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NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

D BULLETIN

A METHOD FOR REMOVAL OF BAKELITE-IMPREGNATED WIRE STRAIN GAGES

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INTRODUCTION

An increasing interest is being shown in the use of wire-type strain gages to measure static and dynamic stresses in aircraft-engine parts. Bakelite cement has been found satisfactory as a bonding agent for attaching the strain gages to machine parts that must operate at elevated temperatures (reference 1). On many occasions, it is desired to remove Bakelite-cemented gages from the test parts for the purpose of replacing faulty gages or of returning the parts to service after strain measurements have been completed. Removal of the gages by means of scraping without prior treatment is very unsatisfactory because it is tedious and almost invariably damages the finished surface. Various solvents have been tried, but all attempts in this direction have been unsuccessful inasmuch as Bakelite cement, when properly baked, forms a polymer of very high molecular weight that resists the action of solvents.

This report presents a gas-flame method of removal that is rapid and does not injure the structural part.

SPECIMENS AND TEST PROCEDURE

Gages and Mounting Bars

The strain gages with which this report is concerned were of the Bakelite-impregnated bobbin type and were 1/2 inch wide, 3/4 inch long, and 0.010 inch thick. Bakelite BC-6035 cement thinned with ethyl alcohol was used as the cementing agent and was set by using a baking cycle consisting of 1 hour at 80° C, 2 hours at 105° C, and $2\frac{1}{2}$ hours at 145° C. The various mounting bars used were made from steel, aluminum alloy, and magnesium alloy; thicknesses ranged from 0.015 inch to 1 inch.

Chemical-Solvent Method

The chemical solvents tried, in addition to the more common ones, were: ethylene dichloride, methyl ethyl ketone, butyl alcohol, ethyl acetate, xylene, and toluene. Test specimens were immersed in these solvents for at least 4 hours to determine any softening effect they might have.

Gas-Flame Method

A flame about 6 inches long with an inner cone of 1 inch was played over the surface of the gage in such a manner that the entire area of the gage was covered in 3 or 4 seconds. After this treatment, the gage was removed by prodding with a blunt instrument. The flames tried were artificial gas and oxygen, acetylene and oxygen, and acetylene and air. A small commercial acetylene tank with a 10-pound reducing valve offers a convenient source of the acetylene-and-air flame because of the ease of portability. The prodding tool was a wood chisel modified in such a way that all the corners were rounded and the edge, after being given a 1/64-inch radius, was well polished. The equipment for removal of the strain gage, together with a mounting bar, is shown in figure 1. One of the two gages originally mounted on the bar has been removed.

The determination of the maximum temperature attained by the surface of the underlying metal during the application of the flame was made by spot-welding an iron-constantan thermocouple in the bottom of a shallow groove beneath the strain gage. The top of the thermocouple was flush with the surface of the bar.

RESULTS

Chemical-Solvent Method

None of the chemical solvents tried had an effect upon the Bakelite. The cement remained hard and the strength of the bond was apparently not affected.

Gas-Flame Method

The best results were obtained using a simple torch with a 3/16-inch nozzle. The flame was adjusted to an inner-cone length of 1 inch and was then played over the surface of the gage. The nozzle was held 1¼ inches above the gage. In the case of steel, it was found that the flame should be applied between 3 and 4 seconds; whereas, for aluminum and magnesium alloys, 1 or 2 more seconds were needed. After application of the flame, the gage was prodded with the removing tool with no more pressure than could be applied with one hand. In some cases, it was necessary to apply the flame more than once and remove the gage in two or three layers. The total time required to remove a gage by this method is about 1 minute.

The other types of flame previously mentioned gave similar results when used in the manner described. After application of the flame, the appearance of the gage was changed very little, but the bond between the metal and the gage was broken. The gage does not become soft but seems rather to become embrittled.

Caution should be used in applying this method of removal for magnesium alloys. A fire hazard is always present and can best be guarded against by protecting the bare metal with sheet asbestos, leaving only the strain gage exposed to the flame.

The maximum temperature that the underlying metal attained in the removal process was found to be a function of the thickness of the metal. The data obtained were for asbestos-backed metal and thus represented the most unfavorable conditions. Figure 2 illustrates the variation in the maximum temperature with the thickness of aluminum alloys. From this curve, the thickness below which this method should probably not be used is about 0.075 inch. It should be noted that, if thin metal is backed with copper or steel blocks, the maximum temperature is considerably lowered. Gages were removed from 0.020-inch and 0.040-inch steel when backed with a 1/2-inch steel plate. The maximum temperature attained was low enough to allow the hand to be placed on the metal immediately after removal of the gage. The curve given is for aluminum alloys but is applicable to steel inasmuch as check points for steel were sufficiently close to warrant no further investigation.

When care was taken to have the removing tool well polished, the surface of the steel mounting bars after removal of the gages was uninjured. In the case of aluminum, the surface was roughened to a slight degree but was readily returned to its original condition by using a fine polishing paper.

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REFERENCE

1. Tucker, Maurice, and Walstrom, Douglas P.: A Knock Indicator Incorporated in a Ceramic Aircraft Spark Plug. NACA ARR No. 3I14, Sept. 1943.

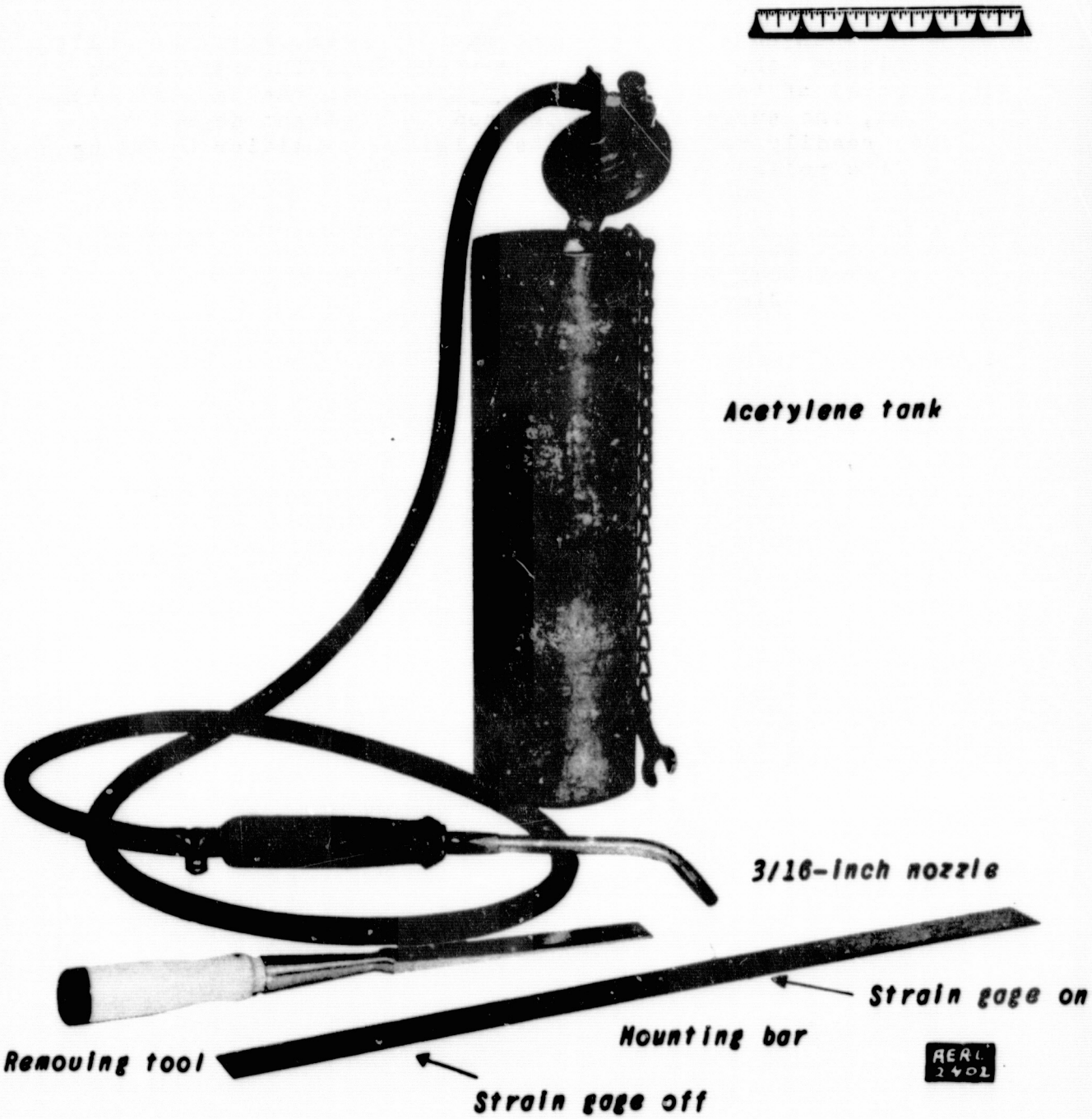

Figure 1.- Strain-gage-removal equipment and mounting bar showing strain gage and section from which strain gage was removed.

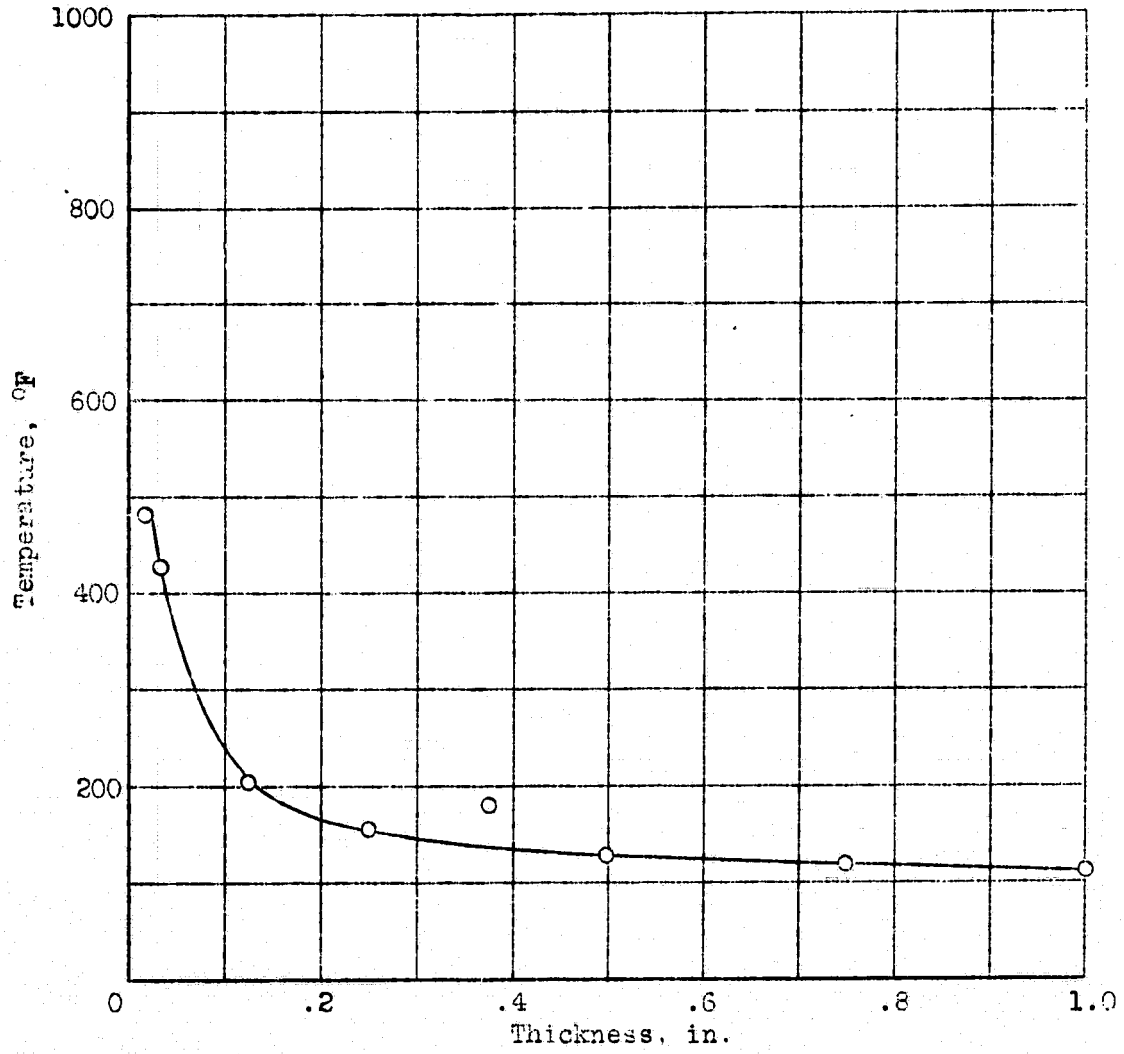

Figure 2.- Maximum mounting-bar temperature against bar thickness for aluminum alloy backed with asbestos.