O T T A W A  July 24th, 1944.

# R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1686.

## Examination of Welded Universal Carrier Track Pins.

(Copy No. 10.)

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Origin of Material:

Poor results had been reported from tests made on collars welded to experimental Universal Carrier NE 8650 pins. The test work described herein was undertaken with the object of improving the quality of these welds.

NE 8650 steel is to be used for track pins. A preliminary check of the pull test on several collars welded to these pins (by a production welder) indicated that the minimum requirements of 7,000 pounds could not always be met. It was thought that an investigation of various welding techniques should be carried out in order to establish a procedure which would produce uniformly satisfactory results. Accordingly, 150 welding collars were obtained from the Ford Motor Company

(Origin of Material, cont'd) -

of Canada Limited, Windsor, Ontario, and 24 collars from the Campbell, Wyant and Cannon Foundry Co., Muskegon, Michigan.

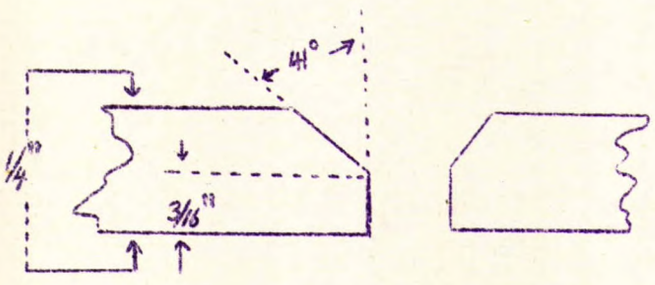
The austempered NE 8650 pins used in these experiments were heat-treated by the Commercial Steel Treating Corporation, Detroit, Michigan. The quenched-and-drawn NE 8650 pins were heat-treated in these Laboratories.

Object of Investigation:

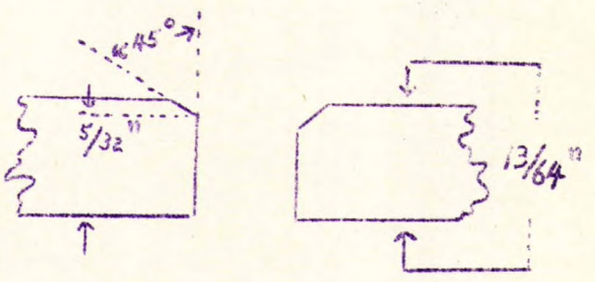
To establish a welding technique that would produce a welded joint capable of withstanding a pull test consistently in excess of the 7,000-pound minimum specified.

Procedure:

1. Collars submitted by Campbell, Wyant and Cannon, Muskegon, Michigan, and Ford Motor Company of Canada, Windsor, Ontario, were examined. Below are sketches of these collars, which differ considerably from one another:




CAMPBELL, WYANT & CANNON
COLLAR.
Machined groove.




FORD MOTOR CO., WINDSOR,
COLLAR.
Stamped groove.

2. Both austempered and quenched-and-drawn pins were used in welding tests and also both types of collars. A.C. welding was used, and both Lincoln Fleetweld No. 7 (3/32 in. dia.) and Wilson No. 98 (3/32 in. dia.) electrodes. Fleetweld No. 7 electrode conforms to the AWS E 6012 specification and Wilson No. 98 to AWS E 6010 specification. The

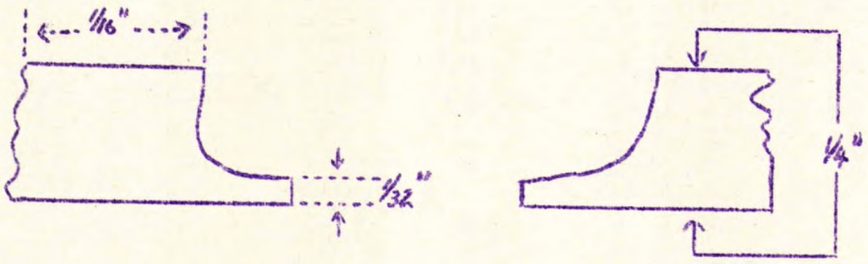
(Procedure, cont'd) -

following table lists the results secured (these figures are averages of the number of tests indicated):

| No. of Tests | Collar Type | Electrode Used | Pull, in pounds | Condition of Pin |
|---|---|---|---|---|
| 6 | Ford Motor | Fleetweld No. 7 | 6,283 | Austempered. |
| 6 | Campbell | " | 7,950 | Quenched and tempered. |
| 6 | Ford Motor | " | 6,700 | " " " |
| 6 | Campbell | " | 7,810 | Austempered. |
| 6 | Ford Motor | Wilson No. 98 | 7,060 | " |
| 6 | Campbell | " | 8,050 | " |
| 6 | Ford Motor | " | 6,680 | Quenched and tempered. |
| 6 | Campbell | " | 8,110 | " " " |

Although some of these averages are above the specified minimum, some individual tests ranged as low as 4,650 pounds and some as high as 10,550 pounds. Considerable difficulty was encountered during welding in preventing flux from being trapped in the narrow groove. Low physical results were always associated with poor fusion and slag entrapment.

3. Twelve collars were machined in these Laboratories as indicated by the sketch below:




These collars were welded to pins as before, using the same electrodes. The following table lists the results secured:

| No. of Tests | Electrode Used | Pull, in pounds | Condition of Pin |
|---|---|---|---|
| 6 | Wilson No. 98 | 8,307 | Quenched and tempered. |
| 6 | Fleetweld No. 7 | 8,080 | Austempered. |

In each case only one of the series fell below the specified 7,000-pound pull test. Less difficulty was encoun-

(Procedure, cont'd) -

tered with slag entrapment.

Discussion:

It will be noted that in every case, irrespective of the electrode used or the condition of the pin, the collar supplied by Campbell, Wyant and Cannon gave superior results. The Ford Co. collar, with its longer nose, does not permit as deep a penetration and this is reflected in the pull test results.

Collars machined here to give a wider and deeper groove gave the best results of all tests. Here again, however, some results were below the specified minimum. The improvement secured points the way to a solution of the problem. The 1/32 inch nose at the bottom of the collar is quite sufficient to act as a chill and retain the molten weld metal. The wider and deeper groove presents opportunity for deeper penetration, and this is reflected in the test results. It should be noted that this weld is tested in shear, and an increase in weld depth naturally tends to increase shear strength. The type of joint design employed is capable of developing high shear efficiency.

In the case of both collars submitted for tests, the groove in which weld metal is to be deposited is too narrow to permit good electrode manipulation and is conducive to slag entrapment. It is considered axiomatic in welding circles that grooves less than 45 degrees are unacceptable due to the above reasons.

The AWS E 6012 (Fleetweld No. 7) electrode has the characteristic of bridging wide gaps. For this reason it is referred to as the "poor fit-up" electrode. This characteristic is a disadvantage for this particular job, in that deep penetration is not secured. The AWS E 6010 (Wilson No. 98) has deep

(Discussion, cont'd) -

penetration characteristics but is designed to operate on reverse polarity in D.C. welding. Unfortunately, it was necessary to employ A.C. welding since D.C. equipment available at the time of testing could not satisfactorily handle these small-diameter electrodes.

The shear strength of the weld depends upon the final composition of the weld metal. This composition is a mixture of metal from the electrode and fused pin metal. It is probable that an electrode of the AWS E 7010 type, or of even higher strength, would yield, with the fused pin metal, a weld of considerably higher average strength. This, combined with a collar design permitting good penetration, would provide consistently greater strength than the specified minimum. It is regrettable that such electrodes were not available to confirm this opinion.

During these tests it was noticeable that the reinforcement of the weld had considerable effect upon the pull strength. A reinforcement of 1/8 inch could provide as much as 1,000 pounds improvement over a flush weld. There seems to be no reason why such reinforcement cannot be consistently employed.

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CONCLUSIONS:

(1) The findings of the investigation are inconclusive. Subsequent experiments will be reported at a later date.

(2) Both types of collars submitted are unsatisfactory in design.

(3) Collars machined in these Laboratories gave superior pull tests.

(Continued on next page)

(Conclusions, cont'd) -

(4) It is probable that the pull strength can also be improved by

(a) Use of AWS E 7010, or even higher strength, electrodes.

(b) Consistent use of a 1/8 inch weld reinforcement.

Recommendations:

1. Should a large number of collars of the types submitted for tests be on hand, a simple drilling operation would make them usable. This would make them conform to the design shown above, which gave superior test results.

2. The use of higher strength electrodes should be given consideration.

3. Weld reinforcements of 1/8 inch or as high as 3/16 inch should be used if permissible.

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HJN:LB.