International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 07 | July -2017 www.irjet.net p-ISSN: 2395-0072

OPTIMIZATION OF JET ENGINE

G.Vinoth.

Student, Department of Aeronautical Engineering, V.S.B. Engineering College, Karur, Tamilnadu, India.

---***---

Abstract: *The conventional jet engine is optimized to produce high thrust and low specific fuel consumption. The changes are made in compressor which is responsible for the pressure raise in the total process. The compressor section is replaced with two smaller compressors which are parallel to each other with separate individual inlets. It is designed that the two compressors do compression separately and produce high pressure raise. This pressure raise will reduce the fuel demand considerably and increase in thrust.*

Key Words: High Thrust Jet Engine, Low Fuel Consuming Jet Engine, Double Compressor Jet Engine.

1. INTRODUCTION

Jet Engine is a machine which converts chemical (Fuel) energy into Thrust. Jet engines are the power source for most of the aircrafts flying now. Generally it has five sections like Inlet, Compression Section, Combustion section, Turbine and Nozzle. Every section depends on each other. Change in the performance of any above section will create a huge change in the performance of the jet engine. The resources of Air Turbine Fuel are becoming very low in the Earth. Nearly 70% of the total expense of one flight is for the fuel. Lot of innovations is emerging to reduce fuel consumption in aircrafts. This is one among them which considerably reduces the fuel consumption.

2. CONCEPT

Generally jet engine has an axial compressor which is driven by turbine shaft to achieve required pressure raise. Now it is replaced with two smaller compressors which will do the same compression individually. Both the compressors are provided with the separate inlets through which separate air stream will flow into the respective compressors as shown the figure.1.

As the compression takes place in two compressors, the total pressure raise of air stream at the entry of combustor should be higher than the single conventional compressor. Thus the fuel required to attain a specific pressure raise at the turbine inlet will be lowered. It reduces the specific fuel consumption of the engine. As the compressors using separate airstream, the mass flow rate will be more which results in high thrust.

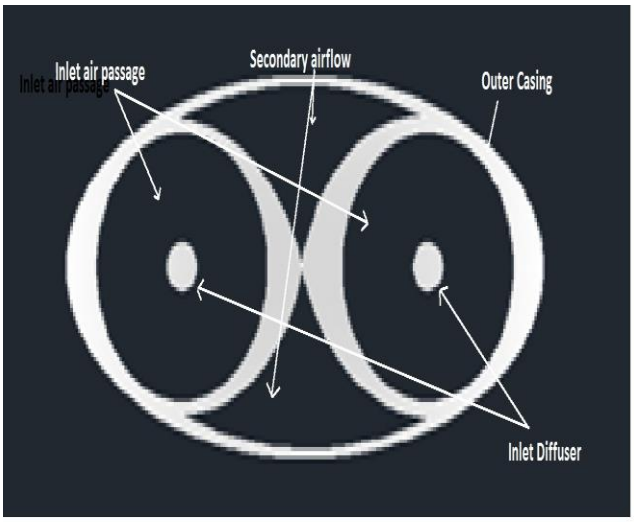

Figure-1: Front View of the Engine.

3. DESIGN

As the new design engine has two compressors, the size of the engine will be very high and it produces serious problems in aircraft performance. So the size of each compressor is reducing to ¾th of the normal compressor. It will be in the scale ratio of 1.5(2 compressors):1 with normal engine compressor. Thus the frontal size of jet engine is 50% more than the normal engine. The number of stages in compressor depends on the application. The engine is roughly designed with 10 stages in compressor. The design of two inlets is made identical to each other in order to have uniform compressor performance. The engine has two ducts as shown the figure.1 for the secondary flow like in turbofan engine. This will help for engine cooling purpose.

The turbine shaft is connected with two compressors through gear wheels as shown the figure.2. The separate lubricant system is provided to gear wheels in order to reduce the gear loss. Various types of combustion chamber are available in aviation industry but I prefer annular combustion chamber for this engine. Annular combustor can take pressurized air from two compressors easily and produce high performance. The rest section of engine will be same as the normal engine.

The turbine cooling system is designed to access the secondary air stream like turbo fan engine.

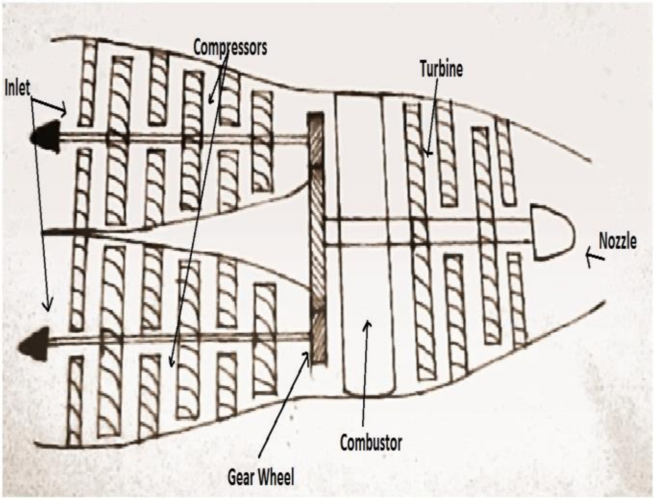

Figure-2: Top View of the Engine.

4. WORKING

The two separate inlets will suck the atmospheric air and supply it to the respective compressors. The pressure of atmospheric air will be raised slightly at inlet ducts. Then the compressors do compression individually and contribute for pressure raise. As the compressor size is ¾th of the original compressor size, the work done by the each compressor is 75% of the normal compressor. At the end, due to two individual process, the pressure raise will be 50% more than the normal one.

The high pressure (50% more than the normal engine) air is mixed with air turbine fuel at particular stoichiometric ratio (smaller than normal engine). It is burnt to produce hot gas with high pressure and high temperature. Hot gas will make the turbine to rotate itself and will make to rotate compressors in required RPM. Thrust is the function of velocity of exit jet and mass flow rate. As the mass flow rate is greater, thrust production will be higher.

5. COMPARISON AND CALCULATION

Consider an engine which produce pressure raise up to 25 times of incoming mass. And it requires certain amount of fuel to burn the airstream. Let

Pressure at compressor inlet P_1=75 KN/m^2
Pressure at combustor inlet P_2=1800 KN/m^2.
Required pressure at the turbine inlet P_3=3500 KN/m^2.
For attaining the pressure, the fuel required f =1.5 l/ km.
Now the optimized engine performance is calculated. As it has two compressors, it produces 50 % more pressure raise.

Pressure at compressor inlet p_1=75 KN/m^2.
Pressure at combustor inlet p_2=**1800*1.5** =2700 KN/m^2.
Required pressure at the turbine inlet p_3=3500 KN/m^2.
To attain the pressure, the fuel required F=0.71 l/ km.

Consider M is the mass flow rate at the normal engine and the thrust will be F_1=M*V. (V is the exit jet velocity which is considered to be same for normal and optimized engine). Let m is the mass flow rate of optimized engine and thrust will be F_2=m*V. The new design has two inlets and the upstream air should be greater than the normal engine which has single inlet. Thus m>M, then $F_2>F_1$.The below graph clearly demonstrates the pressure variation on both type of engines. The addition of components will create losses like frictional loss, Gear loss etc. But the benefit will be more than losses created by this optimization.

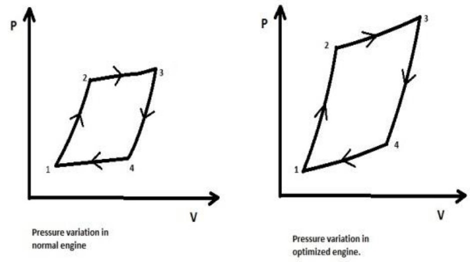

Figure-3: Pressure variation in the Engine.

6. CONCLUSIONS

Through this optimized design, the specific fuel consumption in a jet engine is reduced by raising the pressure at combustor inlet. By increasing the mass flow rate, Thrust production is also enhanced.

7. LIMITATIONS

1) The optimized engine is suitable for low speed aircrafts. At high speed the shock wave formation affects the engine performance.
2) To start the engine, the initial ground power required will be higher as it has to rotate two compressors.
3) Frontal area of the engine will be wider and the engine is heavier.

REFERENCES

[1] http://ae.sharif.edu/~prop/Hill%20Peterson%201992%20Mechanics%20and%20thermodynamics%20of%20propulsion.pdf
[2] https://en.wikipedia.org/wiki/General_Electric_CF6
[3] https://en.wikipedia.org/wiki/Jet_engine_performance
[4] http://www.allstar.fiu.edu/aero/Propulsion2.htm