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REPORT

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Investigation No. 1790.

Examination of Magnaflux Indications on Three Lancaster Aircraft Mainplane Attachment Bolts.

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Physical Metallurgy Research Laboratories

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OF MINUS AND RESOURCES Mines and Geology Branch

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#### Investigation No. 1790.

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## Origin of Haterial and Object of Investigation:

On January 51, 1045, F/L N. S. Spence, on behalf of Chief of the Air Staff, Department of National Defence for Air, Ottawa, Ontario, delivered to these Laboratories, for examination, three Lancaster Aircraft mainplane attachment bolts.

An accompanying lotter (File Nd. 938NIV-5-5 (AMSO DAI) spated that these bolts are used in a very critical location in the structure of the aircraft. The bolts are given a magnaflux examination prior to assembly into the plane. As a result, a number of bolts have accumulated which show magnaflux indications in varying degree, and it is desired to know whether any or all of them can be used with confidence. The three bolts received represent three conditions;

> No. 1 is the average of the worst. No. 2 is average. No. 3 is better than average.

It was requested that the bolts should be magnafluxed and the indications recorded photographically; also, that (Origin of Material and Object of Investigation, cont'd) -

the nature and depth of the indications be determined.

It was stated that the bolts were stressed principally in shear.

### Magnaflux Examination:

All three bolts were magnetized circularly on the magnaflux machine, using the residual magnetization wet method of inspection. 4200 amperes of current (3 shots, 1,400 amps. each) were passed through each bolt.

Figures 1 and 2 illustrate the results obtained on Bolt No. 1. There are two longitudinal indications (A and B) on the main stem of the bolt and one on the thread. Figure 3 shows one of the longitudinal indications observed on Bolt No. 2. Bolt No. 3 had magnaflux indications on the thread, similar to that shown in Figure 2. All of the defects were again observed when the bolts were demagnetized and then remagnetized using 1100 ampères of current. When the amperage was lowered to 400 no indications were observed on Bolt No. 2 but those on Bolts Nos. 1 and 3 were still noticeable. Longidudinal magnetization revealed no defects on any of the bolts.

Figure 1.



BOLT NO. 1, MAGNAFLUXID. (Approximately 2/3 actual size).

(Continued on next page)

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# (Magnaflux Examination, cont'd) -

Figure 2.



# THREAD OF BOLT NO. 1, MAGNAFLUXED.

Figure 3.



BOLT NO. 2, MAGNAFLUXED.

# Microscopic Examination:

Transverse specimens were cut from the three bolts, across the longitudinal magnaflux indications. These specimens were polished and then examined under the microscope in the unstched condition. Figure 4 (X500) illustrates the stringer of inclusions at the point of separation of metal. This is at the thread of Bolt No. 1. Figure 5 (X500) is a photomicrograph of one of the longitudinal lines shown in Figure 1, of Bolt No. 1. FeO and FoMn silicate appear to be present. No · Page 4 ·

(Microscopic Examination, contid) -

indication could be found for Belt No. 2. Bolt No. 3 (cracks on the thread) was not examined under the microscope.



Figure 4.

X500.

THREAD OF BOLT NO. 1, TRANSVERSE SECTION.

Figure 5.



X500.

TRANSVERSE SECTION OF LONGITUDINAL MAGNAFLUX LINE ON STEM OF BOIT NO. 1.

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# Discussion:

The photomicrographs indicate that these bolts have been made from seamy bar stock. In rolling down to size the inclusions have been trapped. The seams penetrate below the surface to 0.001 to 0.0015 inch on Bolt No. 1 which is representative of the worst condition.

If the tolerance of the diameter dimensions would allow further machining, these final traces of the original seams could be removed. If it is not possible to machine any further, consideration has to be given to the stress imposed upon the part in service. Should it be felt that the stress is of such a nature that shallow longitudinal defects would not lead to fatigue failure, acceptance of the bolts could be made. If, however, stresses such as torsion are produced, rejection of the bolts in question is definitely recommended.

The indications in Bolt No. 2 were so shallow that it was not possible to locate them under the microscope. It is interesting that this bolt revealed no defects when given 400 amperes. Bolt No. 3 was given a macro etch on the thread where the magnaflux indications were found. A double series of cracks coinciding with this magnaflux indication is now visible to the eye. This bolt will be submitted along with this report. The two rowsare very close together. This also is considered evidence of the presence of a seam.

# Conclusions:

1. The magnaflux indications on Bolts Nes. 1 and 3 are due to the presence of seams.

2. The seams on Bolt No. 1 penetrate 0.001 to 0.0015 inch below the surface.

3. The defects on Bolt No. 2 are too shallow to be

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# (Conclusions, cont'd) -

revealed by a 400-ampere current and could not be positively detected under the microscope.

# Recommondations:

1. If tolerances allow, further machining would eliminate the defects on Belt No. 1, which is representative of the worst lat of rejects.

2. Acceptence or rejection of the part will depend on the type of stress it is required to undergo in service.

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