THERORITICAL STUDY ON JET ENGINES

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ABSTRACT

In this Paper a brief article about a jet engine and its working explained along with its various types. A Jet Engine is a reaction Engine that discharges a fast moving jet which generates thrust by jet propulsion in accordance with Newton's third Law of Motion. Jet Engine is an internal combustion air breathing jet engine (a duct engine). These typically consist of an engine with a rotary (rotating) air compressor powered by a turbine ("Brayton Cycle"), with the leftover power providing thrust via a propelling nozzle. A young German physicist, Hans von Ohain, worked for Ernst Heinkel, specializing in advanced engines, to develop the world's first jet plane, the experimental Heinkel.

Keyword: - *Brayton cycle, Duct Engine, Turbofan Engine, Ram jet.*

1. INTRODUCTION

A jet engine is a machine that converts energy-rich, liquid fuel into a powerful pushing force called thrust. The thrust from one or more engines pushes a plane forward, forcing air past its scientifically shaped wings to create an upward force called lift that powers it into the sky. A jet engine uses the same scientific principle as a car engine: it burns fuel with air (in a chemical reaction called combustion) to release energy that powers a plane, vehicle, or other machine. But instead of using cylinders that go through four steps in turn, it uses a long metal tube that carries out the same four steps in a straight-line sequence—a kind of thrust-making production line! In the simplest type of jet engine, called a turbojet, air is drawn in at the front through an inlet (or intake), compressed by a fan, mixed with fuel and combusted, and then fired out as a hot, fast moving exhaust at the back.

2. TYPES OF JET ENGINES

2.1 Turbojet engine

A turbojet engine is a gas turbine engine that works by compressing air with an inlet and a compressor (axial, centrifugal or both), mixing fuel with the compressed air, burning the mixture in the combustor and then passing the hot, high pressure air through a turbine and a nozzle. The compressor is powered by the turbine, which extracts energy from the expanding gas passing through it.

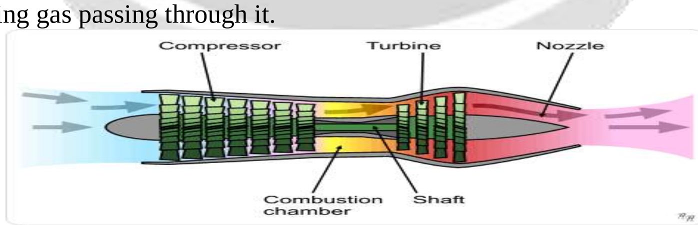

Fig -1: Turbojet Engine

2.2 Turbofan Engine

Like a turbojet, it uses the gas generator core (compressor, combustor, and turbine) to convert internal energy in fuel to kinetic energy in the exhaust. Turbofans differ from turbojets in that they have an additional component, a fan. The bypassed flow is at lower velocities, but a higher mass, making thrust produced by the fan more efficient than thrust produced by the core.

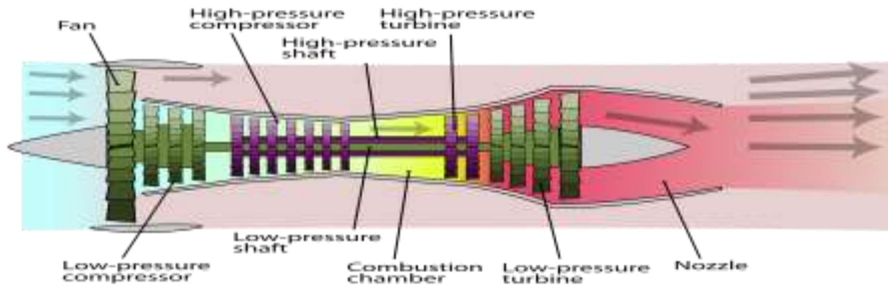

Fig -2: Turbofan Engine

2.3 Turboprop Engine

In turboprop engines, a portion of the engine's thrust is produced by spinning a propeller, rather than relying solely on high-speed jet exhaust. As their jet thrust is augmented by a propeller, turboprops are occasionally referred to as a type of hybrid jet engine. They are quite similar to turbofans in many respects, except that they use a traditional propeller to provide the majority of thrust, rather than a ducted fan. Both fans and propellers are powered the same way, although most turboprops use gear-reduction between the turbine and the propeller (geared turbofans also feature gear reduction). While many turboprops generate the majority of their thrust with the propeller, the hot-jet exhaust is an important design point, and maximum thrust is obtained by matching thrust contributions of the propeller to the hot jet. Turboprops generally have better performance than turbojets or turbofans at low speeds where propeller efficiency is high, but become increasingly noisy and inefficient at high speeds.

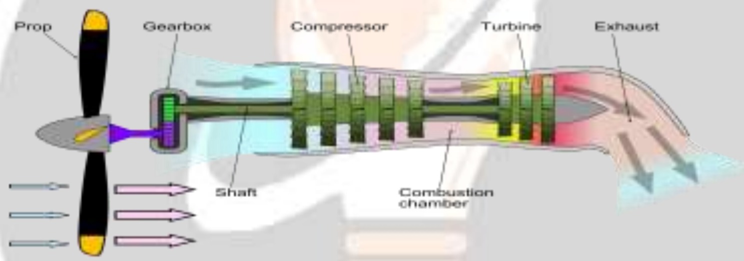

Fig -3: Turboprop Engine

2.4 Turboshaft Engine

Turboshaft engines are very similar to turboprops, differing in that nearly all energy in the exhaust is extracted to spin the rotating shaft, which is used to power machinery rather than a propeller, they therefore generate little to no jet thrust and are often used to power helicopters

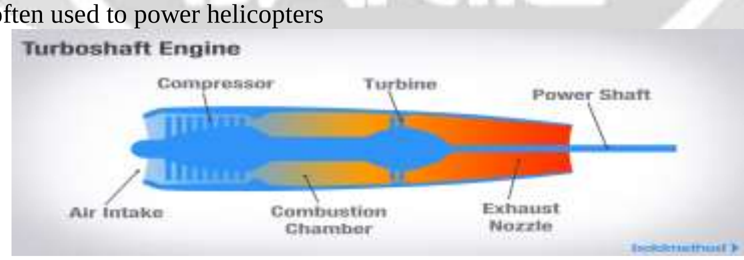

Fig -4: Turboshaft Engine

2.5 Propfan

A Propfan engine (also called "unducted fan", "open rotor", or "ultra-high bypass") is a jet engine that uses its gas generator to power an exposed fan, similar to turboprop engines. Like turboprop engines, Propfan generate most of their thrust from the propeller and not the exhaust jet. The primary difference between turboprop and Propfan design is that the propeller blades on a Propfan are highly swept to allow them to operate at speeds around Mach 0.8, which is competitive with modern commercial turbofans. These engines have the fuel efficiency advantages of turboprops with the performance capability of commercial turbofans. While significant research and testing (including flight testing) has been conducted on Propfan, no Propfan engines have entered production.

Fig -5: Propfan

2.6 Ramjet

Ram powered jet engines are air breathing engines similar to gas turbine engines and they both follow the Brayton Cycle. Gas turbine and ram powered engines differ, however, in how they compress the incoming airflow. Whereas gas turbine engines use axial or centrifugal compressors to compress incoming air, ram engines rely only on air compressed through the inlet or diffuser.

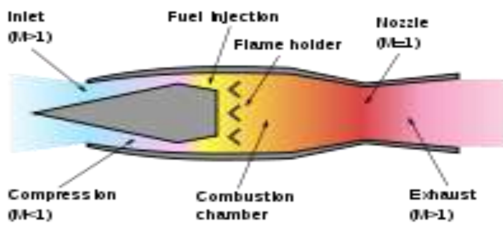

Fig -6: Ramjet

2.7 Scramjet

Like a ramjet, they consist of an inlet, a combustor, and a nozzle. The primary difference between ramjets and scramjets is that scramjets do not slow the oncoming airflow to subsonic speeds for combustion, they use supersonic combustion instead. The name "scramjet" comes from "Supersonic Combusting Ramjet." Since scramjets use supersonic combustion they can operate at speeds above Mach 6 where traditional ramjets are too inefficient. Another difference between ramjets and scramjets comes from how each type of engine compresses the oncoming airflow: while the inlet provides most of the compression for ramjets, the high speeds at which scramjets operate allow them to take advantage of the compression generated by shock waves, primarily oblique shocks.

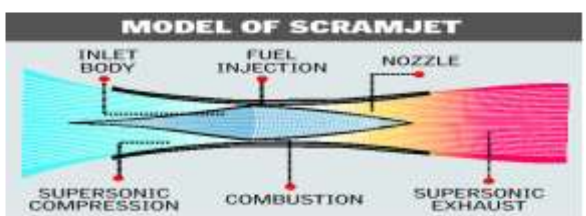

Fig -7: Scramjet

2.8 Rocket

The rocket engine uses the same basic physical principles as the jet engine for propulsion via thrust, but is distinct in that it does not require atmospheric air to provide oxygen; the rocket carries all components of the reaction mass. This allows them to operate at arbitrary altitudes and in space. This type of engine is used for launching satellites, space exploration[6] and manned access, and permitted landing on the moon in 1969.Rocket engines are used for high altitude flights, or anywhere where very high accelerations are needed since rocket engines themselves have a very high thrust-to-weight ratio. However, the high exhaust speed and the heavier, oxidizer-rich propellant results in far more propellant use than turbofans. Even so, at extremely high speeds they become energy-efficient.

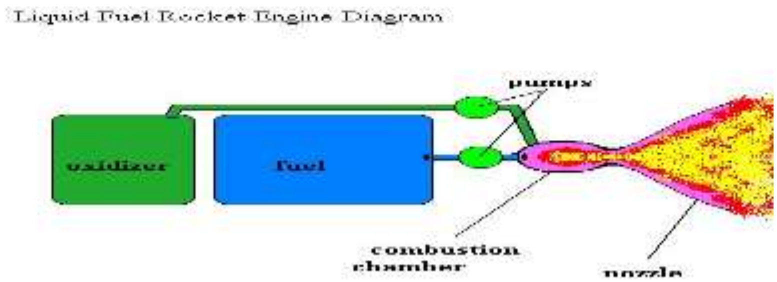

Fig -8: Rocket

2.9 Water jet

A water jet, or pump jet, is a marine propulsion system that utilizes a jet of water. The mechanical arrangement may be a ducted propeller with nozzle, or a centrifugal compressor and nozzle.

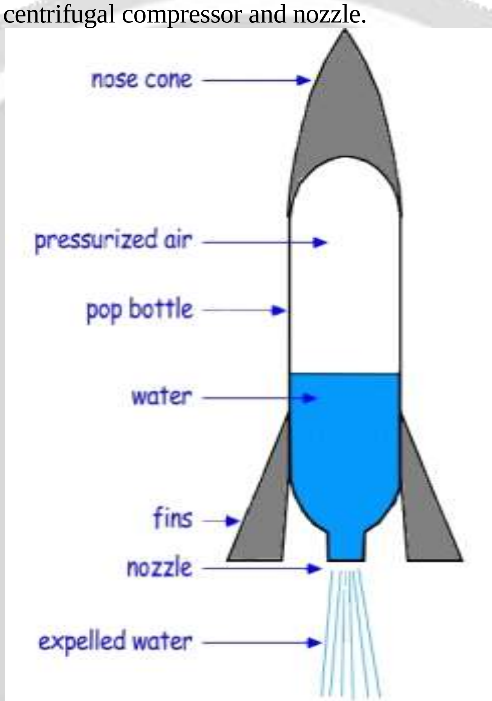

Fig -9: Water jet

3. CONSUMPTION OF FUEL OR PROPELLANT:

A closely related (but different) concept to energy efficiency is the rate of consumption of propellant mass. Propellant consumption in jet engines is measured by Specific Fuel Consumption, Specific impulse. Effective Exhaust Velocity. They all measure the same thing. Specific impulse and effective exhaust velocity are strictly proportional, whereas specific fuel consumption is inversely proportional to the others. For air breathing engines such as turbojets energy efficiency and propellant (fuel) efficiency are much the same thing, since the propellant is a fuel and the source of energy. In rocketry, the propellant is also the exhaust, and this means that a high energy propellant gives better propellant efficiency but can in some cases actually can give lower energy efficiency.

4. CONCLUSIONS

Propeller engines handle larger air mass flows, and give them smaller acceleration, than jet engines. Since the increase in air speed is small, at high flight speeds the thrust available to propeller-driven aero planes is small. However, at low speeds, these engines benefit from relatively high propulsive efficiency. On the other hand, turbojets accelerate a much smaller mass flow of intake air and burned fuel, but they then reject it at very high speed. When a de Laval nozzle is used to accelerate a hot engine exhaust, the outlet velocity may be locally supersonic. Turbojets are particularly suitable for aircraft travelling at very high speeds. Turbofans have a mixed exhaust consisting of the bypass air and the hot combustion product gas from the core engine. The amount of air that bypasses the core engine compared to the amount flowing into the engine determines what is called a turbofan's bypass ratio (BPR).While a turbojet engine uses all of the engine's output to produce thrust in the form of a hot high-velocity exhaust gas jet, a turbofan's cool low-velocity bypass air yields between 30% and 70% of the total thrust produced by a turbofan system

5. REFERENCES

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