INTRODUCTION

By D. E. Weiss¹

The mission of the Aeronautical Structures Laboratory of the Naval Air Material Center, Philadelphia, Pa., is to develop and evaluate aircraft structures, both in the laboratory and in flight. One of the more important tools in this work has been the bonded resistance wire strain gage. In recent years the increasingly higher temperatures to which airframes are subjected has necessitated a more detailed evaluation of the wire strain gage. In addition, the design of nuclear reactor structures and other new industrial and military projects has resulted in an increasing need for strain gages capable of measuring static strains at temperatures above 600 F. Very little had been accomplished by gage manufacturers or other laboratories in developing a gage suitable for measuring static strains at temperatures higher than 350 F.

In 1953 the Office of Naval Research financed a survey of the high-temperature strain gage field. The results of this survey were published in 1954 by the Baldwin-Lima-Hamilton Corp. Meanwhile, the Bureau of Aeronautics had established a project at the Aeronautical Structures Laboratory for the development of a gage capable of measuring static strains at elevated temperatures. A three-pronged attack was undertaken. First, the Aeronautical Structures Laboratory established a facility for the development and evaluation of gages at temperatures up to 1000 F. Gages were supplied by a number of manufacturers and by the National Bureau of Standards; a large number of gages of various configurations were fabricated by the Aeronautical Structures Laboratory. Secondly, the Bureau of Aeronautics and Wright Air Development Center jointly sponsored work in this field at the National Bureau of Standards. The National Bureau of Standards is currently working on both the development of gages and the establishment of a facility and techniques for the evaluation of gages developed by all sources. Thirdly, a contract was awarded in 1955 to the Armour Research Foundation for the development of alloys more suitable for use as the sensing element of hightemperature strain gages than the materials used heretofore. The work of all three groups-the Aeronautical Structures Laboratory, National Bureau of Standards, and Armour Research Foundation-is coordinated by the Aeronautical Structures Laboratory.

At the same time efforts were being expended on this problem at a number of instrumentation laboratories throughout the country, mainly those

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associated with the leading aircraft and engine manufacturers and at least one other Government agency. In 1956 a survey indicated that most of the laboratories were engaged in evaluating gages which manufacturers were beginning to offer for this application; a few were fabricating their own gages; none, to our knowledge, had developed a replacement for the resistance type gage. Some duplication of effort existed, both because of the lack of communication among the various investigators and because of the very meager information supplied with the gages being marketed.

For these reasons, as well as to disseminate information concerning the work in progress at the Aeronautical Structures Laboratory and the laboratories associated with it, it was decided to conduct a Symposium on Elevated Temperature Strain Gages. Papers and candidates for panelists were solicited from all laboratories, investigators, and manufacturers known to be working in this field. Selection was based upon an attempt to cover as wide a field as possible. The subjects covered included: calibration techniques and instruments, gage alloys, foil gages, weldable gages, bonding agents, temperature compensation. It is to be noted that no investigator has reported upon a device to replace the resistance gage, although the shortcomings of the latter at elevated temperatures are well documented herein.

The Symposium was held at the Naval Air Material Center, Philadelphia, on December 4 and 5, 1957. H. J. Huester, Assistant Director of the Aeronautical Structures Laboratory, was general chairman. Eleven formal papers were presented in two sessions, the first presided over by the author, the second by Robert L. Cavanagh, Chief of Research Instrumention Unit, Aircraft Laboratory, Wright Air Development Center. The third technical session was a panel discussion, of which the moderator was W. M. Murray, Department of Mechanical Engineering, Massachusetts Institute of Technology, and National Secretary of the Society for Experimental Stress Analysis. Five-minute presentations were made by each panelist prior to discussion from the floor. Only the formal presentations are published herein. The sessions were attended by more than 250 scientists and engineers from all sections of the country and from Canada and England. Dennis Drew of Rolls Royce Ltd. offered comments extemporaneously some concerning his work in this field. The papers by Anderson and Brewer were not presented at the symposium but are considered pertinent.

The papers presented describe the latest work in the design and application of strain gages at high temperatures as of December, 1957. It is considered that this publication, which the American Society for Testing Materials has undertaken, may serve as a recipe book and guide manual to those concerned with experimental stress analysis at elevated temperatures.

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