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OTTAWA October 24th, 1944.

# R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1725.

Interim Report on Investigation of Corrosion
of Ranger Aircraft Sludge Plugs.

(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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### Introductory:

At the request of the office of the Chief of Air Staff, Department of National Defence for Air, Ottawa, Ontario, a series of tests was devised to determine the nature of corrosive attack on, and, if possible, to select a method of protection for, magnesium sludge collecting plugs used inside the hollow crankshafts of Ranger aircraft engines. Sample plugs were delivered to these Laboratories by F/L N.S. Spence on August 26th, 1944, and these were cut up to give small test pieces, 5/8" x ½" x 1/16" in dimension, for use in this investigation.

As yet the tests have not produced results that are conclusive, but they do give information as to the type of attack suffered by these plugs when corroded by crankcase oil. Also, there is evidence that the selenium coating developed by Canadian Copper Refiners Limited gives magnesium a protection that improves its performance over the uncoated metal.

This report should be considered as preliminary in nature; further tests will be carried on to compare the selenium coating with the regular zinc-chromate treatment now used on the Ranger plugs.

Description of Tests:

The tests consisted of experiments on small sections of metal, cut from the plugs, which were attached to a spindle and revolved at high speed in used oil from Ranger crankcases (see Figure 1). Four test pieces at a time were placed on the spindle, two coated with selenium and two with the clean magnesium surface exposed.

Other tests were conducted, suspending coated and uncoated magnesium in a solution of 3 per cent NaCl with 5 c.c. per litre hydrogen peroxide. This was done in order to learn how effective the selenium coating was when exposed to a commonly used corrosive medium (see Table I, Tests 7 to 10).

(Table I appears on Page 3)

Discussion of Results:

The interesting results of the tests so far conducted are disclosed by a study of the photographs, Figures 1 to 3. These pictures show that the uncoated magnesium test pieces have been attacked at the point where an eddy caused by the whirling motion of the spindle assembly in the oil has allowed the building-up of an accretion of solids (sludge). This built-up sludge probably duplicated exactly the condition in the collecting pocket of the plug after it has been in operation long enough to become partly filled with solids from the used oil. Apparently, then, the conclusion to be drawn is that the attack on these plugs is caused by, or promoted by, the solid phase in the oil. This bears out the suggestion that the trouble might come from such compounds as lead oxide in the sludge. The selenium-coated specimens were attacked to a lesser degree than the uncoated pieces, as may be seen in Figure 2. Only minor attack is noticeable on the sections of the test pieces that were exposed to the freely agitated oil, indicating

(Continued on Page 4)

TABLE I. = TABULATION OF WEIGHT CHANGES IN DIFFERENT TESTS.

| Test No. | Test Conditions | Weight Before, grams | Weight After, grams | Loss in Weight, grams | Remarks |
|---|---|---|---|---|---|
| 1 | 280 hours at 300 r.p.m. in used oil. | 0.4496 | 0.4387 | 0.0119 | Uncoated. |
| 2 | " | 0.4599 | 0.4549 | 0.0050 | " |
| 3 | " | 0.3575 | 0.3521 | 0.0054 | Selenium coated. |
| 4 | " | 0.4254 | 0.4219 | 0.0060 | " |
| 5 | 700 hours at 1300 r.p.m. in used oil. | 0.4117 | 0.4133 | 0.0016 | Uncoated. Gain in weight due to collection of corrosion product. |
| 6 | " | 0.3432 | 0.3433 | 0.0001 | Selenium coated. Slight gain in weight. |
| 7 | 18 days in 3% NaCl, 5 c.c. $H_2O_2$ | 40.8890 | 34.5716 | 6.3174 | Uncoated. |
| 8 | " | 51.3575 | 43.8803 | 7.4772 | " |
| 9 | " | 49.5771 | 48.5862 | 0.9909 | Selenium coated. |
| 10 | " | 44.0689 | 43.2350 | 0.8339 | " |

(Discussion of Results, cont'd) -

that the attack is corrosive, not erosive, in nature.

Unfortunately for laboratory tests, this type of corrosion is much slower under these conditions than in actual service. This is to be expected, since the corrosive agents in the oil of an operating engine would be constantly renewed. The slowness of action makes it difficult to measure results by loss-in-weight tests; even after 700 hours the attack has gone only to the point where it is visible, with small amounts of metal removed. This weight-loss is more than compensated for by the building-up of corrosion product at the point of attack, as is shown in Table I, Tests 5 and 6, where it is seen that a gain in weight has taken place, more by the uncoated than by the coated specimen. This was borne out by visual inspection at the time the specimens were removed from the testing bath.

These specimens were cleaned by vapor degreasing followed by a brushing in a solvent. A more severe cleaning process, using chemicals, etches away so much of the specimen that weighing gives an inconclusive result (see Table I, Tests 1 to 4).

The tests using salt solution as a corrosive agent bear out previous observation to the effect that the selenium coating gives a high degree of protection against this sort of attack.

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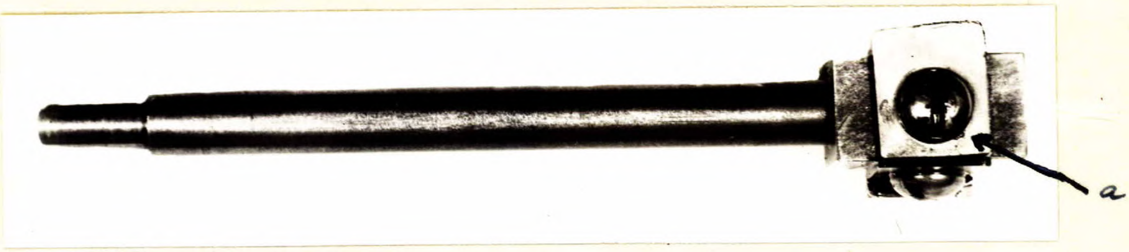
Figure 1.




SPINDLE ASSEMBLY WITH SPECIMENS IN PLACE.

(Approximately to size).

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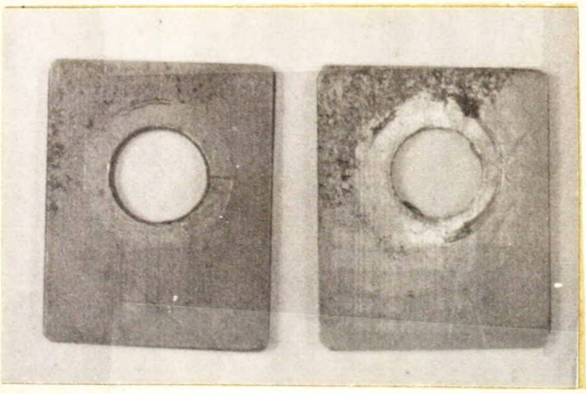
Figure 2.



SELENIUM-COATED SPECIMEN (left, above)
COMPARED WITH UNCOATED SPECIMEN (right, above).

(Approximately 4 times actual size).

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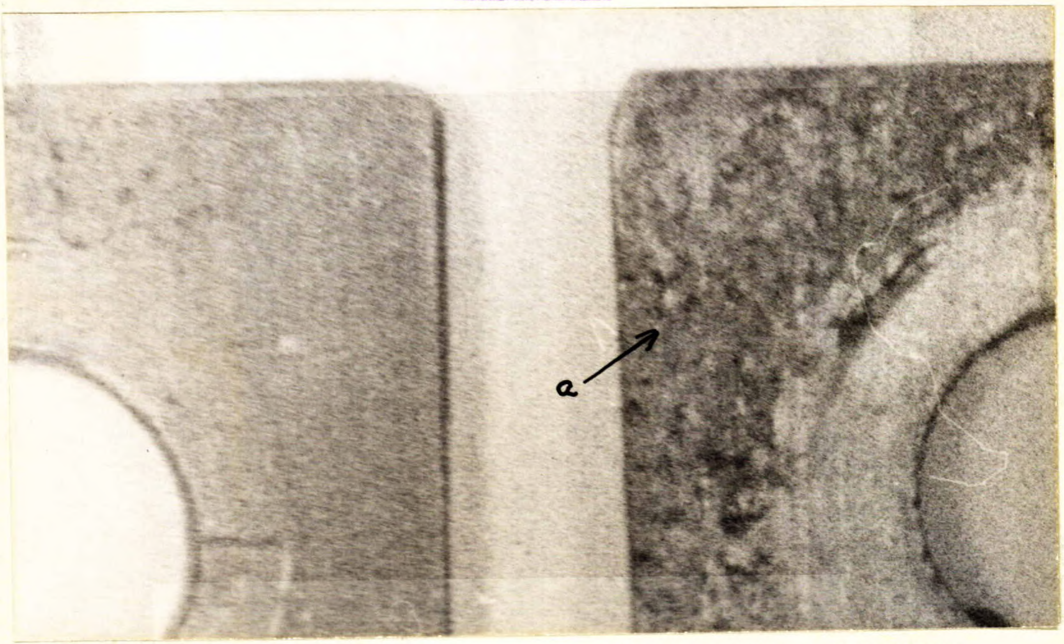
Figure 3.




PHOTOGRAPH, AT HIGHER MAGNIFICATION, SHOWING
EFFECT ON SELECTED PARTS OF EACH TYPE OF SURFACE.

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