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# Working Model of Turbojet Engine

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**Abstract** – The project made to show the working model of Turbojet Engine. The turbojet engine operates on the Brayton cycle and features four primary stages: **air intake**, **compression**, **combustion**, and **exhaust**. The turbo-jet engine is for high speeds. The working model shows how atmospheric air is taken in and compressed using a multi-stage axial or centrifugal compressor. The compressed air then enters the combustion chamber, where it mixes with fuel and undergoes ignition, producing high-energy exhaust gases. These gases rapidly expand through a turbine, extracting mechanical energy to drive the compressor and producing thrust as they accelerate through a nozzle to generate forward propulsion. This model serves as an educational tool, illustrating critical concepts such as the conversion of chemical energy into kinetic energy.

***Key Words:*** Turbojet Engine, Air Intake, Compression, Combustion, Exhaust, Centrifugal Compressor, Chemical Energy, Kinetic Energy.

## 1. INTRODUCTION

Turbojet engines have introduced in the field of aviation since the mid-20th century, enabling powered flight at unprecedented speeds and altitudes. These engines converts the chemical energy of fuel into kinetic energy, propelling aircraft forward. Understanding the working model of a turbojet engine is not only essential for aviation enthusiasts but also for engineers and scientists who aim to innovate and improve aircraft performance. This paper aims to elucidate the fundamental components and principles that govern turbojet engine operation. However, they continue to play a role in specific applications, particularly in military and high-speed aircraft.

## 2. BASIC PRINCIPLES OF OPERATION

Turbojet engines works on the Brayton Cycle, which involves four main processes: **intake, compression, combustion, and exhaust**. These processes are discussed in detail as follows:

**2.1 INTAKE -** The intake of a turbojet engine is the first stage in the propulsion process. It's a critical component designed to efficiently capture and direct ambient air into the engine's compressor. The intake design is crucial to maximizing airflow and reducing drag at high speeds.

**2.2 COMPRESSION –** For Compression we use the component Compressor. It is very crucial component in a turbojet engine, responsible for increasing the pressure and temperature of the incoming air. The compression is typically achieved using multiple stages of rotating blades that progressively compress the air.

There are two types of Compressors in this category, they are:

- Axial Flow Compressor
- Centrifugal Flow Compressor

**2.3 COMBUSTION -** The combustion chamber is known as the heart of the turbojet engine. In the combustion chamber, the compressed air is mixed with fuel. Its function is to burn large amount of fuel, which are delivered through fuel spray nozzles, using a high volume of air provided by the compressor. This process generates heat that is released to produce a steady flow of uniformly heated gas for the turbine.

There are three types of Combustion Chambers and they are:

- Can type combustion chamber
- Can-Annular type combustion chamber
- Annular type combustion chamber.

**2.4 TURBINE -** The turbine provides the power to drive the compressor and accessories and, in the case of engines which do not make use singly of a jet for propulsion. The hot gases pass through this section, which gives energy to drive the compressor. It does this by taking out energy from the hot gases released from the combustion system and sending them to a lower pressure and temperature.

**2.5 EXHAUST -** The exhaust system in a turbojet engine is the final stage where the high-energy, high-temperature gases, after powering the turbine, are expelled to generate thrust. The design of the exhaust system, exerts good performance of the engine. The turbine starting temperature, the heavy mass airflow and the velocity and pressure of the exhaust jet. The following components of Exhaust system are:

- Turbine Exhaust Duct
- Exhaust Nozzle
    - Convergent Nozzle
    - Convergent-Divergent Nozzle.

## 3. METHODOLOGY –

The methodology for designing and developing a turbojet engine involves a multi-step process. It begins with conceptual design, where performance goals are defined. This is followed by detailed design, where components are designed to precise specifications. The project is based as we need to create a turbojet engine of performance based with very high efficiency and fuel-efficient engine. As high-powered engine is required to create higher engine RPM. And the engine showed should be high weight to strength ratio. The manufacturing process involves component fabrication and assembly, followed by rigorous testing on test stands and flight tests to validate performance and durability.

## 4. IMPLEMENTATION PLAN –

***Phase 1: Design and Analysis***

Firstly, we prepared a rough diagram of engine from the idea of some of the books. And then we decided the size of the engine it should be of. And then we designed a blueprint of the engine in computer through programming language. And then we revived the thermodynamic cycle involved in engine operation.

***Phase 2: Manufacturing and Fabrication***

We manufactured the required components using some of the techniques such as machining and forging. And then we fabricated the parts like compressor blades, turbine rotor etc.

***Phase 3: Assembly***

We assembled the various components of the engine (compressor, combustion chamber, turbine, exhaust nozzle). We ensured the precise alignment and fitment of components. Also ensured the fuel supply, lubrication and cooling system.

***Phase 4: Testing***

We tested the engine under controlled conditions to check out thrust output, fuel consumption and efficiency. And measured some performance standards such as exhaust temperature, pressure drop and airflow rates.

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Then we compared the test results with our theoretical predictions and made necessary adjustments.

## 5. MATERIALS/DESIGN –

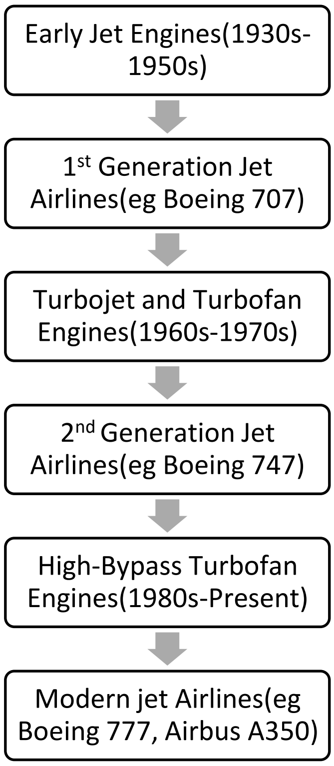
As using materials, the main thing to keep in mind is the temperature and weight. As using Aviation fuel was very dangerous so the one thing, we could use was **propane**. As with weight factor the material, we used to be steel due to its melting point i.e. 1500 °C and as burning point of propane is 1900 °C as we can also vary the air bypass by varying the supply of the fuel.

The outer casing, the combustion chamber and shaft was made from the steel, which was a foundation. The blades of the turbine, the inlet and plates of the compressor was made from the aluminium. As the high temperature air directly enter from the combustion chamber and directly hit the turbine blades for the safety we have to make a coating of steel upon the aluminium. After looking out on fuel as it needed to be corrosion resistant so we made the fuel line with copper tube. And the main advantage of that tube was its flexibility, as it can be bent into circular shape and kept in aft section of combustion chamber. For the inlet section we used the pieces of brass that were soldered with silver to flow the fuel to the chamber.

### 5.1 DESIGN

The core components include an inlet, compressor, combustion chamber, turbine, and nozzle. The air first enters the inlet section which must give a smooth stream of air to the compressor. The compressor is a component which involves a pump which raise the pressure of the air. Then the pressurized air enters the combustion chamber, there the fuel is burned and this adds more energy to airflow. This is done to increase the temperature. After this section airflow will be taking characteristics of gas. Then this gas energy is sent to the turbine section that dives the compressor by the conversion of mechanical energy. This energy of the hot gas is not generated by only turbine. In fact, there are three components (compressor, combustion chamber and turbine) combined to process this gas to do some work. That is the reason these three units together named as a gas generator, regardless of any engine. In a turbojet engine the major part of the heat and pressure still should be converted to kinetic energy. This work should be done by exhaust nozzle which is a tubelike shaped which complete energy conversion from heat and pressure to velocity. As we can increase exhaust velocity by afterburning.

### 5.2 FLOW CHARTS




## 6. CONCLUSION

As we conclude here, we have our efforts on making of a turbojet engine as it should be useful for all the visitors to understand the working of a turbojet engine and all the stages of it, the stages that are very important in understanding the working of the engine. And we also built an engine that works on less

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consumption of fuel and which gives the feedback of high thrust and works efficiently.

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