HIGH-TEMPERATURE COMBUSTOR LINER TESTS IN STRUCTURAL COMPONENT RESPONSE TEST FACILITY

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ABSTRACT

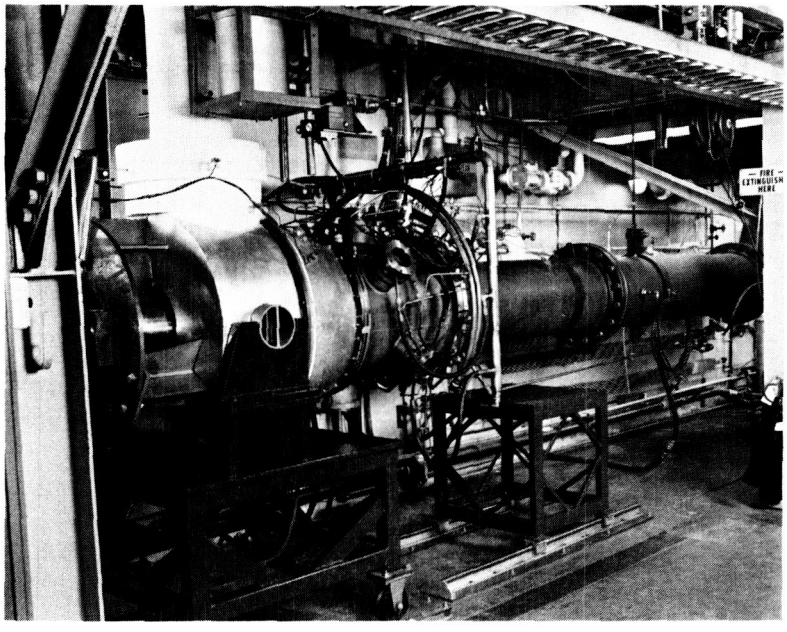
Jet engine combustor liners were tested in the structural component response facility at NASA Lewis Research Center in a cooperative program with Pratt & Whitney Aircraft, East Hartford, Connecticut. In this facility combustor liners are thermally cycled to simulate a flight envelope of takeoff, cruise, and return to idle. Temperatures were measured with both thermocouples and an infrared thermal imaging system.

A conventional stacked-ring louvered combustor liner developed a crack at 1603 cycles. This test was discontinued after 1728 cycles because of distortion of the liner.

A segmented or float-wall combustor liner tested at the same heat flux showed no significant change after 1600 cycles. Changes are being made in the facility to allow higher temperatures. Testing is continuing.

STRUCTURAL COMPONENT RESPONSE TEST FACILITY

Jet engine combustor liners were tested in the NASA Lewis structural component response test facility to see if damage developed in this testing simulated the damage in actual engine tests. Work was also done on developing methods to measure strain on the liner during testing. In this facility the heat flux to simulate the heat of combustion is supplied by 112 6.5-kW quartz lamps arranged in a cylindrical configuration inside the combustor liner. The lamps are cycled automatically by using a dual-loop programmable controller to simulate takeoff, cruise, and return to idle.



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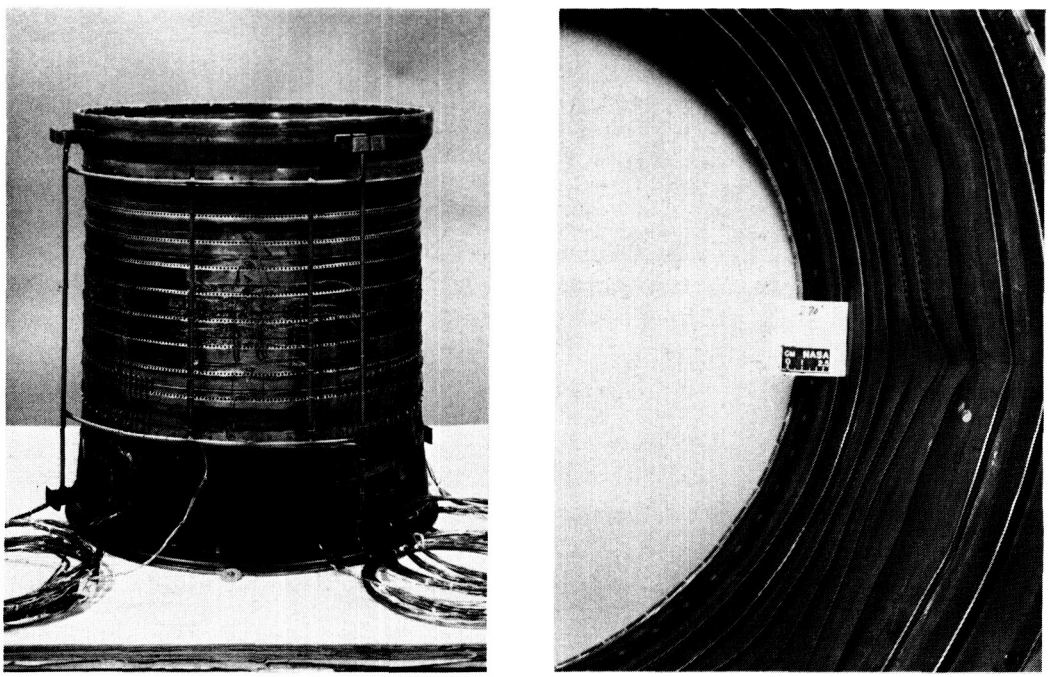
STACKED-RING LOUVERED COMBUSTOR LINER

A conventional stacked-ring louvered combustor liner as instrumented before testing is shown below. After 1603 cycles a crack developed that had increased 2 percent in length at 1728 cycles. The test was discontinued at this point because the distortion caused the liner to interfere with the lamp brackets. The distortion noted was similar to distortion in combustor liners in jet engines.



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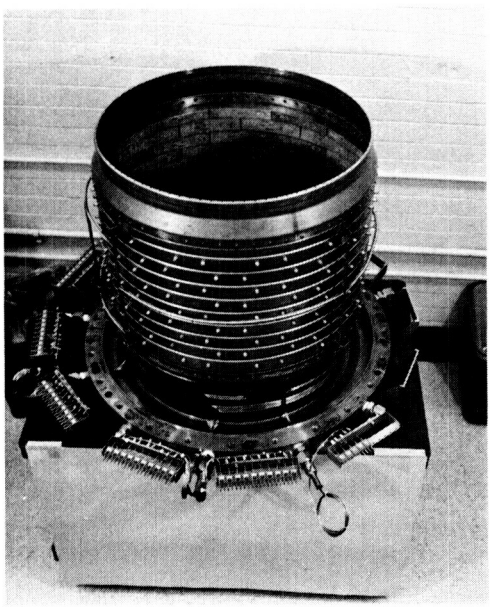
SEGMENTED OR FLOAT-WALL COMBUSTOR LINER

A segmented or float-wall combustor liner is currently under test. At 1600 cycles there was little or no distortion in the liner. Changes are being instituted in the facility to allow higher operating temperatures.



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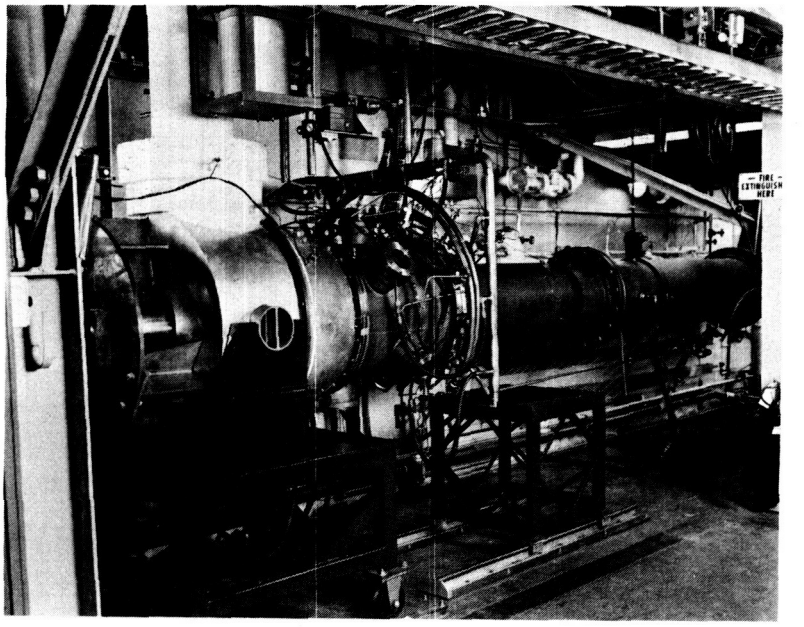
POSTER PRESENTATION

STRUCTURAL COMPONENT RESPONSE TEST FACILITY

Jet engine combustor liners are being tested in the structural component response test facility. The facility was designed to simulate the thermal cycling encountered by a jet engine combustor liner during takeoff, cruise, and return to idle. The heat flux from combustion is simulated by quartz lamp heaters. The purposes of the tests are (1) to see if damage developed in these tests simulates damage developed in actual jet engine operation and (2) to compare measured strain with calculated strain on liners. The tests would not be relevant unless the damage developed was of the same type that occurs in actual engines. Computer calculations of stain are not relevant unless there is correlation between calculations and measured values. The program is a cooperative program between the NASA Lewis Research Center and Pratt & Whitney Aircraft, East Hartford, Connecticut.



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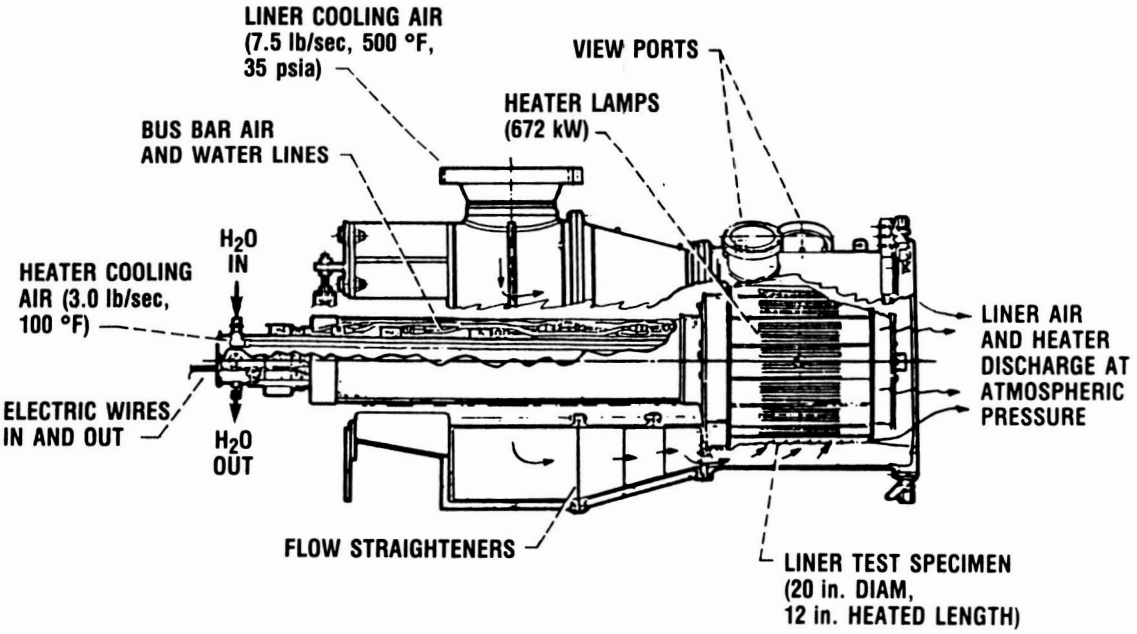
AIRFLOW THROUGH COMBUSTOR LINER TEST FACILITY

Cooling air is preheated to simulate the air from a compressor section and flows through circumferential cooling holes in the liner and out the exhaust. The airflow through the test facility is shown in the line drawing below.



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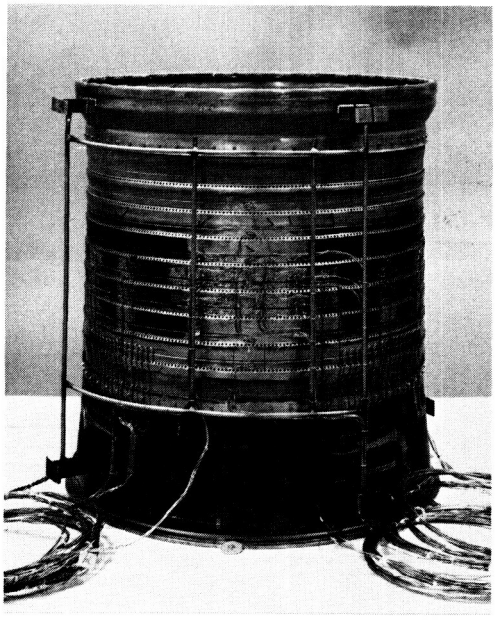
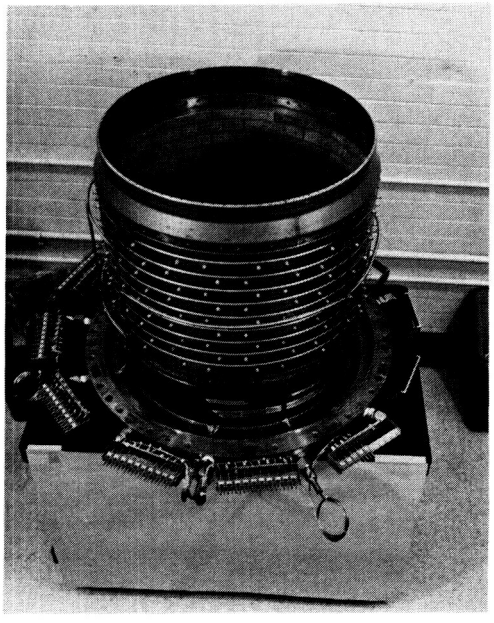
COMBUSTOR LINER CONFIGURATIONS

One type of combustor liner tested was a conventional stacked-ring louvered liner. A second type under test is the "segmented" or float-wall combustor liner. The water flow and airflow through the test rig are controlled manually. The temperature cycling is controlled by a dual-loop programmable controller.

STACKED-RING LOUVERED LINER



SEGMENTED LINER



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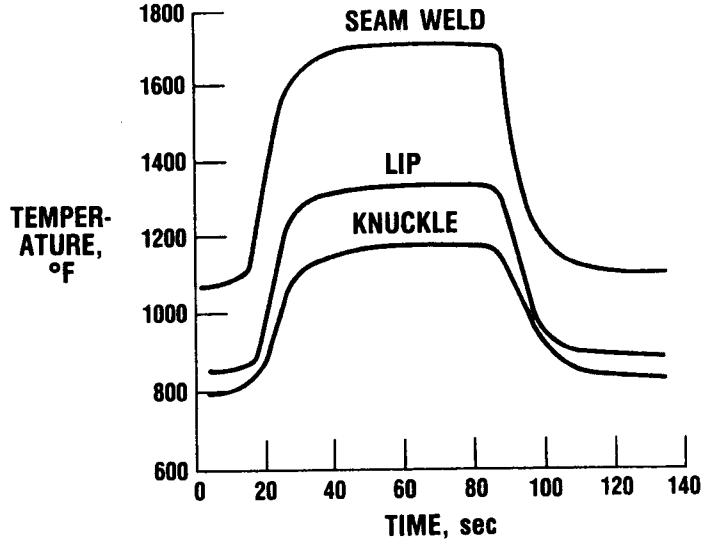
STACKED-RING LOUVERED COMBUSTOR LINER TEMPERATURE HISTORY

The stacked-ring louvered liner was cycled on a 2.2-minute thermal cycle. Cycling between 25 and 65 percent of nominal power was carried out for 1000 cycles. The temperatures measured at several locations on a louver in the hot zone are shown below.



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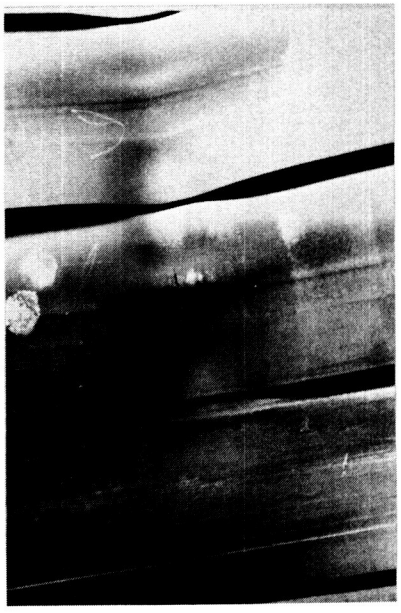
THERMAL CYCLING DAMAGE

Although a small amount of distortion occurred, no damage was noted that would lead to failure in a reasonable number of cycles. Therefore the maximum power during the cycle was raised to 70 percent, which resulted in an increase in the maximum temperature of about 60 deg F. Thermal cycling was continued and resulted in more distortion. After 1603 cycles a crack developed. This was actually the result of a hot spot that developed because machining deflects blocked cooling holes. The crack showed about 2 percent extension at 1728 cycles. The test was terminated at this point because the combustor liner collapsed on the lamp bracket frame.



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