PROGRESS REPORT NO. 14

A STUDY OF SPECIAL AND UNUSUAL CONDITIONS
AFFECTING HIGH-SPEED AIRCRAFT AND MISSILES

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PURPOSE

This project covers theoretical analyses and laboratory tests to determine the type of tests necessary to substantiate the structural integrity of aircraft operating under elevated temperature conditions and to investigate methods of heating and load application.

STATUS

Studies of methods for the determination of memory function based on material representation by means of linear dynamic models are continuing. Preliminary tests have been made using 17-ST extrusions, and the results have been analyzed using the Maxwell and Standard solids. Some 24-ST specimens are now being prepared for test.

The large oven for the AT-6 fin tests is practically completed, and has been given a short preliminary run at 350°F. Higher temperatures will not be reached until gaskets have been completed for front and rear doors.

The test jig for loading the fins is being designed, but no drawings have been delivered to the shop as yet.

THEORETICAL PHASE

The problem of determining the memory functions experimentally, representing the material by linear dynamic models, continues to occupy the
major portion of the time spent on the theoretical phase. Dead-load tests of a cantilever beam and vibration tests with a large mass at the free end of a cantilever have been conducted on 17-ST extrusions at 550°F, and some 24-ST specimens are now being prepared for test. It appears that the Maxwell solid probably cannot be used to represent aluminum alloys with sufficient accuracy for engineering purposes, except for rough preliminary calculations, or for certain dynamic problems covering a very few seconds of time. The Standard solid gives better results, but additional check tests will be required before definite conclusions can be drawn. The Maxwell-Kelvin solid has not yet been applied to the test results.

**EXPERIMENTAL PHASE**

The large oven for the AT-6 fin tests is nearly ready for operation. Without the gaskets on front and rear doors, the oven was operated for approximately an hour with an input of about 15 KW. A thermocouple in the center of the oven registered a maximum of 350°F. A large heat loss which was observed at the doors will be reduced when the gaskets are installed, producing higher temperatures for the same input; with larger inputs it should be possible to attain temperatures approximating 500°F or more in a comparable period of time. The sheet-metal panels forming the inside of the oven were buckled into waves of about 1/2-inch amplitude, but there was no failure of the metal parts. Several small cracks appeared in the transite, which indicates that there will be additional trouble with this material at the higher temperatures.

Figure 1 shows the front door of the oven with the driving motor for the blower. Figure 2 shows the other side of the front door, with the blower and heaters in place. The blower takes in air axially from the center of the oven, and blows it out past the resistance heaters along the sides of the oven. Figure 3 shows the oven with a temporary plywood rear door with windows for observing flow conditions inside. The outflow past the heaters is not as uniform around the periphery as expected, but considerable turbulence is generated within the oven, and it is hoped that this will result in a uniform temperature distribution in the fin.

As soon as the static test at room temperature is completed, the failed fin will be instrumented with thermocouples and used to check the temperature distribution. If this is not sufficiently uniform, additional baffles will be installed between the blower and the heaters, or along the inside walls of the oven. Figure 4 shows the oven in the open position, with the fin mounted on the support jig.
For the load tests on the fin it has been decided to extend the steel support for the main spar to a point just below the first rib. It is hoped that by this means failure can be induced in the fin itself rather than in the main spar extension. It had originally been decided that the first tests would be performed using formers around the fin, but it has now been decided to apply the load to the lower surface by means of 3/16-inch rivnuts, as a test has indicated that these will carry at least 800 lb per rivnut in tension. Rivets will be drilled out at several points along the rib-skin and spar-skin joints, and replaced by the rivnuts. A series of whiffle trees will distribute the load so as to simulate a constant pressure over the surface. The load will be collected into a single tension rod which will extend through the bottom of the oven.
Fig. 1. Movable Door of Oven, Front View

Fig. 2. Movable Door of Oven, Rear View
Fig. 3. Oven with Temporary Rear Panel

Fig. 4. Complete Oven, Both Ends Open