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OTTAWA March 28, 1945.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1824.

Metallurgical Examination of Defective Striker Needles for Fuze 119B Mk. 10.

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(Copy No. 10.)

Bureau of Mines
Division of Metallic
Minerals
-
Physical Metallurgy
Research Laboratories

CANADA

DEPARTMENT
OF
MINES AND RESOURCES

Mines and Geology Branch

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Origin of Material and Object of Investigation:

On February 7, 1945, under Analysis Requisition No. O.T. 4327, the Controller General of the Inspection Board of United Kingdom and Canada, Ottawa, Ontario, submitted four (4) defective striker needles for examination. It was reported that the needles, which had been machined from cold-drawn SAE 1113 bar stock, were brittle and that the steel appeared to be defective.

Continuing the same investigation, on February 24, 1945, the Inspection Board submitted, under Analysis Requisition No. O.T. 4333, samples of SAE 1113 cold-drawn bar stock and additional striker needles. These needles had been subjected to a bend test and had been found satisfactory.

It was requested that both the satisfactory and the defective needles be examined microscopically to determine

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

cause of failure to pass bend tests, also that the bar stock be used for experimental heat treatments to find out whether stress relief would improve the functioning of striker needles made from this material. The following stress-relief experiments were suggested:

That Izod and tensile bars be machined and tested

(a) as received,
(b) after stress relief at 750° F.,
(c) after stress relief at 950° F.,
(d) after stress relief at 1100° F., and
(e) after normalizing at about 1650° F.

Chemical Analysis:

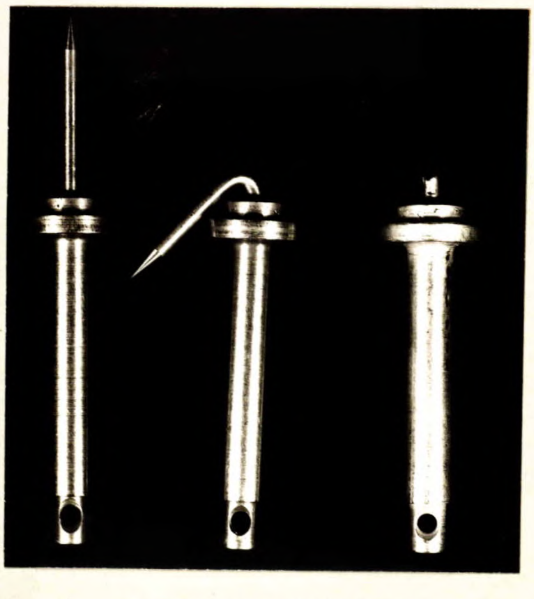
The chemical compositions of needles and bar stock were found to be as follows:

	Defective Needles	Satisfactory Needles	Bar Stock
		- Per Cent -	
Carbon -	0.18	0.09	0.09
Manganese -	0.95	0.82	0.81
Sulphur -	0.283	0.229	0.279

Macroscopic Examination:

Striker needles are considered defective if they break when bent (see Figure 1).

Figure 1.



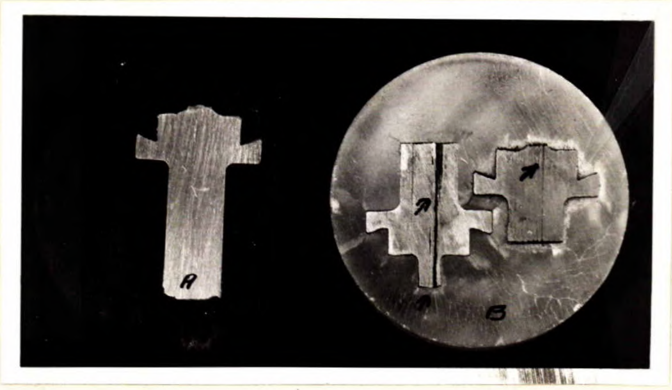
STRIKER NEEDLES.
(Approximately to size).

-

(Macroscopic Examination, cont'd) -

Defective and satisfactory needles were sectioned longitudinally and macro-etched with 50 per cent HCl, to determine the presence of internal defects. As shown in Figure 2, a pipe in the defective needles extends from the thicker section up into the needle. The metal in the striker needles which did not break is sound.

Figure 2.



LONGITUDINAL SECTIONS MACRO-ETCHED WITH 50 PER CENT HCl.

(A) Satisfactory striker needle.
(B) Defective striker needles; arrows indicate pipe.

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Hardness:

	V.H.N., (10-kg. load)
Satisfactory needles	200-207
Defective needles	190-207

Microscopic Examination:

Microscopic examination confirmed the presence of internal defects in the broken needles as well as the soundness of the others. Figures 3 and 4 illustrate the extent of this pipe defect, which ranged from elongated bands of mixed oxide and sulphide inclusions to large cavities in the extreme condition.

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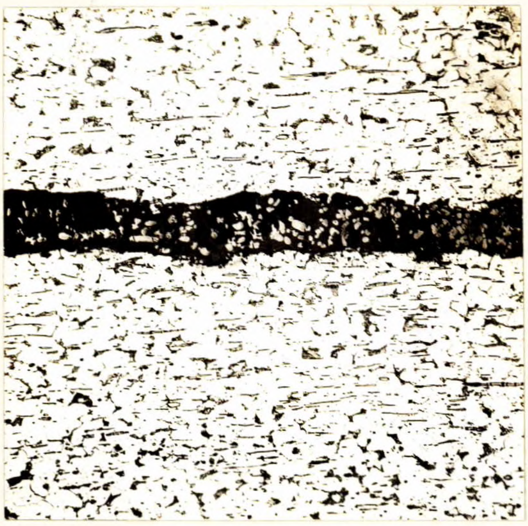
(Microscopic Examination, cont'd) -

Figure 3.



X100, etched in
2 per cent nital.

PIPE, CONTAINING SULPHIDE
AND OXIDE INCLUSIONS.

-

Figure 4.

X35, unetched.

PIPE CAVITY WHICH EXTENDED INTO NEEDLE.

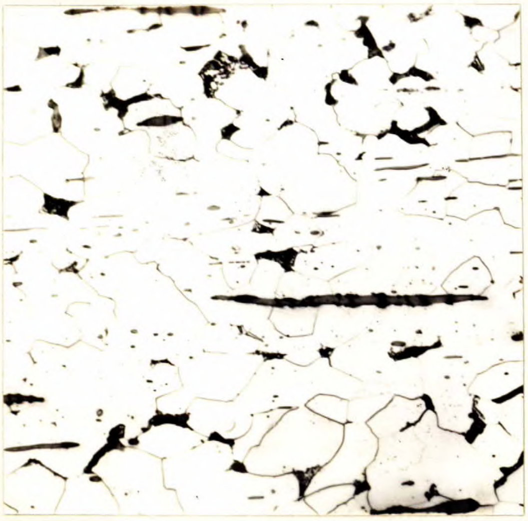
-

The microstructures of satisfactory and defective needles were similar, consisting of ferrite and pearlite with numerous elongated sulphide and silicate-sulphide inclusions

(Microscopic Examination, cont'd) -

typical of drawn SAE 1113 steel. Examples of these microstructures are shown in Figures 5 and 6. The larger proportion of pearlite (dark constituent) in the microstructure of the defective needles substantiates the higher carbon content found by chemical analysis.

Figure 5.



X250, etched in
2 per cent nital.

MICROSTRUCTURE OF SATISFACTORY
STRIKER NEEDLE.

Figure 6.

X250, etched in
2 per cent nital.

MICROSTRUCTURE OF DEFECTIVE
STRIKER NEEDLE.

Stress Relief:

Tensile and Izod specimens were machined from the bar stock supplied and were tested after the suggested heat treatments. Results are shown in Table I.

(Continued on next page)

(Stress Relief, cont'd) -

TABLE I.

Heat treatment	Maximum strength, p.s.i.	Yield strength, p.s.i.	Per cent elongation, 1-in. gauge	Reduction in area, per cent	Izod impact, ft-lb.	Vickers hardness, 10-kg. load
As received	96,000 95,800	88,700 90,000	17.0 19.0	38.7 38.0	5, 6 5, 5	212-217
750° F., 1 hour	91,000	82,200	21.0	40.3	3, 4	202-207
950° F., 1 hour	85,800 85,500	74,900 75,800	24.0 24.0	41.9 43.5	9,11 10,12	212-217
1100° F., 1 hour	83,600 82,000	70,600 71,800	26.0 26.0	46.8 46.8	12,15 12,14	193-197
Normalized: 1650° F.	75,200 74,500	55,700 55,200	33.0 36.0	46.7 50.0	33,37 36,38	212-217

Discussion:

Failure of some striker needles to pass bend tests may be attributed to internal defects (pipe) which weakened the needle and may also have resulted in brittleness since the metal about areas of pipe is prone to segregation.

The higher carbon content of the defective needles would be significant only if it resulted in higher hardness and less ductility. This does not seem to apply to the striker needles examined, since there was no appreciable difference in hardness (190-207 Vickers).

Possible variations in mechanical properties from stress-relieving heat treatments have been shown in Table I. It may be that higher Per Cent Elongation and Impact values would improve the functioning properties of sound striker needles. However, no heat treatment will overcome the effects of pipe. The use of sound bar stock is the first consideration if the production of defective striker needles is to be eliminated.

(Continued on next page)

(Discussion, cont'd) -

If greater ductility and toughness are required in striker needles machined from bar stock, it would be advisable to change from SAE 1112 to a higher-carbon steel (with suitable machining characteristics) which would respond to such heat treatments as austempering. The present use of cold-drawn SAE 1112 steel is warranted by good machinability rather than high ductility and toughness in the final product.

Conclusions:

1. Failure of some striker needles to pass bend tests is attributed to pipe defects which weakened the needle and may have resulted in the metal being brittle.

2. The suggested stress-relieving heat treatments increased the ductility and impact strength but decreased maximum and yield strength.

3. The use of sound bar stock, rather than stress relief, is the first consideration in eliminating production of defective striker needles.

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