File.

FILE COPY

O T T A W A December 23rd, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1767.

Investigation on the Reclamation of Track Adjuster Brackets.

(Copy No. 10)

O T T A W A December 23rd, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES

Investigation No. 1767.

Investigation on the Reclamation of
Track Adjuster Brackets.

==========

Origin of Material and Object of Investigation:

On December 10th, 1944, under Requisition No. 681 (A.E.D.B. Lot No. 574, Report No. 9, Section V, Test No. 10), Mr. R. J. Robinson of the Army Engineering Design Branch, Department of Munitions and Supply, Ottawa, Ontario, submitted six (6) Universal Carrier track adjuster brackets for examination.

An accompanying letter (File No. 141-5-8) stated that these brackets had been heat-treated to give a low Brinell (as low as 149) while just meeting the physical properties required by British Standard Specification 592, which calls for approximately 79,000 p.s.i. tensile strength with 15 to 20 per cent elongation. It was requested that heat treatment experiments be carried out to determine whether it was possible to change

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

them to a hardness of 189-229 Brinell. A minimum tensile of 90,000 p.s.i. and a minimum elongation of 10 per cent were required. Since these brackets had already been machine-finished, it was also requested that a special effort be made to employ a heat treatment which would give little distortion.

It is understood that some 700 brackets are involved in this investigation.

Chemical Analysis:

Drillings were taken for chemical analysis.

	AS FOUND	FORD #4
	- Per Cent -	
Carbon	0.43	0.35-0.45
Manganese	0.80	0.70-0.90
Silicon	0.33	0.20-0.40
Phosphorus	0.022	0.05 max.
Sulphur	0.048	0.05 max.
Copper	--	Optional 0.50-1.50
Nickel	Nil.	--
Molybdenum	Trace.	--

Heat Treatments:

1. A bracket was placed in a Vapocarb furnace at neutral atmosphere for 1½ hours at 1800° F. It was then cooled in air to room temperature and drawn at 1000° F. for 2 hours.

2. Preheated at 1000° F. for 45 minutes and transferred to a Vapocarb unit in neutral atmosphere at 1300° F. Twenty-five minutes was then taken to attain 1500° F., where it was held for 1½ hours. The bracket was air-cooled for 15 minutes--this brought the temperature down to 650° F. (gauged with Tempilstiks)--then drawn at 950° F. for 1 hour, cooled in the furnace to 700° F., and followed by an air cool.

3. Preheated at 1000° F. for 1 hour. Transferred to 1200° F., brought up to 1550° F. in 35 minutes, held for 1 hour; air-cooled for 15 minutes, and drawn at 900° F. for 1 hour; then cooled to 700° F. in the furnace, followed by an

(Heat Treatments, cont'd) -

air cool to room temperature.

Effect of the Draw Temperature on Hardness:

A bracket was normalized at 1550° F. for 1½ hours, the Brinell hardness was taken, and then it was cut into 3 pieces. The three pieces were drawn at different temperatures, after which hardnesses were taken. Table III shows the results obtained.

Table III.

Draw Temperature, °F.		Brinell Hardness No.
Normalized - No draw	-	207
800° F.	-	197
900° F.	-	197
1000° F.	-	197

Mechanical Tests:

The mechanical tests were made on both 0.252- and 0.282-inch diameter tensile specimens machined from the brackets. Results obtained from such specimens are usually lower than those obtained from regular test coupons poured from the same heat of steel. The reason for this is the difficulty of obtaining a satisfactory bar from a casting. Table I lists the results obtained from the brackets heat-treated as shown above. The yield point was obtained by the drop of the beam. Elongations are reported for 1 inch, which is standard for the small-diameter test specimen used. The Brinell hardness reported is from the surface of the bracket itself.

Table I.

Heat Treatment No.	Diameter of Test Specimen, inches	Maximum Stress, p.s.i.	Yield Strength, p.s.i.	Elongation, per cent in 1 inch	Reduction of Area, per cent	Brinell Hardness
1	0.252	101,500	78,000	7	--	201
2	0.282	93,600	62,400	12	18	187
3	0.282	98,300	69,300	10	11	197

Warpage:

Three of the castings were checked for warpage, in the 'as received' condition and after heat treatment. They were placed on a flat plate and checked at three corners (A, B and C in Figure 1) with a feeler gauge. The centre hole X was measured in diameter. The results are shown in Table II. No bracket having had Heat Treatment No. 2 was checked.

Figure 1.

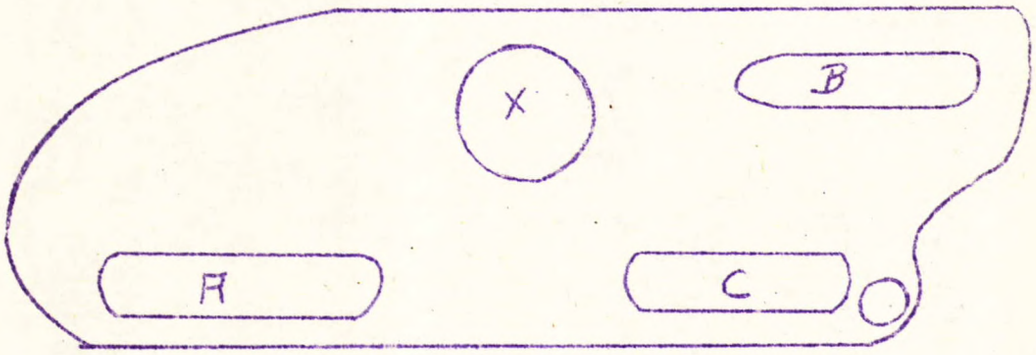

Table II. - Warpage Measurements.

Bracket No.	Corner	'As Received'	Heat Treatment No.	Out of Flat After Heat Treatment, inches
4	A	0.010	3	0.015
4	B	0.007	3	0.004
4	C	0.002	3	0.003
4	X	2.002	3	2.000
5	A	0.008	3	0.010
5	B	0.003	3	0.004
5	C	0.002	3	0.004
5	X	2.0025	3	2.000
6	A	0.011	1*	0.006
6	B	0.003	1	0.0025
6	C	0.000	1	0.0006
6	X	2.0025	1	1.998-2.005

* The draw treatment was omitted for Bracket No. 6.

Discussion:

Heat Treatment No. 1, which consisted in normalizing from 1800° F., gave the highest tensile strength but the elongation did not meet the minimum requirement of 10 per cent.

(Discussion, cont'd) -

A lower normalizing temperature, such as used in Heat Treatments Nos. 2 and 3, although lowering the Brinell and tensile somewhat, increased the elongation. No change in hardness was observed by varying the draw temperature of a normalized bracket from 800 to 1000° F. Heat Treatment No. 3 appears to be the most satisfactory. In production it would not be expected that the exact time cycles at the preheat and heating-up temperatures should be employed.

Warpage on the brackets varied considerably. At some points it was increased over the original whereas at others it was decreased. Brackets Nos. 5 and 6 were taken to the experimental garage in Ottawa and were placed on a universal carrier. It was impossible to get the pin into the centre hole of Bracket No. 5 using a press with 60 tons pressure; the pin may not have been properly aligned, however. The pin was readily fitted into Bracket No. 6, using a 30-ton maximum load. This bracket when placed on the vehicle appeared to be satisfactory. The trial established two main points regarding warpage:

(1) The amount which the bracket was out of flat was not a serious matter. The bracket is bolted onto a flat plate and the warpage is readily taken up.

(2) An endeavour should possibly be made, in heat treating, to maintain the tolerances on the centre hole.

In regard to point 2 above, it was found that Ford Motor Co. used 30 tons at the start to press-fit the pin into the hole. In order to push the pin the last $\frac{1}{8}$ inch, however, they have to jam the press. They estimate that the force there applied is roughly 120 tons.

In view of this latter situation, it is felt that about 12 brackets should be submitted for heat treatment. On

(Discussion, cont'd) -

some of the brackets an attempt should be made to maintain the centre-hole diameter, whereas no such precaution should be taken on the others. These should then be submitted to the Company for their inspection. Decisions can then be made regarding the necessity of maintaining the degree of straightness.

Conclusions:

1. The brackets are cast from steel that conforms to the chemical analysis specifications for Ford No. 4.

2. The following heat treatment gave the proper physical requirements:

Preheated at 1000° F. for 1 hour,

Transferred to 1200° F. and brought to 1550° F. in 35 minutes. Held for 1 hour at 1550° F. Air cooled for 15 minutes. Drawn at 900° F. for 1 hour, cooled to 700° F., and cooled in air.

3. Variation of draw temperature from 800-1000° F. did not appreciably change the hardness on the one bracket tested.

4. Warpage out of flat does not appear to be as serious as that of the centre hole.

Recommendations:

Twelve brackets should be heat-treated for approval by the Company's inspection department. Precautions can be taken on some of them, such as packing with sillimanite, to keep the centre-hole warpage to a minimum.

oooooooooo
ooooooo
o

SLG:LB.