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ANALYSIS OF THE ROLLS-ROYCE ENGINE SERIES FOR POSSIBLE QUALITATIVE CHANGES OF ITS MODELS

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Even those who are not into the topic of engines have heard the name Rolls-Royce. Everybody knows that engines of this brand are practically the best among others. When Rolls-Royce was privatised in April 1987, its share of the large civil turbofan market was only 8 per cent. At that time, the aircraft manufacturers were proposing new planes that were going to require higher levels of thrust than before. Rolls-Royce would have to offer engines for every large civil airliner. In view of the enormous development costs, the only way to do this would be to have a family of engines based on a common core. The Rolls-Royce Trent became this family of by – pass turbofan engines. This decision led the company to the great commercial success – its total market share in mass production in which it competes is 40 percent now. Sales of the Trent family engines made Rolls-Royce the second largest supplier of large civil turbofan engines after General Electric, pushing Pratt & Whitney to third place. So what qualitative changes of Rolls-Royce Trent engines led it to the achievement of global success?

When Airbus was planning its new twin-jet A330 in the late 1980s, Rolls-Royce proposed the Trent 700. It is a three coaxial shaft turbofan by-pass engine. The fan has 26 wide blades and is driven by a 4-stage low pressure turbine. The 8-stage intermediate pressure compressor and the 6-stage high pressure compressor are driven by a single-stage turbine. The single annular combustion chamber has 24 nozzles. The Trent 700 is capable of thrust up to 316 kN.

By 1990, Boeing decided to launch a new, larger 777 family of aircraft with thrust requirements of 350 kN or more. The 2.47m Trent 700 fan would not be large enough to meet this requirement, so Rolls-Royce offered a new version with a 2.79m fan and up to 423kN thrust, designated the Trent 800.

In 1995, Airbus began considering an engine for two new versions of its A340 aircraft, to which Rolls-Royce responded with the development of a new Trent 500. The Trent 500 is a Trent 800 with a 2.47m fan with 26 non-rolling blades, like the Trent 700. Intermediate compressors and high pressure are reduced by 20 % compared to the Trent 800, and the turbines are scaled down by 90 percent. Fuel consumption is 1 percent lower thanks to 3D aerodynamics. It produces up to 275 kN of thrust on takeoff and has a bypass ratio of up to 8.5: 1 compared to 5:1 for the Trent 700 and 6,4:1 for the Trent 800.

In October 2000, the Trent 900 became the launch engine for the Airbus A380. It can reach 374 kN thrust. It incorporates a significant number of technologies, including a 2.95 m reverse sweep fan that provides more thrust for the same motor size and is about 15 percent lighter than previous wide chord blades. It is also the first member of the Trent family to be equipped with a counter-rotating high pressure spool using the very reliable Trent 500 core.

The Trent 1000 engine has been used in Boeing 787 aircraft since 2006. The Trent 1000 is a no-bleed design, with power take-off from the medium pressure spool instead of the high pressure spool used in other models in the Trent family to meet Boeing's requirements for a «more electric» engine. A fan with a 2.84 m diameter was specified with a stepped head

and a smaller hub diameter to maximize air flow. The bypass ratio has been increased to 10: 1 by adjusting the main flow accordingly. It is also has a tiled combustion chamber.

Also in 2006, after reviewing the Airbus A350, Rolls-Royce reached an agreement to supply all versions of the aircraft with a completely new version of the Trent XWB with thrust up to 420 kN. The Trent XWB retains the characteristic Rolls-Royce Trent coaxial three-shaft architecture. The fan is up to 3m in diameter. The Trent XWB has a two-stage intermediate pressure turbine, rather than a single-stage one like in previous Trent engines.

Announced on 14 July 2014 at the Farnborough Air Show, the Trent 7000 is an exclusive engine for the Airbus A330neo, replacing the Trent 700 used in the Airbus A330. Compared to the 20 year old Trent 700, the Trent 7000 has a larger fan – 2.84 m. This doubles the bypass ratio from 5 to 10. It has the highest bypass ratio of any Trent engine, on par with the Trent 1000 The fan has 20 blades. He is capable of developing thrust up to 320 kN.

This paper has reviewed the process of improving the Rolls-Royce Trent series of aircraft engines. Having analyzed this process it can be concluded that these qualitative changes were obtained by increasing the diameter of the fans and the shape of their blades as in the Trent 900 or Trent 1000, or due to the increase in the number of turbine stages, but at the same time maintaining the classic three-shaft structure, such as in the Trent XWB. Thus, thanks to the timely decision of Rolls-Royce to create and develop the Trent series of aircraft engines based on the common core, it was able to become one of the leading manufacturers of civilian turbofan bypass engines, having sold 510 models of this series by the end of 2019 [1–9].

References

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