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THE COLLEGE OF AERONAUTICS

DEPARTMENT OF MATERIALS

Stress redistribution due to creep in Nimonic 90

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Report for the period June, 1965 to July, 1966

- by -

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Introduction

Part I of this report, dated September 1965, deals mainly with the design and construction of the special apparatus to simulate the stress redistribution occurring during the creep of a cooled turbine blade. It reported some preliminary experiments using aluminium alloy test specimens.

During the past year, the period covered by this report, a series of experiments have been completed using specimens machined from nimonic 90 alloy.

Experience gained in operating the apparatus, have resulted in several modifications both to the apparatus and the associated instrumentation. These are detailed within this report.

2. Modification to apparatus

2.1 Mand extensometers

The original extensometers as received from Mand Precision Engineering Co. were of sufficient length to permit the use of the furnaces as constructed and detailed in Part I section 2.3. They have been lengthened by inserting a nimonic rod into each arm of the extensometer.

The two pairs of arms comprising the unit are held together at the lower end by a system of springs and rods which trap hardened steel rollers between the arms and the lower specimen grip. Due to the increased ratio of specimen to pivot and pivot to spring distance caused by the above modification it was difficult to maintain contact between the extensometer grooves and the specimen ridges. Thin nimonic strips were therefore welded to each of the extensometer arms adjacent to the grooves so that each pair of arms could be wired into position onto the specimen gauge length.

2.2 Transducers

In the original design it was considered adequate to use only one strain measuring transducer per specimen. Subsequent experiments, however, have shown that during the initial loading some bending takes place leading to an incorrect strain reading. Two transducers are now used per specimen: they are electrically coupled to read the average strain, computed from readings taken from either side of the gauge length. All tests, after and including No. 38 were carried out using this modification.

2.3 Load Transfer

The flexible tubes interconnecting the load drums, (ref. Part I, section 2.2), have been replaced by tubes of a larger diameter allowing an increased rate of load transfer during the initial part of the experiment,

after which the throttling valve is adjusted to minimise the effect of hunting during the steady conditions.

This modification is effective after and including test No. 57.

2.4 Load cutout device

Throughout the majority of tests prior to No. 51, an intermittent fault occurred when the indicator was programmed to select the standard transducer and thus set and lock the position of the automatic uniselectors, (Ref. Part I, Appendix 2).

The fault resulted in an incorrect reading being indicated. In the majority of cases, the error was .0001", and occurred perhaps once per 25 to 30 readout cycles.

With the uniselectors locked in a different position to that at the start of the test, load transfer occurred triggered by the fault and not by an error signal generated by a difference in strain reading.

Various attempts were made both by the College and the manufacturers, to cure this fault, with very little success. Consequently it was decided to accept an occasional error and design a device to reject resulting information.

Fig. 1 shows the circuit employed. The indicator bridge is balanced by shifting the tap on each of four cascaded auto-transformers the position of which when at rest is indicated by neon number tubes.

The circuit is such that the anode of individual number tubes is supplied with a positive dc voltage and the particular number selected by grounding the respective cathode to the negative rail, via a segment on the automatic uniselectors.

A separate isolated d.c. supply was constructed with negative rail grounded and positive rail connected to one side of three relays coils, RL_1, RL_2, and RL_3.

The circuit to each coil was completed by connection to the wipers of three, ten-way single pole switches S_1, S_2, and S_3, and then to the indicator bank on the indicator uniselectors US_1, US_2, US_3.

Thus when a particular number is selected on the ten way switches the associated relay is energised only when that number is indicated, earth continuity to the relay coil being through the switch and through the uniselector bank.

Three normally open contacts, one on each relay, are connected in series and used to control the operation of the pumping mechanism.