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METALLURGICAL EXAMINATION OF CORRODED BRASS BELLOWS

by

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SUMMARY OF RESULTS

Chloride-containing corrosion products in brass bellows manufactured in Canada and in the United States, indicated inadequate washing of the parts subsequent to reaction-flux soldering.

Bellows manufactured in Canada exhibited light but positive corrosion. The U.S. bellows were deteriorated by advanced dezincification.

Complete reclamation of existing bellows, similar to those examined, would be doubtful. It is evident that vigorous post-solder washing of subsequent production is essential, and the use of a less active flux is also desirable.

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CONTENTS

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INTRODUCTION

On October 2, 1958, Mr. G.T. Truman, Assistant Division Manager, Canadian Arsenals Limited, Lindsay, Ontario, submitted twenty bellows, of 80-20 brass, exhibiting internal stains. Twelve of the bellows were identified as manufactured in Canada and the remaining eight bellows were manufactured in the United States.

It was stated that, during manufacture, the bellows were furnace-soldered with acid flux, subsequently washed, and bright dipped in a dilute sulphuric acid solution.

Mr. Truman requested an investigation of the nature and cause of the corrosion, with the reclamation of existing bellows and preventive treatment of subsequent production in view.

At a later date, it was suggested that the corrosion might have been caused by the bright dip treatment in sulphuric acid, subsequent to the soldering operation.

VISUAL EXAMINATION

Several of the Canadian and U.S. bellows were dismantled so that the inside of each individual corrugation of the bellows could be examined.

The U.S. bellows exhibited extensive internal corrosion which increased toward the bottom of the bellows (see Figure 1). The corrosion products were green and blue in color, and metallic copper stains on the underlying brass indicated dezincification.

The Canadian bellows exhibited light corrosion and copper stains, but were considerably cleaner than the U.S. product.

QUALITATIVE ANALYSIS OF THE CORROSION PRODUCTS

A qualitative test for chloride ion, and sulphate radical was performed on the corrosion products of selected Canadian and U.S. bellows. Three samples, as shown in Figure 1, were immersed in acidified solution to dissolve the corrosion salts.

The addition of barium chloride to a hydrochloric acid solution of the corrosion products, gave a negative indication for the presence of sulphate radical in both the Canadian and U.S. bellows.

The addition of silver nitrate to a nitric acid solution of the corrosion salts, indicated positively the presence of chloride ion in both the Canadian and U.S. bellows. However, chloride ion in the Canadian samples was barely detectable, whereas the U.S. samples gave a heavy positive indication of chlorine which increased toward the soldered bottom bellows.

MICROSCOPIC EXAMINATION

Cross-sections of some of the corroded bellows were examined under a microscope. The U.S. samples showed advanced dezincification (see Figure 2). The Canadian samples showed considerably less attack (see Figure 3).

DISCUSSION

The presence of appreciable chlorine in the U.S. bellows indicated not only that washing of the soldered parts had been inadequate, but that the washing medium had distributed some of the soldering-flux chlorides to the upper part of the bellows.

The microsection of the U.S. bellows, Figure 2, shows advanced dezincification of the walls of the bellows and it is

evident that other U.S. bellows in a similar condition are not reclaimable.

Although the Canadian bellows exhibited less corrosion, (Figure 3), complete reclamation of similar bellows, by some type of cleaning process, would be doubtful since in small local areas, dezincification may have reached an advanced stage.

For subsequent production, it is apparent that a very vigorous washing of the bellows, such as might be obtained with a jet of water, is necessary, or a soldering procedure utilizing a less active flux could be adopted.

Fused zinc chloride residues are best removed[1] by washing with boiling water containing a few drops per gallon of muriatic acid. The acidified water removes the crust of zinc oxychloride which retards the removal of the residue beneath. A subsequent water wash should remove all corrosive materials.

CONCLUSIONS

Chloride-containing corrosion products in U.S. and Canadian manufactured brass bellows indicated inadequate washing of the parts subsequent to reaction-flux soldering. Microexamination of the corroded bellows disclosed deterioration of the bellows walls by dezincification.

The Canadian manufactured bellows exhibited light but positive corrosion stains and dezincification.

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(1) "Symposium on Solder", ASTM Special Technical Publication No. 189, (June 19-20, 1956).

Complete reclamation of existing bellows, similar to those examined, would be doubtful unless an extensive examination of a large number of parts shows that it is feasible.

It is evident that a vigorous post-solder washing of subsequent production is necessary. For washing, a strong jet of hot water containing a few drops per gallon of muriatic acid, followed by a water rinse, is recommended(1). Less active solder fluxes could be used with advantage.

The predominance of chloride ion in the corrosion products confirms that the bright dip in sulphuric acid subsequent to the soldering operation, was not the prime cause of corrosion.

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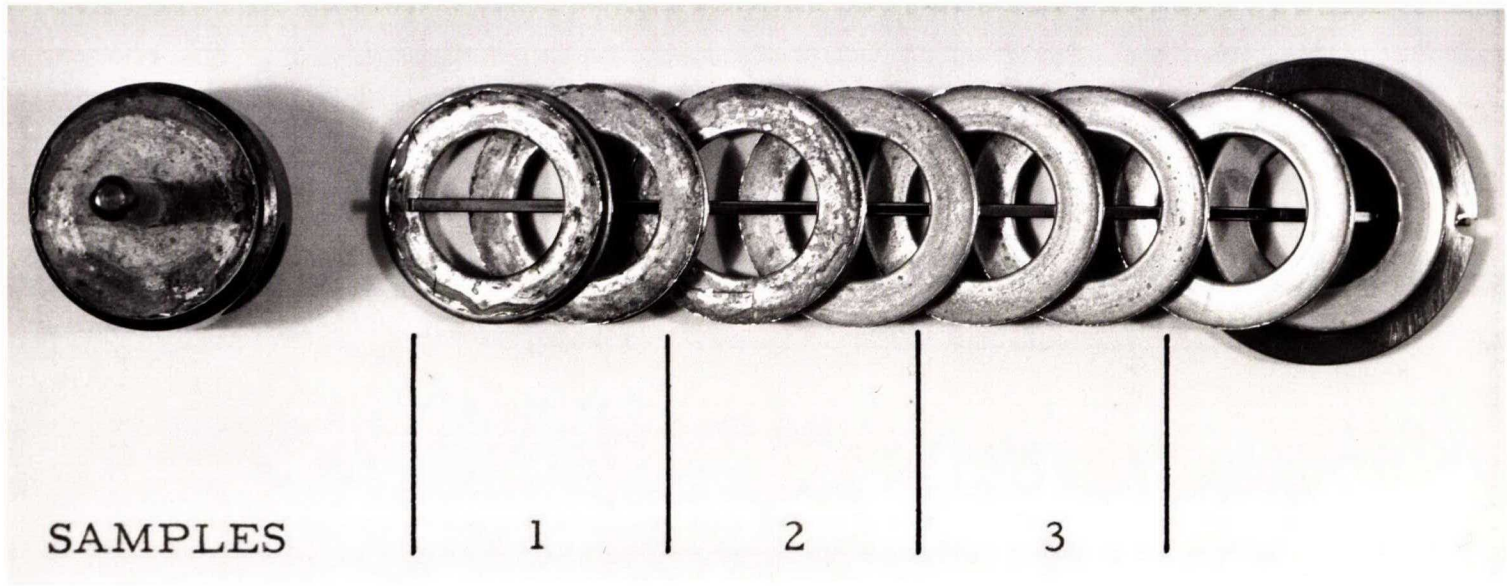

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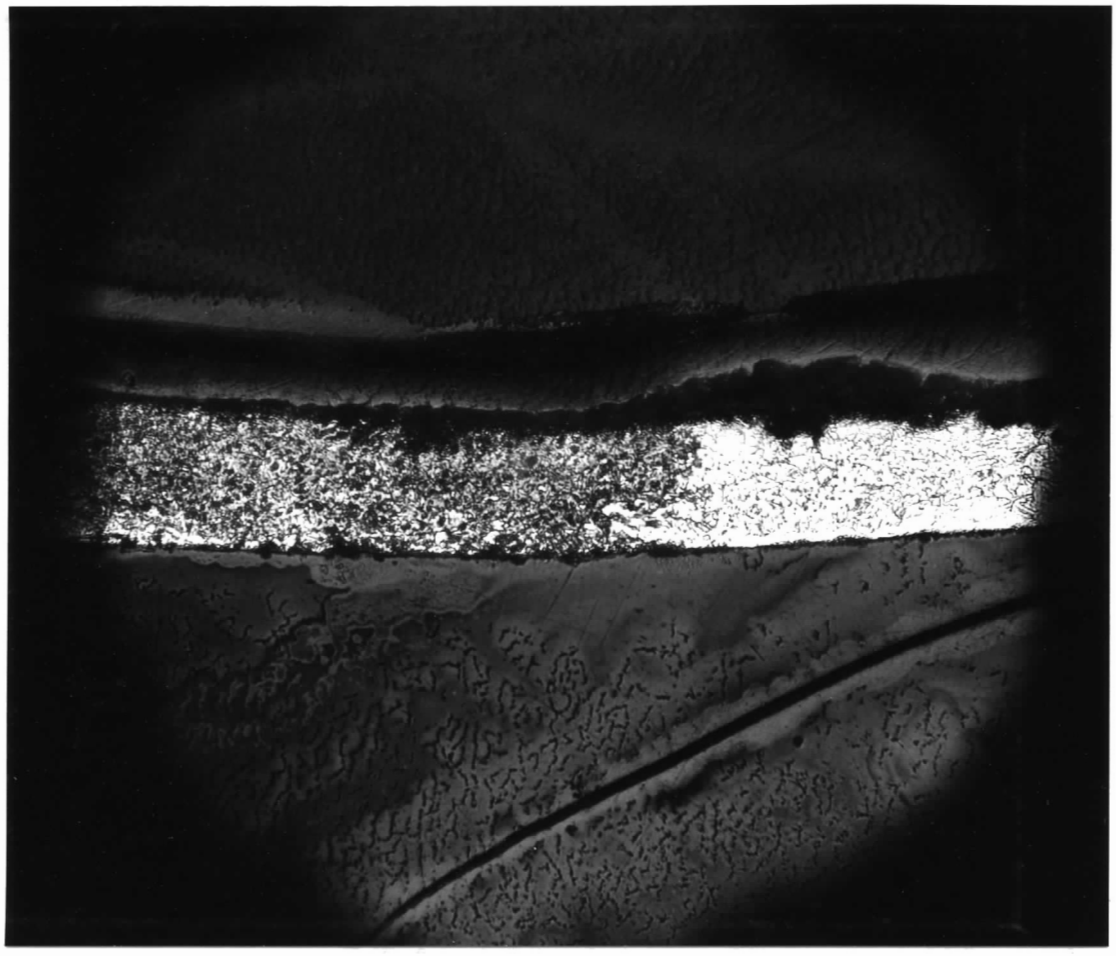
Figure 1. - Dismantled U.S. bellows showing increased corrosion toward the soldered bottom bellows. The corrosion products of three samples, as shown, were tested qualitatively for chloride ion and sulphate radical, for both U.S. and Canadian bellows.



(magnification X200)

Figure 2. - Cross-section of U.S. bellows. Note dark-coloured spongy mass of copper, indicative of advanced dezincification, extending completely through the bellows wall.

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(magnification X200)

Figure 3. - Cross-section of Canadian bellows. The dark-coloured constituent, along the upper edge of the section, is porous metallic copper deposited by primary dezincification.

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