O T T A W A June 19th, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1245.

Investigation of Drop Forged Naval Gun Cam.

(Copy No. 16.)

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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Origin of Material and Object of Investigation:

On June 1st, 1942, Lieut. Commander (E) G. Taylor, R.N.V.R., of the British Admiralty Technical Mission, 58 Lyon Street, Ottawa, Ontario, submitted a drop forged unmachined cam. In an accompanying letter (dated June 1st, Reference No. 11-11-5-1), it was requested that the cam be sawn up and etching and fibre run tests taken.

In Lieut. Commander (E) G. Taylor's letter of

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

February 4th, 1942, (Reference No. 11-11-5-3), the chemical analysis and physical properties of this material are outlined. Material submitted for testing at that time, reported on in P.M. Lab. Report No. 5007, met these physical requirements.

Macroscopic Examination:

Figure 1 is a photograph of the cam, about $\frac{1}{4}$ size.

Figures 4, 5, and 6 are photographs showing the forging lines on etched sections. This structure was developed by etching in hot 38% HCl, 12% H_2SO_4. These pictures are also about $\frac{1}{4}$ size.

Physical Tests:

Figure 5 shows where test bars were taken for physical tests. The results are reported in Table I.

Table I. - Physical Tests.

	Specified	Test Bar No. 1	2	3	4
Ultimate tensile strength, t.s.i.	43	53	53	52.2	53
Yield strength, t.s.i.	29	29.2	28.6	28	29.2
Elongation, per cent	19.5	12	19	21.9	21.9
Reduction in area, per cent	44.9	17.6	34.6	36.4	39.2
Izod impact, foot pounds	20	3	7	10	12

Microscopic Examination:

Sections for the microscopic examination were obtained from under the hub and also from out in the plate. Figure 6 is a photomicrograph of the structure under the hub at 100 diameters. Figure 7 is a photomicrograph of the structure in the plate at 100 diameters.

A piece was normalized at 1600° F. Figure 8 shows the resulting structure.

Another piece was normalized at 1600° F., oil quenched

(Microscopic Examination, cont'd) -

from 1550° F., and drawn at 1200° F. The resulting structure is shown in Figure 9.

Discussion of Results:

The macro-etching shows that the lines of forging are in the proper direction to develop the best properties in the forging.

The low reduction in area and low impact strength point to faulty heat treatment. This is verified by the photomicrographs. The structure is characteristic of that resulting from forging with no subsequent heat treatment. As illustrated in Figure 8, normalizing will do much to refine this structure and develop higher physical properties, while, as reported in our P.M. Lab. Report No. 5007 (Feb. 19th, 1942), an oil quench and draw will develop maximum toughness.

Conclusions:

1. The forging practice is good.
2. The forging received no subsequent heat treatment.

Recommendations:

It is not possible to state a definite heat treatment schedule for these forgings, as this will have to be worked out by the manufacturer to suit production conditions. As a starting point, however, the following procedure is outlined:

The forgings should first be normalized. The suggested treatment here is to heat up the parts to 1600° F., soak at 1600° F. for 4 hours, and air cool. This soaking period may vary from, say, two hours to six hours, depending on the cooling rate from the forging temperature.

After normalizing, the rough machining may be done.

For quenching, the parts should be heated up to

(Recommendations, cont'd) -

from 1525° F. to 1550° F., held at that temperature for from 2 to 4 hours, and then quenched in oil.

Following the quench the parts are immediately tempered at 1200° F., held at this temperature for from 2 to 4 hours, and then quenched again in oil. It may be necessary to vary this temperature somewhat when this heat treatment is being done on a large scale. The parts should be tempered to a hardness of about 235 V.P.N. and the tempering temperature adjusted to suit.

It should be remembered that the treatments outlined above, particularly the normalizing treatment, may have to be varied from time to time to compensate for varying forging conditions. The above outlined heat treatment should therefore only be regarded as a starting point from which to develop the proper practice.

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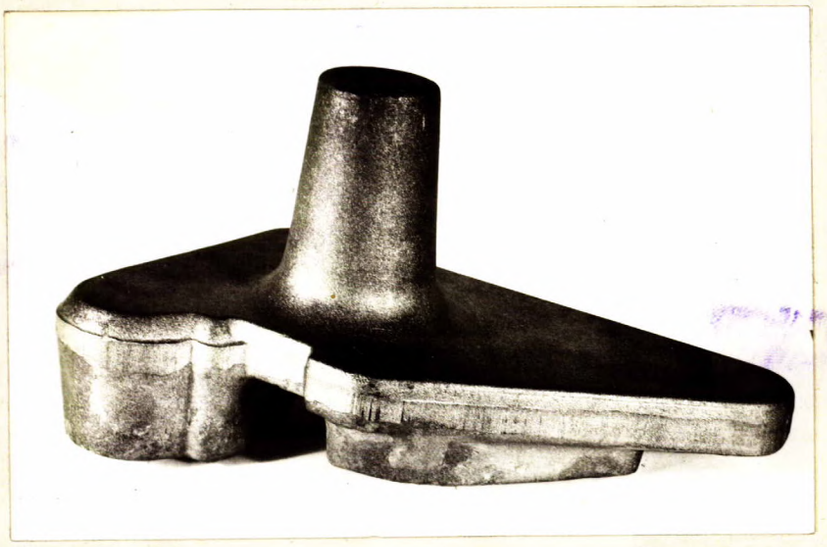
HVK:GHB.

1245
cam

Figure 1.



Photograph of cam, ¼ size.

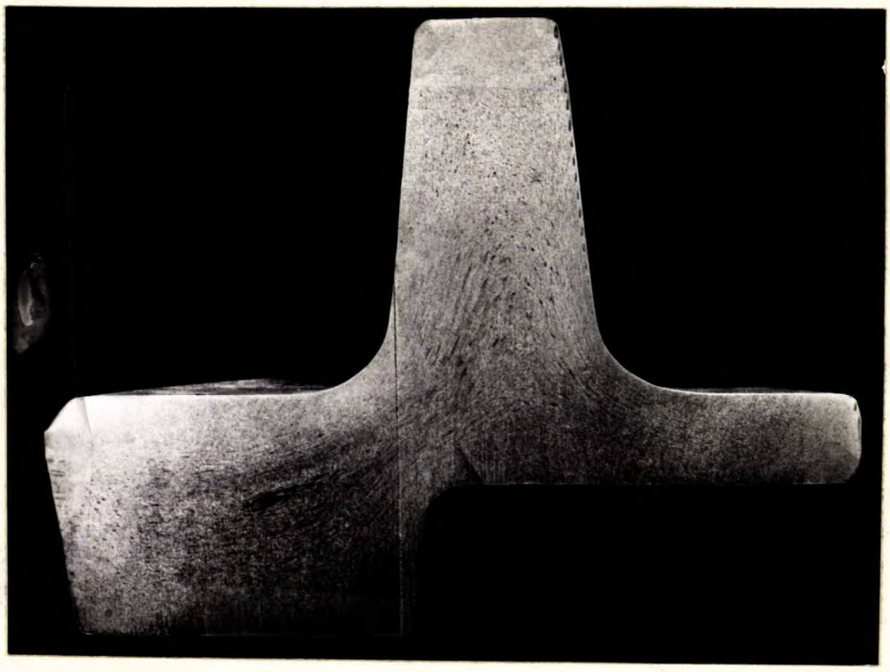
Figure 2.

Macro-etched cross-section, about 1/3 size.

Figure 3.

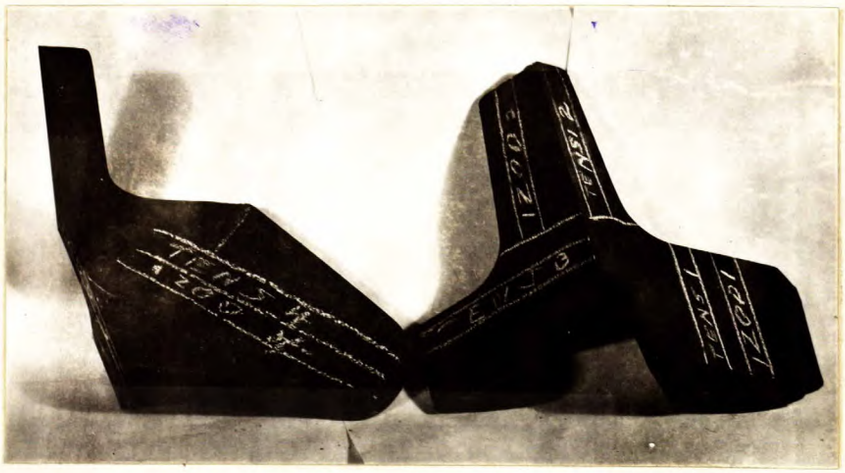
Macro-etched cross-section, about 1/3 size.

Figure 4.



Macro-etched cross-section, about 1/3 size.

Figure 5.



Photograph, about ¼ actual size, showing position of test bars.

Figure 6.

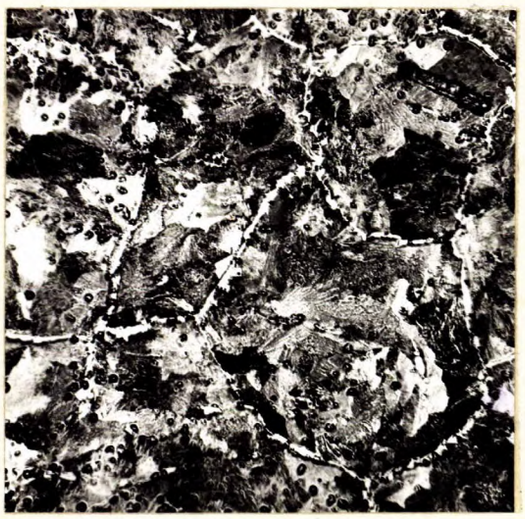
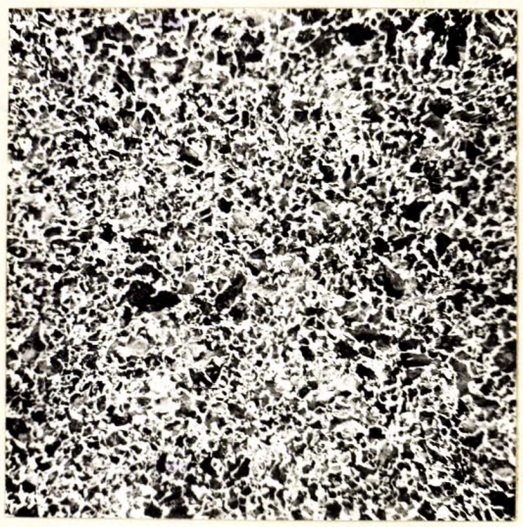


Figure 7.

Photomicrographs, X100, picral etch, showing structure existing in forging as received.
Figure 6 - beneath hub. Figure 7 - in plate.

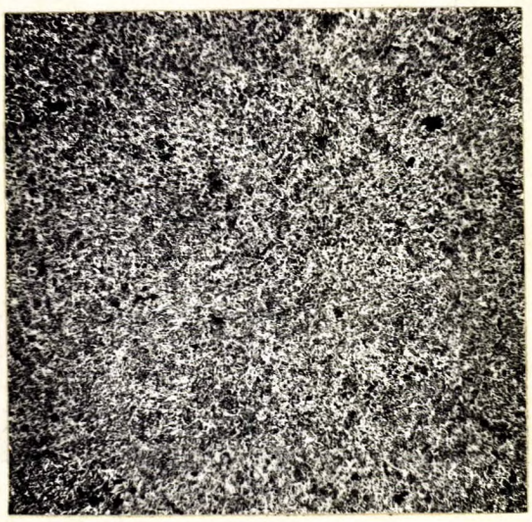
Figure 8.



X100, picral etch.

Normalized at 1600° F.

Figure 9.



X500, picral etch.

Normalize - 1600° F.
O. Q. - 1550° F.
Draw - 1200° F.

HVK:GHB.