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O T T A W A January 21st, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1579.

Investigation on the Canadian Dry Pin Rivetting Tip.

(Copy No. 14.)

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Abstract

The rivetting tips of Canadian Dry Pins have been examined. The structures and hardnesses of tips which failed during rivetting and those which were of excellent peening quality are compared. A spheroidal structure is associated with good rivetting quality.

General Introduction:

SAE 9255 steel, homogeneously hardened, is being used for the manufacture of the Canadian Dry Pin. This is an air-hardening steel. Until recently, considerable difficulty has been encountered in producing a suitable tip for rivetting. From time to time track assembly plants would complain about the tips being too hard and cracking during rivetting. Also, the average time for rivetting one pin was more than 45 seconds. This was considered excessive and slowed up assembly of the track. The use of

(General Introduction, cont'd) -

hot rivetting was considered unpractical, although these Laboratories had always been of the opinion that in so far as hot rivetting is concerned, a method of heating the tips by induction could be worked out. In addition, the plant softening the tips (Cockshutt Plow Co.) had to be careful not to draw the pin to any great distance up the longitudinal axis as only 1½ inches was allowed by specification.

Since January 10th of this year, pins have been produced with excellent rivetting tips. The rivetting time has been cut down to approximately 10 seconds per pin. It was thought that an examination of the various tips was in order.

Origin of Material:

Tips representative of four different sets of pins were received for examination:

Lot No. 1. - Two (2) pins which had been in service for over 500 miles. No trouble was encountered in the field with the tips of these pins.

Lot No. 2. - Five (5) pins which had broken on rivetting at Hull Iron and Steel Foundries, Hull, Quebec, on January 4th, 1944. One pin from the same lot but which had not been rivetted. All these pins had been given a cyanide treatment and drawn to 45-51 R. 'C'. They had then been reclaimed by drawing at a higher temperature to meet the hardness limits of 42-48.

Lot No. 3. - Four pins, representing 14,000 pins of good rivetting quality received at Hull Iron and Steel Foundries during the week of January 10th, 1944.

Lot No. 4. - One tip received from Mr. G. Wedlake of the Cockshutt Plow Co., Hamilton, Ontario, on January 13th, presumably

(Origin of Material, cont'd) -

of the same type as Lot No. 3, on previous page.

Hardness:

The tips were cut transversely at the shoulder adjoining the regular diameter of the pin. Hardness readings were taken on the face of the transverse section, using the Rockwell machine 'C' scale. The results listed in Table I are the average of 3 readings.

TABLE I.

Lot No.	Pin No.	Hardness, Rockwell 'C'	Remarks
1	1	24.5	Unbroken in service.
1	2	24	" " "
2	1	30	Broken on rivetting.
2	2	35	" " "
2	3	36	" " "
2	4	38	" " "
2	5	37	" " "
3	1	20	Unbroken. Satisfactory on rivetting.
3	2	33	do.
3	3	26	do.
3	4	25.5	do.
4	1	21.5	do.

One tip taken from the pin in Lot No. 2 which had not been rivetted was tested for surface and core hardness, using the Vickers machine with a 10-kilogram load. The results were:

	V.H.N.
Surface	- 306
Core	- 250

Carbon Analysis:

A carbon analysis was made on the tip submitted by the Cockshutt Plow Co.,

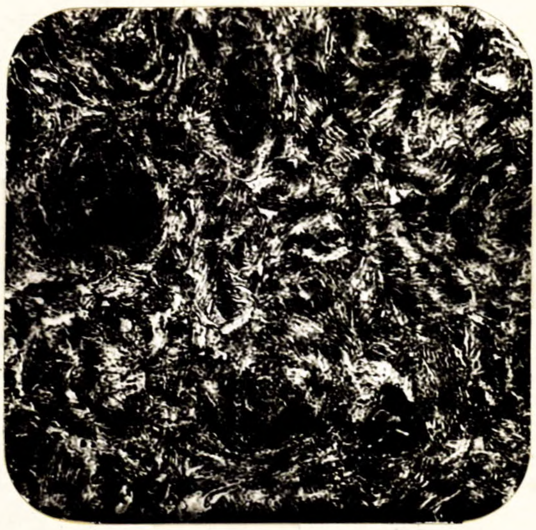
Lot No. 4, above. - Carbon, 0.57 per cent.

-

Microscopic Examination:

The tips were examined under the microscope after polishing the transverse faces and etching in 2 per cent nital. Figure 1, taken at X500 magnification, illustrates the distorted structure of the tips of Lot No. 1. Figure 2 (X500) shows the finely divided tempered martensite which is characteristic of the pins in Lot No. 2. Figure 3 (X1000) is representative of Lots Nos. 3 and 4. A spheroidal structure has been obtained. Figures 4 and 5 (X250) are taken at the surface of pins from Lots Nos. 1 and 3 respectively. There is 0.002-inch decarburization shown in Figure 5 and none at all in Figure 4.

Figure 1.



X500, etched in 2
per cent nital.

Note distorted structure.

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(Continued on next page)

Figure 2.

X500, etched in 2
per cent nital.

TEMPERED MARTENSITE.

Figure 3.

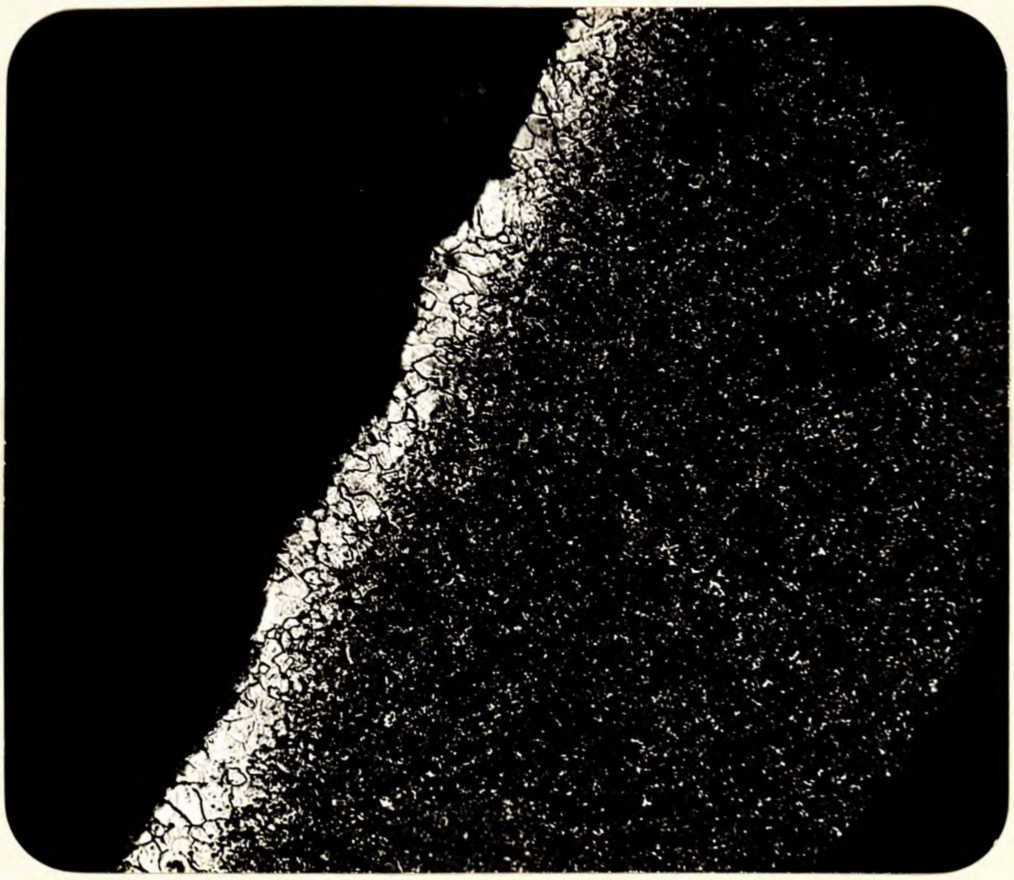
X1000, etched in 2
per cent nital.

SPHEROIDAL STRUCTURE.

Figure 4.

X250, nital etch.
SURFACE OF A TIP FROM LOT NO. 1.

Figure 5.



X250, nital etch.
SURFACE OF A TIP FROM LOT NO. 3.
Note decarburized layer.

Discussion:

The distorted structure observed with pins of Lot No. 1 indicates that the effect of rivetting penetrates through the entire length of the tip. The depth of this effect, of course, is influenced by the hardness of the tip.

The pins of Lot No. 2 varied in hardness from Rockwell 'C' 30-38. This high hardness makes rivetting extremely difficult. The tip-softening process for these pins evidently was merely a draw treatment, probably around 1100° F. Vickers hardness tests on an unrivetted pin of this lot definitely showed that the surface was harder than the core. This would suggest a higher carbon or nitrogen content, due to the presence of a cyanide skin. This lot of pins had been treated in cyanide baths in order to prevent decarburization on the hardening treatment. This harder skin could be expected to crack up on rivetting.

The spheroidal structure obtained for pins from Lots Nos. 3 and 4 indicates a change in the tip-softening process. These tips are probably being alternately heated above and below the lower critical (1400° F. approximately), a standard spheroidizing procedure which, by alternate solution and precipitation of carbides, allows for a coarsening of carbide particle size.

For SAE 9255 steel the above process need not be very long. This structure appears to be excellent for rivetting and whereas it formerly was difficult to rivet pins of hardnesses higher than 27 R. 'C' in the core, it now appears that the 30 R. 'C' maximum allowed by the specification still gives a reasonably good rivetting tip. However, it would be advisable to check on the rivetting process from time to time by microscopic examination, to ensure the presence of this structure, (Discussion, cont'd) -

especially when the hardnesses appear to be running high.

It is interesting to note that there is a slight amount of decarburization in the pin of the spheroidal type. It is felt that this is a good thing, in so far as the rivetting operation is concerned, nor is it regarded as being serious from the fatigue strength angle for C.P.R. pins of the Valentine type had low carbon tips of 150-180 Brinell and were very satisfactory, consequently high strength material in the tip does not appear to be necessary for this service. Indeed, the more ductile lower strength material would better withstand heavy blows without cracking. No decarburization is noted in pins from Lot No. 1. Pins from Lot No. 2 appeared to have a high carbon area to a depth of about 0.010 inch which etched somewhat deeper, but this could not be reproduced satisfactorily by a photomicrograph.

CONCLUSIONS:

1. Peening caused distortion of the metal right up to the shoulder of the pins. The hardness of the tip determines the depth to which this phenomenon occurs.

2. The hardnesses of the pins unbroken in service were 24-24.5 Rockwell 'C'.

3. The hardnesses of the pins broken during the rivetting operation varied from 30-38 Rockwell 'C'.

4. Spheroidal structure indicates a satisfactory rivetting tip. The hardnesses of these tips range from 21.5-33 Rockwell 'C'.

5. No attempt should be made to eliminate decarburization at the tip surface as it is thought that this should

(Conclusions, cont'd) -

aid rivetting and in no way impair service quality.

6. A case on the tip cracks on rivetting.

7. An occasional check should be made on the tip-softening process to ensure that spheroidization is taking place.

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