

Working principles of Turbojet Engine

1. The demand for increasing speed and size for the aircraft led to the use of gas turbine engines in place of reciprocating engines.
2. The Thrust of the turbojet is developed by compressing the intake air in the inlet diffuser and then in the compressor, mixing the air with fuel and burning in the combustor and expanding the gas stream through the turbine and the exhaust nozzle.
3. As the aircraft moves forward in the atmosphere, the atmospheric air enters the air intake, called the inlet diffuser.
4. After initial compression in the diffuser, the air enters an adiabatic compressor
5. A portion of the air after compression, directly enters the combustion chamber where fuel is added in the required propulsion.
6. The fuel and air gets mixed and the combustion reaction takes place releasing heat energy.
7. The flow through the combustion chamber is assumed to be steady and the heat addition is at constant pressure.
8. The remainder of the compressed air is used to cool the chamber, and eventually all excess air is mixed with the products of combustion to cool to the required level before entering the turbine.

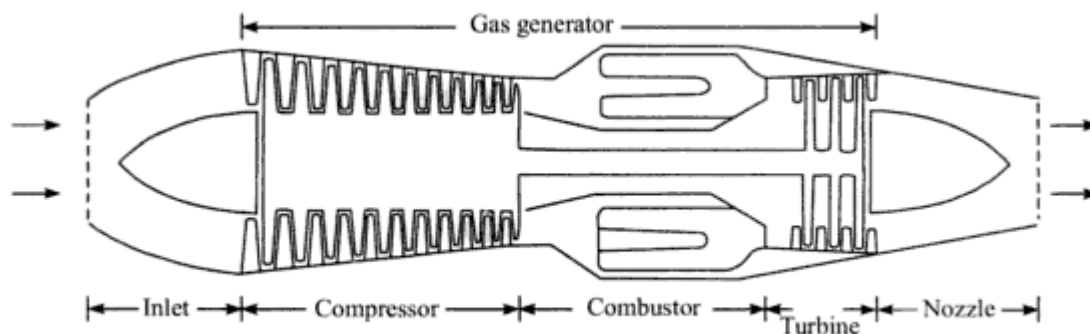


Fig. 13.2 Schematic of a turbojet engine.

Intake Diffuser:

1. The air inlet of the engine is employed to reduce the velocity of the entering air to a level suitable for entering the compressor without loss.
2. The air velocity is reduced by diffusion (compression) processes which increases the air pressure.

Compressor:

1. This function is further increase the pressure of the incoming air so that sufficient pressure can be achieved for expansion in the turbine and nozzle.
2. By increasing the pressure, the size of the components; combustor and exhaust nozzle can also be reduced and the combustion process in the combustion chamber can be carried out efficiently.
3. Centrifugal compressors are sometimes used in small gas turbine engines.
4. In most of the present day aircraft gas turbine engines, split or two spool axial flow compressors are employed to attain higher pressure ratios of the order 10 to 15.

Combustion Chamber:

1. In the combustion chamber, high pressure air leaving the compressor is burned with fuel at constant pressure.
2. The combustor is usually designed to burn fuel with the air at an air fuel ratio of about 50 to 150.
3. The combustor is designed to have maximum pressure loss with maximum combustion efficiency.
4. In order to ignite the fuel air mixture, a high voltage electrical ignition system is employed.

Turbine:

1. Turbine is located at the exit of the combustion chamber to extract some of the energy from the combustion products to power the compressor and other engine accessories.
2. Nearly one fourth of the energy available in the products of combustion is required to drive the compressor.
3. Axial flow multistage turbine is usually employed for this purpose.
4. The two basic types of axial turbines used in propulsion engines are impulsion and reaction turbine.
5. Most turbines in jet engines are a combination of impulse and reaction principles.

Exhaust Nozzle:

1. In turbine engine, the hot gas after the expansion enters the exhaust nozzle in order to expand further to ambient pressure or less before getting discharged to the atmosphere.
2. For low pressure ratio requirements, convergent nozzle is employed.
3. For high pressure ratio requirements, a convergent-divergent nozzle is employed.
4. The convergent-divergent nozzle employed in most of the supersonic aircrafts are of adjustable area type.

Thrust Augmentation:

1. In order to increase the performance of turbojet engines during its take off, the thrust during take-off is usually augmented by adding an afterburner or by water injection.
2. Thrust augmentation by water methanol injection is achieved by injecting a mixture of water and methanol into either the compressor inlet or combustion chamber.
3. When injection is into the inlet of the compressor the intake air is cooled which results in an increased compressor pressure ration in addition to increased mass flow.
4. The higher pressure and the increase in mass flow combine to increase the thrust.

Advantages:

1. Highly suitable for higher speeds, higher altitudes and long distance to travel.
2. The power to weight ratio is very high
3. Simple and easy to maintain
4. It require little lubrication
5. Thrust developed by the turbojet engine can be increased by using afterburner when required

Disadvantages

6. The fuel economy is very low at lower operational speeds and altitudes
7. It is uneconomical for short distance flights.

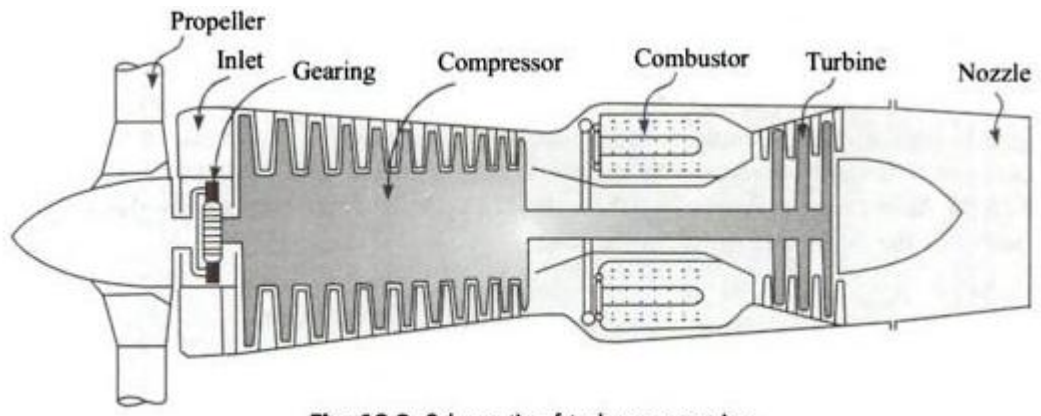


Fig. 13.8 Schematic of turboprop engine.