

# Rolls-Royce Nene

The **Rolls-Royce RB.41 Nene** is a 1940s British centrifugal compressor turbojet engine. The Nene was a complete redesign, rather than a scaled-up Rolls-Royce Derwent<sup>[1]</sup> with a design target of 5,000 lbf, making it the most powerful engine of its era. It was Rolls-Royce's third jet engine to enter production, and first ran less than 6 months from the start of design. It was named after the River Nene in keeping with the company's tradition of naming its early jet engines after rivers.

The design saw relatively little use in British aircraft designs, being passed over in favour of the axial-flow Avon that followed it. Its only widespread use in the UK was in the Hawker Sea Hawk and the Supermarine Attacker. In the US it was built under licence as the **Pratt & Whitney J42**, and it powered the Grumman F9F Panther. Its most widespread use was in the form of the Klimov VK-1, a reverse-engineered, modified and enlarged version which produced around 6,000 lbf of thrust, and powered the famous Mikoyan-Gurevich MiG-15, a highly successful fighter aircraft which was built in vast numbers.

A more powerful slightly enlarged version of the Nene was produced as the Rolls-Royce Tay.

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## RB.41 Nene / J42



Rolls-Royce Nene on display at RAAF Base Pearce, Western Australia - note the wire mesh grille around the air intake to prevent Foreign object damage

<b>Type</b>	Turbojet
<b>Manufacturer</b>	Rolls-Royce Limited
<b>First run</b>	27 October 1944
<b>Major applications</b>	Canadair CT-133 Silver Star Dassault Ouragan de Havilland Vampire Grumman F9F Panther Hawker Sea Hawk
<b>Number built</b>	1,139 (J42)
<b>Developed from</b>	Rolls-Royce Derwent
<b>Developed into</b>	Rolls-Royce Derwent V Rolls-Royce RB.44 Tay Pratt & Whitney J48 Klimov VK-1

# Design and development

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An FMA IAe 33 Pulqui II without tail section, showing its Rolls-Royce Nene II turbojet

The Nene was designed and built as a result of an early 1944 Air Ministry request for an engine of 4,200 lbf thrust, and an engine was schemed-out by Stanley Hooker and Adrian Lombard as the B.40. In the summer of 1944 Hooker visited the US and discovered that General Electric already had two engine types, an axial and a centrifugal, of 4,000 lbf thrust running. On returning to the UK Hooker decided to go for 5,000 lbf of thrust and, working with Lombard, Pearson and Morley, a complete redesign of the B.40 resulted in the B.41,<sup>[1]</sup> later to be called the Nene.

The double-sided impeller was 28.8 inches in diameter, compared to 20.68 for the Derwent I, to produce an airflow of 80 lb/s, while the overall diameter of the engine was 49.5 inches. A scaled up Derwent would have a 60-inch diameter. The compressor casing was based on

Whittle's Type 16 W.2/500 compressor case which was more aerodynamically efficient than that on the Derwent but also eliminated cracking. Other design advances included nine new low pressure-drop/high efficiency combustion chambers developed by Lucas and a small impeller for rear bearing and turbine disc cooling.<sup>[2]</sup> The first engine start was attempted on 27 October 1944. A number of snags delayed the run until nearly midnight, when with almost the entire day and night shift staff watching, an attempt was made to start the engine, without the inlet vanes, which had not yet been fitted. To everyone's dismay the engine refused to light - positioning the igniter was a trial-and-error affair at the time. On the next attempt, Denis Drew unscrewed the igniter and as the starter motor ran the engine up to speed, lit the engine with an oxy-acetylene torch. The engine was run up to 4,000 lbf and more, and a cheer went up around the assembled personnel. Upon Hooker's arrival next morning, and informed that the inlet vanes had been fitted during the night, Hooker was satisfied to see the thrust gauge needle registering 5,000 lbf, making the B.41 the most powerful jet engine in the world. Weight was around 1,600 lb.<sup>[3]</sup>

The Nene was based on the "straight-through" version of the basic Whittle-style layout, with the flow going directly through the engine from front to rear, as opposed to a "reverse-flow" type,<sup>[4]</sup> which reverses the direction of air flow through the combustor section so that the turbine stage can be mounted within the combustor section; this allows for a more compact engine, but increases the combustor pressure losses which has an adverse effect on engine performance.<sup>[5]</sup> Less thrust is generated with the same fuel flow. It was during the design of the Nene that Rolls decided to give their engines numbers as well as names, with the Welland and Derwent keeping their original Rover models, **B/23** and **B/26**. It was later decided that these model designations looked too much like RAF bomber designations (i.e. "English Electric Canberra B.Mk 2" would often be shortened to "Canberra B.2"), and "R" was added to the front, the "R" signifying "Rolls" and the original Rover "B" signifying Barnoldswick. This **RB** designation scheme continued into the late 20th Century, with turbofan designs such as the RB.199, RB.203 and RB.211; the most recent family of Rolls-Royce turbofans (a development of the RB.211) goes under the simple designation "Rolls-Royce Trent", with variants given their own designator number or letter series (i.e. Trent 500, Trent 900, Trent 1000, Trent XWB, etc.).

Early airborne tests of the Nene were undertaken in an Avro Lancastrian operated by Rolls-Royce from their Hucknall airfield. The two outboard Rolls-Royce Merlins were replaced by the jet engine. The Nene's first flight however was in a modified Lockheed XP-80 Shooting Star.<sup>[6]</sup>

After seeing the Nene running, at an after work drink at the Swan & Royal Hotel, Clitheroe, and hearing the complaints about a lack of any official application for the engine, someone - thought to be Whittle - suggested that the Nene be scaled-down to fit a Meteor nacelle. J.P. Herriot or Lombard did the calculation on a tablecloth and announced a thrust of 3,650 lbf. At this time they were attempting to increase the

Derwent's thrust from 2,200 lbf to 2,450 lbf, and the idea seemed "too good to be true". On hearing this, Hooker did a quick calculation and announced, "We've got a 600-mph Meteor".<sup>[7]</sup>

Drawings for the 0.855 scale Nene, now known as the Derwent V, were started on 1 January 1945 and on 7 June the engine began a 100-hour test at 2,600 lbf, soon reaching 3,500 lbf. Weight was 1,250 lb. By 1946 thrust had been increased to 4,200 lbf using Nimonic 90 turbine blades.<sup>[7]</sup>

The development of the Nene was continued with this scaled-down version, the Derwent V having no direct relationship to the earlier Derwent series. On 7 November 1945, the first official air speed record by a jet aircraft was set by a Meteor F.3 of 606 miles per hour (975 km/h) powered by the scaled-down Nene.



The Rolls-Royce Avro Lancasterian Nene test bed in 1948 fitted with the jet engines in the outboard position

## Service use

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The Nene doubled the thrust of the earlier generation engines, with early versions providing about 5,000 lbf (22.2 kN), but remained generally similar in most ways. This should have suggested that it would be widely used in various designs, but the Gloster Meteor proved so successful with its Derwents that the Air Ministry felt there was no pressing need to improve upon it. Instead a series of much more capable designs using the Rolls-Royce Avon were studied, and the Nene generally languished.

A total of twenty-five Nenes were sold to the Soviet Union as a gesture of goodwill - with reservation to not use for military purposes - with the agreement of Stafford Cripps. Rolls-Royce were given permission in September 1946 to sell 10 Nene engines to the USSR, and in March 1947 to sell a further 15. The price was fixed under a commercial contract. A total of 55 jet engines were sold to the Soviets in 1947.<sup>[8]</sup> The Soviets reneged on the deal after the Cold War broke out in 1947, and reverse engineered the Nene to develop the Klimov RD-45, and a larger version, the Klimov VK-1, which soon appeared in various Soviet fighters including Mikoyan-Gurevich MiG-15.

Pratt & Whitney acquired a licence to produce the Nene as the **Pratt & Whitney J42**, and it powered the Grumman F9F Panther which first flew in November 1947.<sup>[9]</sup>

The Nene was used to power the first civil jet aircraft, the Nene Viking,<sup>[10]</sup> a modified Vickers Viking, the single example of which first flew on 6 April 1948 from Wisley Airfield.<sup>[11]</sup>

It was briefly made under licence in Australia for use in the RAAF de Havilland Vampire fighters. It was also built by Orenda in Canada for use in 656 Canadair CT-133 Silver Star aircraft from 1952.

Hispano-Suiza in France built the Nene under licence as the **Hispano-Suiza Nene**, with limited production before concentrating on the larger Rolls-Royce Tay/Hispano-Suiza Verdon.

## Variants

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**RN.1**

**RN.2**

**RN.6**

**Nene I**

**Nene Mk.3**

With an electric starter motor and two torch igniters the Mk.3 powered the Supermarine Attacker F Mk.1.

#### **Nene Mk.10**

Similar to the Mk.102 but with a larger accessories wheelcase for the Lockheed T-33.

#### **Nene Mk.101**

With a bifurcated jet-pipe for the Hawker Sea Hawk, at a reduced output of 5,000 lbf (22.24 kN)

#### **Nene Mk.102**

Similar to the Mk.3, but incorporating more modern equipment, for the Supermarine Attacker FB Mk.2

#### **Nene Mk.103**

Upated to 5,200 lbf (23.13 kN) for the Hawker Sea Hawk FB.5 and FGA.6. Some were retrofitted to convert existing FB.3 and FGA.4 aircraft.

#### **Pratt & Whitney J42**

US licence production<sup>[12]</sup>

##### **J42-P-4**

[12]

##### **J42-P-6**

[12]

##### **J42-P-8**

[12]

##### **Turbo-Wasp JT-6B**

[12]

#### **Kuznetsov RD-45**

Unlicensed copy produced in the USSR

#### **H.S. Nene 102**

[13]

#### **H.S. Nene 104**

[13]

#### **H.S. Nene 104-BR**

[13]

#### **H.S. Nene 105A**

[13]

#### **H.S. Nene 105-AR**

[13]

## **Applications**

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### **Nene**

- Armstrong Whitworth AW.52
- Avro Ashton
- Avro Lancastrian (test-bed)
- Avro Tudor VIII
- Boulton Paul P.111
- Boulton Paul P.120
- Canadair CT-133 Silver Star
- Dassault Ouragan
- de Havilland Vampire

- [FMA IAe 33 Pulqui II](#)
- [Gloster E.1/44](#)
- [Handley Page HP.88](#)
- [Hawker P.1052](#)
- [Hawker P.1081](#)
- [Hawker Sea Hawk](#)
- [Nord 2200](#)
- [Rolls-Royce Thrust Measuring Rig](#)
- [SNCAC NC.1071](#)
- [SNCAC NC 1080](#)
- [SNCASO SO.4000](#)
- [SNCASO SO.6000 Triton](#)
- [Sud-Est Grogard](#)
- [Sud-Ouest Bretagne](#)
- [Sud-Ouest Triton](#)
- [Supermarine Attacker](#)
- [Vickers Type 618 Nene-Viking](#)

### **Pratt & Whitney J42**

- [Grumman F9F Panther](#)

### **Kuznetsov RD-45**

- [Mikoyan-Gurevich MiG-15](#)

## **Engines on display**

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- A complete Nene engine is displayed at the RAF Manston History Museum, Manston, Kent.
- A sectioned Rolls-Royce Nene is on display at the [Fleet Air Arm Museum](#), [RNAS Yeovilton](#).
- [Gatwick Aviation Museum](#) (<http://www.gatwick-aviation-museum.co.uk/>) Charlwood surrey
- A cutaway Nene II on display at the [New England Air Museum](#)
- A sectioned Hispano-Suiza Nene is on display at the Ailes Anciennes Toulouse Museum in France.
- [Ailes Anciennes Toulouse Museum](#) (<http://www.aatlse.org/>) Toulouse/Blagnac.
- A sectioned RR Nene is on display at the Queensland Air Museum, Caloundra, Australia.
- A complete Nene engine is on display at the [Historical Aircraft Restoration Society](#), at Albion Park, New South Wales, Australia
- A Nene, from a Pulqui II, is on display at the National Aeronautics Museum, Moron, Buenos Aires, Argentina.
- A Nene is on display at the [Rolls-Royce Heritage Trust](#) (<https://R-RHT.com>) Collection (Derby).

## **Specifications (Nene)**

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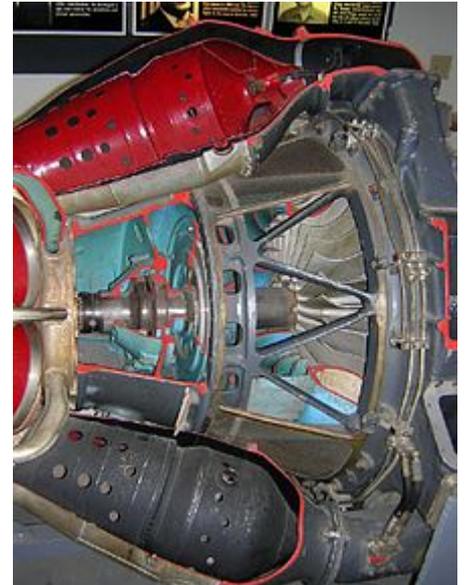
*Data from* <sup>[14]</sup>

### **General characteristics**

- **Type:** centrifugal compressor turbojet
- **Length:** 96.8 in (2,458.7 mm)
- **Diameter:** 49.5 in (1,257.3 mm)
- **Dry weight:** 1,600 lb (725.7 kg)

## Components

- **Compressor:** single stage centrifugal with double-sided impeller
- **Combustors:** 9 x can combustion chambers
- **Turbine:** single-stage axial
- **Fuel type:** kerosene (R.D.E.F./F/KER)
- **Oil system:** pressure feed, dry sump with scavenge, cooling and filtration, oil grade 70 S.U. secs (13 cs) (D.T.D 44D) at 38 °C (100 °F)



Cutaway view showing the combustion chambers and compressor

## Performance

- **Maximum thrust:** 5,000 lbf (22.24 kN) at 12,300 rpm at sea level for take-off
- **Specific fuel consumption:** 1.06 lb/(lbf·h) (30 g/(kN·s))
- **Thrust-to-weight ratio:** 3.226
- **Military, static:** 5,000 lbf (22.24 kN) at 12,300 rpm at sea level
- **Max. cruising, static:** 4,360 lbf (19.39 kN) at 12,000 rpm at sea level
- **Cruising, static:** 3,620 lbf (16.10 kN) at 11,500 rpm at sea level
- **Idling, static:** 120 lbf (0.53 kN) at 2,500 rpm at sea level

## See also

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### Related development

- Rolls-Royce RB.44 Tay
- Pratt & Whitney J48
- Klimov VK-1

### Related lists

- List of aircraft engines

## References

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1. "Rolls-Royce Aero Engines" Bill Gunston, Patrick Stephens Limited 1989, ISBN 1-85260-037-3, p.111
2. "Not Much Of An Engineer" Sir Stanley Hooker, Airlife Publishing 2002, ISBN 1-85310-285-7, p.88
3. "World Encyclopedia of Aero Engines - 5th edition" by Bill Gunston, Sutton Publishing, 2006, p.193

4. "R-R W2B" ([https://web.archive.org/web/20140507185055/http://www.enginehistory.org/GasTurbines/r-r\\_w2b.shtml](https://web.archive.org/web/20140507185055/http://www.enginehistory.org/GasTurbines/r-r_w2b.shtml)). Web.archive.org. Retrieved 29 February 2020.
5. Fig.17 (<http://naca.central.cranfield.ac.uk/reports/arc/rm/2579.pdf>)
6. [1] (<http://www.flightglobal.com/pdfarchive/view/1946/1946%20-%200764.html>)
7. "World Encyclopedia of Aero Engines - 5th edition" by [Bill Gunston](#), Sutton Publishing, 2006, p.194
8. "Jet Engines (Foreign Sales)" (<http://hansard.millbanksystems.com/commons/1948/nov/22/jet-engines-foreign-sales>). HC Deb, 22 November 1948 vol 458 cc839-41 (<https://hansard.parliament.uk/html/Commons/1948-11-22/CommonsChamber#839>)
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10. "The Vickers 'Nene/Viking'" (<http://www.flightglobal.com/pdfarchive/view/1949/1949%20-%200401.html>). *Flight*, 3 March 1949. Retrieved 8 March 2017.
11. Gunston, Bill (1980). *The Illustrated Encyclopedia of Commercial Aircraft*.
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- Connors, Jack (2010). *The Engines of Pratt & Whitney: A Technical History*. Reston. Virginia: American Institute of Aeronautics and Astronautics. [ISBN 978-1-60086-711-8](#).
- Kay, Anthony L. (2007). *Turbojet History and Development 1930-1960*. **1** (1st ed.). Ramsbury: The Crowood Press. [ISBN 978-1-86126-912-6](#).

## External links

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- [Pratt & Whitney History page on the J42 \(http://www.pw.utc.com/J42\\_Engine\)](http://www.pw.utc.com/J42_Engine)
- [The Nanton Lancaster Society \(https://web.archive.org/web/20040702054756/http://www.lancastermuseum.ca/engine\\_rollsene.html\)](https://web.archive.org/web/20040702054756/http://www.lancastermuseum.ca/engine_rollsene.html)
- ["Rolls-Royce Nene I" \(http://www.flightglobal.com/pdfarchive/view/1946/1946%20-%200757.html\) a 1946 Flight article on the Nene](http://www.flightglobal.com/pdfarchive/view/1946/1946%20-%200757.html)

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