ANALYSIS OF ENGINE

MAY 6 1952

In an earlier report, the writer reviewed a proposed engine invented by Mr. J. Frost, and described in his memorandum of Feb. 7th, 1952. In a later report, dated April '52, proposing a new aircraft type, Mr. Frost has described an engine of a different type.

This later engine is much less unconventional and can be described as a divided flow jet engine. Here the air is compressed and heated, and a fraction of the hot gas used to drive the turbine driving the compressor, the remainder being expanded straight to atmosphere in a jet.

This type of engine is well known, and in fact the writer worked in 1943 or 1944 on a basically similar proposal made by Dr. A.A. Griffith. The distinguishing features of Mr. Frosts' proposal lines in the use of Llungstrom type compressor and turbine, and the relation of the engine to the aircraft.

A brief analysis of such an engine has been made. The component efficiencies used were compression 80%, turbine 90%. Nozzle expansion 97%, combustion pressure losses 3%. No allowance was made for turbine leaving velocity losses. Assuming a maximum turbine inlet temperature of 1200 °K and an ambient temperature of 288 °K, the maximum specific thrust is about 45 lbs/lb/sec of air at a compression ratio of about 5 to 1. At this compression ratio the specific fuel consumption would be 1.37 lbs/lb of thrust per hour. At 8 to 1 compression ratio the specific consumption is 1.28 lbs/lb/hr, while the specific thrust is about 43 lbs/lb sec of air. These figures would be better with a higher compression efficiency, and a figure of 87% might possibly be achievable after development (57.5 lbs/sec at 1.06 lbs of fuel/lb thrust /hr.)

Hence performance wise, the engine proposed is suitable. To obtain the 5 to 1 compression ratio, three rows of compressor blading and three of turbine blading would probably be required.

The main points that raise themselves are:

(1) Development of satisfactory combustion is not going to be easy. The design shown in the drawings would not be a very practical starting point and a great deal of effort will be required and considerable facilities.

(2) The fact that the jet nozzles will operate at a pressure ratio of 5.0 to 1 demands a convergent, divergent nozzle for complete expansion. There will be severe mechanical problems in arranging for the proper adjustment of throat-discharge area ratio to suit varying engine conditions.

(3) The feasibility of efficiently directing the jets by the guide vanes and halo ring is queried. These jets will be at a Mach number of order 2.0.

(4) Complete utilisation of the thrust figures calculated will be impossible due to losses encountered in turning the forward facing jets backwards.

These comments relate only to the engine, and some of the difficulties apply only to a large engine. Development of a small scale prototype would not be too big a job and would provide the answers to queries 2, 3 and 4 above. If these could be adequately answered, the proposal would seem to be a practical proposition, assuming the aerodynamics are correct.

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