn above 1200° F. to obtain a Brinell hardness value of 255.

Published charts indicate that the following heat treatment should be used for Steel No. 2: quenched into oil from 1425°. to 1475° F.; drawn at 1150° F. and quenched from the draw temperature. This would normally produce the desired hardness. Laboratory tests indicate that a higher draw temperature would probably be required for this particular steel.

The ultimate strength and the yield strength of Steel No. 2 were found to be higher than those of Steel No. 1; however, the elastic properties and izod impact values were lower. According to S.A.E. heat treating charts (Steel No. 2 is an S.A.E. 3150 steel), the above heat treatment for this steel should give izod impact values of approximately 35 foot pounds. The low impact strength of the "as received" sample indicates temper brittleness, a common defect in nickel-chromium steels

(Discussion of Results, cont'd) -

that are not quenched from the draw.

Conclusions:

Steel No. 1 meets the specification for hardness and chemical composition. The heat treatment would appear to be satisfactory, although slight variations in the quenching technique may be in order.

Steel No. 2 is an S.A.E. 3150 steel. This steel, if heat treated to the same hardness, should have higher tensile properties than Steel No. 1. The elongation values would, however, be somewhat lower than those of the S.A.E. 6135 steel.

It is understood that some of these tie rods are bending in service and some are standing up to the impact shocks. If breakage were being encountered the deviation of Steel No. 2 from the specification would be considered serious, as it is certainly more brittle than the specified type No. 1. However, as bending seems to be the trouble, Steel No. 2 would certainly have more resistance to deformation. The possibility exists that the specification is at fault and that greater strength is required rather than greater toughness. If, however, a nickel-chromium steel is used in this service, it is essential that it be quenched from the draw if the proper impact strength is to be developed.

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