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ST. LOUIS 3, MISSOURI

PROGRESS REPORT NO. 51

MONTH OF NOVEMBER 1950

RAM JET HELICOPTER ROTOR DEVELOPMENT

SUBMITTED UNDER Contract AF 33(038)-9845

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1. ROTOR DEVELOPMENT

1.1 General

During November the major effort on rotor development was directed toward preparing the 27 foot diameter rotor for whirl tests and modifying the No. 2 XH-20 for flight tests of the 27 foot rotor. The blade fatigue samples described in Progress Report No. 48 for August 1950 were received and preparations for tests were begun.

1.2 Modification to XH-20 No. 2

All rotor gear box parts were completed and modifications to the fuselage were about 80% complete. It is expected that the gear box will be assembled and installed on the fuselage by mid-December.

1.3 27 Foot Diameter Rotor

Prior to installation on the whirl stand the 27 foot diameter rotor was checked for static natural frequencies in flapwise and chordwise bending. The strain gauge instrumentation was used to record the frequencies after the rotor was excited by hand and released. With the relatively crude method of manual excitation used it was possible to record only the first and second modes of flapwise bending and only the first chordwise mode. The following table lists the static frequencies as determined with 12.3# ram jets installed

| | | |
|---|---|---|
| Flapping | First Mode | 132.5 CPM |
| | Second Mode | 407.0 CPM |
| Chordwise | First Mode | 259.0 CPM |

Torsional rigidity was also checked and it was found that the tips deflect at the rate of 30 lbs. ft/deg. This figure includes deflection from the pitch arms to the blade tips.

Due to the difficulties experienced with fatigue cracking of the shells of the L605 high speed ram jets Nos. 30 and 31, the rotor was placed on the whirl stand with the old type ram jets Nos. 26 and 27 installed. Since the ram jet installation required adapter fittings, no tip fairings were used for the preliminary runs, and due to the high drag and inferior performance of the old type jets a self sustained run was not possible. A maximum of 450 RPM was reached, using both external and ram jet power without incident.

It is planned to install ram jets Nos. 28 and 29 modified as described below, and tip fairings to cover the adapter fitting prior to any further whirl testing.

1.4 Blade Fatigue Tests

The blade fatigue test samples discussed previously have been received and a test rig is being prepared. Two samples each of the blade root and blade tip section will be vibrated to attempt to determine the endurance limit of the samples with zero steady load. This data combined with future flight test results should enable establishment of blade fatigue life on a relatively economical basis.

1.5 Improved Trailing Edge Constructions

Good progress has been made on the construction of the stronger trailing edge sections. Preparations are being made to bond the samples in the McDonnell plant. A curing fixture for the blades and the necessary equipment for bonding and pulling test samples have been built. All other materials are expected to be available by the end of December. Metlbond will be the adhesive used for the samples.

2. RAM JET DEVELOPMENT

2.1 High Speed Ram Jet

A limited number of tests were run on ram jets Nos. 30 and 31. Little improvement was made in performance because of the short duration of the runs due to difficulties encountered with failures of the L-605 shells.

A longitudinal crack about one inch long located at about the 60% point along the shell and near the weld bead joining the inner and outer shell halves, occurred after about 10 minutes of operation. Both ram jets (30 and 31) failed in the same manner. The cause was originally attributed to one or more of the following effects:

a. Residual welding stresses
b. Thermal stresses
c. Contaminated or deteriorated material near weld
d. Fatigue failure due to high frequency pulsation characterizing the operation of this engine.

It has been established that the cracks are primarily due to fatigue failure caused by the shell vibrating in a ring type mode. Subsequent test runs with the combustion chamber restrained by a heavy ring and radial rods f 'al over an hour without signs of cracking. Further verification was provided by vibration tests which indicate natural frequencies near 300 and 2000 cycles/second and sound analysis tests which indicate loudness peaks in bands covering 150-300 and 1600-3200 cycles/second. As a matter of interest the older type engines which were used on the 20 foot diameter rotor have only one loudness peak located in the 150-300 cycles/second band.

2.2 Modified Radial Finger Ram Jets

Ram jets 26, 27, 28 and 29 have been tested at 800 ft/sec free air jet velocity with Delavan spray nozzles replacing the original Benjamin nozzles. Considerable improvement of performance has been obtained. Ram jet No. 28 developed a maximum thrust of 55 lbs. at a TSFC of 8.13. The operating range of all engines was good and the resonating frequency was considerably lower than that of the high speed engines. Jets 28 and 29 will be used for interim 27 foot diameter rotor tests.

3. WORK PROGRAM FOR MONTH OF DECEMBER

3.1 Rotor Development

The 27 foot diameter rotor will be tested further on the whirl stand. Blade sample fatigue tests will be initiated and development of the strengthened trailing edge will be continued.

3.2 Ram Jet Development

Major effort on the high tip speed ram jets will be the solution of vibration and fatigue problems. Further tests will be made on the original type ram jets with fuel nozzle variations.

3.3 General

It is anticipated that modifications of the No. 2 XH-20 for installation of the 27 foot diameter rotor will be completed in December.

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RAM JET HELICOPTER ROTOR DEVELOPMENT - PROGRESS REPORT NO. 51 - MONTH OF NOV 1950

A.C. BALLAUER 15 DEC 50 8PP TABLE

USAF CONTR. NO. AF-33(038)-9845

HELICOPTER ROTORS, JET ENGINES, RAMJET H-20

ROTATING WING AIRCRAFT (34) ROTOR DESIGN AND DYNAMICS (4)

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## J1 HELICOPTER TEST DATA

DATE: 28 November 1950 Operator: C. Wood

TEST STAND: No. 1

ROTOR: 20 Foot Diameter Rotor with Nos. 28 and 29 jets

PURPOSE: The purpose of this test was to check out operation of rotor having new jet fairings.

TEST SET-UP: A new set of aft jet fairings were fitted to the rotor. New batteries were installed, the fuel filter was cleaned, and the hand starter was installed. The jet exit cracks were welded.

REMARKS: The test stand was able to hover with part fuel at 600 RPM in 20°F air.

The governor was set up to cut off at a higher speed and the metering valves were adjusted for better jet operation.

The jet exits cracked again within a few minutes of operation.

Flight time required for test: 14 minutes
Running time required for test: 25 minutes

Total flight time to date: 29 hours 4 min.
Total running time to date: 120 hours 27 min.

## J1 HELICOPTER TEST DATA

DATE: 30 November 1950 Operator: C. Wood

TEST STAND: No. 1

ROTOR: 20 Foot Diameter with 10-inch chord and Nos. 29 and 29 jets.

PURPOSE: The purpose of this test was to check out the repaired jets.

TEST SET-UP: Nos. 28 and 29 jets were repaired by welding into the outboard side of the exit a thick gusset.

REMARKS: The metering valves were again adjusted in an attempt to make a smoother running rotor.

To reduce the thrust of No. 28 to match the thrust of No. 29 the No. 28 metering valve was partly closed. This caused violent rotor shaking indicating that there was a static rotor unbalance due to differences in fuel heads in the fuel lines and due to the extreme drop-off in thrust of jet No. 28. Further adjustments were made and for the smoothest operation No. 29 valve was set at 13/16 turn open and No. 28 was set at 7/8 turn open.

Flight time required for test: 14 minutes
Running time required for test: 21 minutes

Total flight time to date: 29 hours 18 min.
Total running time to date: 120 hours 48 min.