Technical Description of the GEnx Brand

GEnx Turbofan Engine

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Author's Note

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Abstract

The purpose of this paper is to discuss the operation and design of a turbofan engine, specifically a GEnx. This paper will contain the function, parts, the overall history of turbofan engines and its effects in the aviation industry. GEnx is the newest most modern and efficient turbofan engine as of today.

Introduction

For a commercial passenger aircraft to move forward through the air, it requires a jet engine -also known as a gas turbine engine- specifically a turbofan engine. This type of jet engine is utilized within modern airliners because of its high thrust and fuel efficiency (Cutler, 2020). The GEnx is a turbofan engine (fig. 1) that produces thrust, which initiates an aircraft to move onwards and fly throughout the atmosphere. This type of engine uses a fan to intake air, and the greater the amount of air intake means the greater thrust (Cutler, 2020). Turbofan engines are quieter in comparison to other jet engines, such as turboprop and turbojet engines(Types Of Turbine Engines, n.d.).

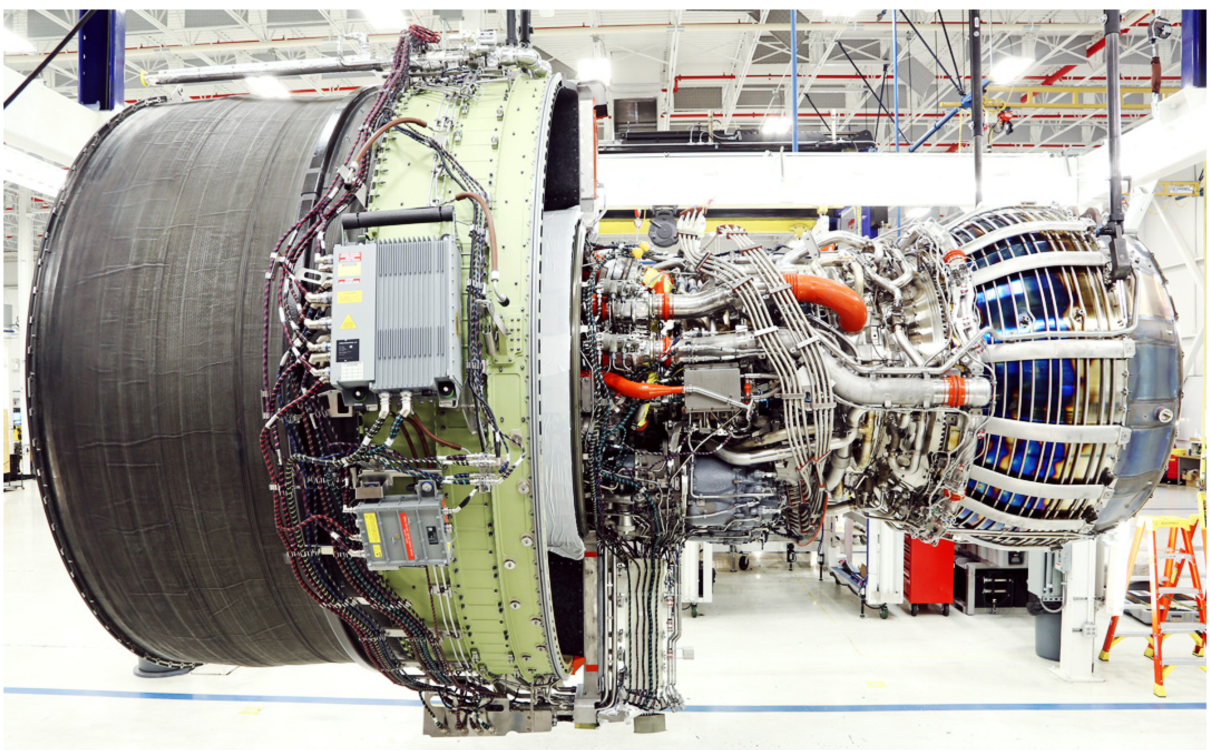

Figure 1: The GEnx turbofan engine. Reprinted from “Power in Numbers: GE Rolls Out GEnx Engine No. 1,000 in Only Five Years Since Entering Service” on “ge.com” by Krista Carroll October 22, 2015

Background

The years that World War II was happening, Nazi bombers were raiding over London like shooting stars (Keller, 2018). Yet, England wanted to win the war which required them to have a powerful and efficient jet engine. As a result, in 1941, the U.S. Army Air Corps assigned General Electric (GE) to advance and rebuild a British based jet engine that was designed by Britain's Sir Frank Whittle (Aviation History, n.d.). Thus, General Electric built America's first jet engine. On April 18, 1942, General Electric engineers successfully built America's first jet engine, the I-A engine (Aviation History, n.d.).

However, concerns were made by the U.S. Army Air Corps stating they needed more powerful and efficient jet engines. On the other hand, General Electric required another source of profit, since the I-A engine sales were depreciating. As a result, they came up with the J47 jet engines (Aviation History, n.d.). America was officially in the jet age era and therefore the J47 became the first jet engine certified for commercial aviation (Keller, 2018). In the aftermath, a total of 35,000 J47s were produced, naming the J47 as the most produced jet engine in aviation history (Keller, 2018).

As General Electric jet engines became more advanced, the desire for power and efficiency grew. As a result, the turbofan era started. Commercial Aviation grew tremendously making General Electric engineer's focus: the civil market. In 1971 General Electric created its first turbofan engine called CF6-6 high bypass turbofan engine (Aviation History, n.d.). Since then the turbofan engines have been flourishing with advancements from GE90 to GEnx. The GE90 is considered the world's most powerful and largest turbofan engine to date (Aviation History, n.d.). Additionally, the GEnx is known to be more reliable, fuel-efficient, quieter and the fastest-selling high thrust engine in General Electric Aviation history (The GEnx Engine: GE Aviation, n.d.).

List of the parts and function

The GEnx turbofan engine (fig. 2) functions the same way as any turbofan engine. GEnx utilizes all these parts to function, without these parts GEnx wouldn't be considered a turbofan engine. GEnx turbofan engines are mostly used on Boeing 787 Dreamliners and the 747-8 passenger aircraft (The GEnx Engine: GE Aviation, n.d.). To manufacture one such engine it takes up to six countries, specifically 12 states and 21 GE manufacturing sites(Manufacturing the GEnx, 2016). They make 1.1 million of total parts to form one GEnx jet engine (Manufacturing the GEnx, 2016). The GEnx utilizes 18 carbon fiber composite made fan blades and the first-ever composite made fan case (Manufacturing the GEnx, 2016). That ultimately reduces 350lbs of weight on the engine in addition to increasing the engine's efficiency (Manufacturing the GEnx, 2016). Overall, the air going into the core gets compressed in the compressor section, mixes with fuel in the combustion section, ignites with the fuel/air mixture and shoots out huge forces from the exhaust, creating thrust (Cutler, 2020).

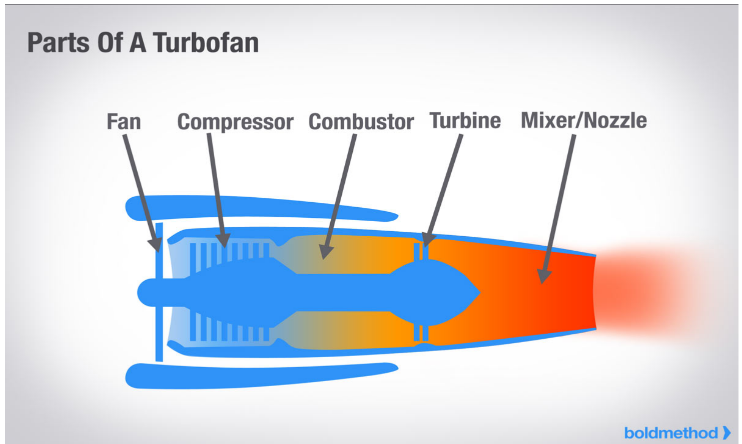

Figure 2: A turbofan engine parts/sections. "How Does A Turbofan Engine Work ?" on "bolthmethod.com" by Colin Cutler January 21, 2020

1)Fan/Inlet
2)Compressor
3)Combustor
4)Turbine
5)Mixer/Nozzle

1. The Fan/Inlet

To begin with, the fan or the inlet section of a turbofan engine (fig. 3) is where tremendous amounts of air are being sucked into the engine (Cutler, 2020). Additionally, there are two air streams. One airstream goes into the engine's core, this is where the combustion will occur that will create thrust. The rest of the air that goes around the engine's core is called the bypass air. The bypass air creates additional thrust, cools the engine and makes the engine quieter (Types Of Turbine Engines, n.d.).

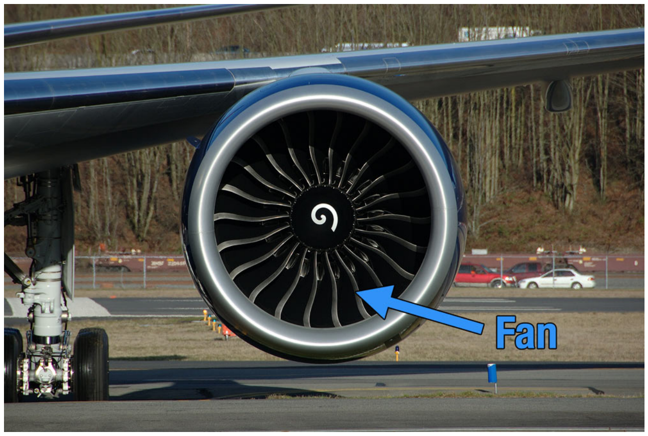

Figure 3: A turbofan engine inlet section. “How Does A Turbofan Engine Work ?” on “bolthmethod.com” by Colin Cutler January 21, 2020

2. The Compressor

In the compressor section, the air ultimately gets compressed down. As the air enters this section a series of airfoil shape blades increases the speed of the air and compresses it even further. Next, as the air moves through the compressor, there is a set of blades that are a little smaller, which was created purposely by the GE engineers because it added more energy and compression to the air (Cutler, 2020). Between each set of compressor blades, there are airfoil-shaped blades called "stators" (fig. 4) that are considered non-moving. These stators (also called vanes), help increase the pressure of the air by converting the rotational energy into static pressure (Cutler, 2020). Also, stators help straighten the flow of air (Cutler, 2020).

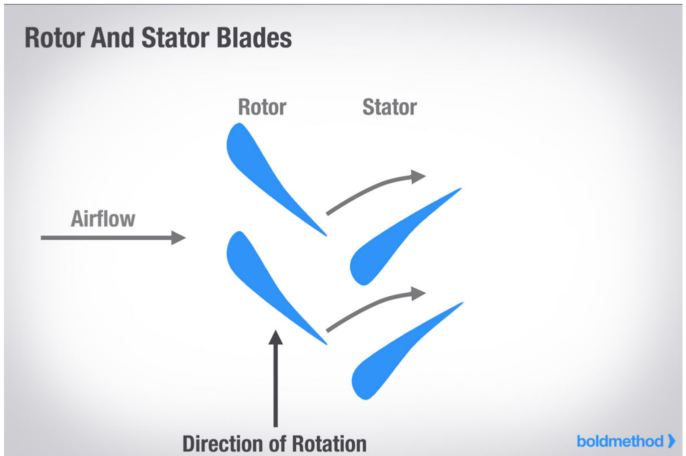

Figure 4: A turbofan engine rotor and stator blades. “How Does A Turbofan Engine Work ?” on “bolthmethod.com” by Colin Cutler January 21, 2020

3. The Combustor

This is the third part of the turbofan engine. Here is where the fuel and air are mixed and then ignited. As the air is entering the combustor from the compressor section the air is leaving the compressor at a very high velocity and so it needs to be slowed down. The diffuser will work first, it’s purpose is to slow down the speed of the air so that it can be easier to ignite (Cutler, 2020). Fuel injector comes in and sprays fuel into the air stream coming in creating fuel/air mixture. Now you have made combustion right after the fuel and air is mixed and the ignitor causes that combustion to occur.

4. The Turbine

After the air has passed the combustor it is now moving towards the turbine section. The turbine section has a series of blades that are driven by the hot and very high-speed air coming in from the combustion(Cutler, 2020). The purpose of the turbine section is to extract energy from the air that is coming in from the combustor and to turn the compressor as well as to fan at the front. It does this by being connected with a shaft that both the compressor and turbine sections are connected to. When spinning the turbine it simultaneously turns the compressor blades in the front by this air is being sucked in by the compressor and the fan continuously (Cutler, 2020).

5. The Mixture/Nozzle

Finally, the mixture/nozzle section - also called the exhaust- is where all the hot and air gases shoot out at a dangerous rate, which is thrust. All the air that came in through the front has been compressed, ignited and by being very hot creates a force that is shooting out the back of the GEnx engine. This force called thrust is what pushes an aircraft forward. Many aviation experts say this is where Sir Isaac Newton's third law comes in: "For every action, there is an equal opposite reaction". The mixer is responsible for a quieter engine because it only allows some of the bypass air to mix in with the stressed air thus decreasing the noise level.

Conclusion

Jet engines have gone through many advancements throughout history. To the point when the first jet engine was made in the United States, it was generating about 1250 pounds of thrust compared to the GEnx which was making 125,000 pounds of thrust (Aviation History, n.d.). General Electric is still the top leading brand for making jet engines, distinctively turbofan engines for the commercial aviation industry (The GEnx Engine: GE Aviation, n.d.).

However, some may say turbofan engines are very expensive to make and that is why they are sold at a very high price. Though especially in the airline industry, turbofan engines are not normally purchased, they are mostly leased and the airline owners make more than enough money. At the end of the day, there is not anything as efficient and powerful as the GEnx as well as all the previous turbofan engines for long haul flights. Jet engines are very fuel-efficient and that is what makes the commercial aviation industry more in tune with it. The less fuel that is needed, the more money generated and saved. Overall, turbofan engines including the GEnx produce power by intake, compression, power, and exhaust.

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