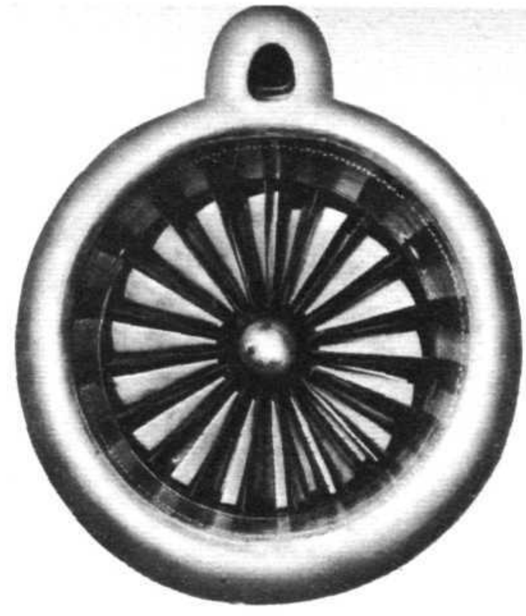

CONWAY

THE EVOLUTION OF THE FIRST ROLLS-ROYCE BY-PASS TURBOJET

WITH the Rolls-Royce Dart turboprop Britain won, for the first time in history, a substantial slice of the market in airline powerplants. This was achieved not by any intrinsic efficiency of the Dart so much as by the fact that it worked reliably and was available at a time when few of its competitors could do either (and none both). In contrast, the Rolls-Royce Conway by-pass turbojet has from the outset had to contend with keen competition from engines which in most respects are quite comparable.

With the advent of the American "Big Jets" a situation has arisen in which the world's airlines can choose either American or British powerplants for the most expensive equipment ever offered to them. That in many cases the Conway has been chosen can be attributed clearly to the fact that it is technically superior to any alternative engine. This is not an idle claim: Rolls-Royce can point directly to greater thrust, lighter installed weight, lower specific fuel consumption and greater promise for the future. As a result the Conway bids fair to becoming the finest transport powerplant for the largest airliners throughout the Western world. But it is also an engine of extraordinary technical interest, and it is fortunate that permission to describe the present airline version has come when a Conway-powered aeroplane is being delivered to our global flag-carrier (see the two preceding pages).

As we have already outlined (notably in our issues of February 8, 1957 and October 30, 1959), the overall efficiency of an aero engine is the product of its thermal efficiency and Froude propulsive efficiency. What is ideally required is an engine which operates at the highest possible peak temperature and pressure ratio, yet which imparts a low acceleration to the largest possible airflow in order to minimize the jet velocity. To achieve this goal, the by-pass turbojet employs an oversized low-pressure compressor, the delivery from which is split into two distinct streams. The innermost core is further compressed in a high-pressure compressor and passed through the combustion chambers and turbine. The outer part of the delivery is discharged through a duct surrounding the rest of the engine and is finally mixed with the hot central jet in the propulsive nozzle.

Compared with a simple turbojet of the same thrust such an engine handles a larger airflow, and the lower mean jet velocity reduces the noise energy by a very wide margin. Moreover, since all components behind the low-pressure compressor can be substantially reduced in size, the engine can be made significantly lighter than the simple turbojet. Again, although the maximum flame temperature can be raised to the highest level consistent with good turbine life, the adverse effect which this has on jet velocity (from the viewpoints of Froude efficiency and noise) can be overcome by the injection of by-pass air. As a result, an engine with a carefully chosen by-pass ratio can beat any simple turbojet of the same thrust when the two engines are installed in similar aircraft and assessed on a basis of air-miles per pound of fuel.

It is recalled that Sir Frank Whittle conceived and patented the basic thermodynamic principle of the by-pass engine, and patents were assigned to Power Jets (R & D) Ltd, the Government-owned company which holds all Sir Frank Whittle's patents relating to aircraft gas turbines.

Nevertheless, it remained for Rolls-Royce to design and develop the Conway—the first, and so far the only, large by-pass engine in the world. Like most of the powerplants conceived at Derby, the basic Conway has already evolved into a complete family, current members of which give exactly double the thrust of the first prototype.

Just ten years after Sir Frank's original patent, Dr A. A. Griffith, the chief scientist of Rolls-Royce, sketched a by-pass engine built up from parts of the AJ.65 (Avon) and AJ.25 (Tweed). In April 1947 a revised version was studied, rated at rather less than 5,000lb thrust, and further projects appeared in October 1947 and April 1948. In October of the latter year Rolls-Royce decided to submit a by-pass engine to meet a Ministry of Supply requirement for a powerplant for the Vickers-Armstrongs Pathfinder (a special development of the Valiant for which the black-painted B.2 served as the prototype). Initially designated RB.80, its design thrust was 9,250lb. Considerable further development took place upon this basic design, and finally a prototype was manufactured in January 1950 as the Conway RCo.2.

During the development of the RCo.2 it became apparent that

(*continued on page 80, after double-page drawings of Conway*)

Engine type	RCo.2	RCo.5	RCo.8	RCo.10-12	RCo.11	RCo.15	RCo.42
Configuration and design changes.	First R-R by-pass engine. Two-shaft engine, with 4-stage l-p. compressor, 8-stage h-p compressor, 2-stage h-p. turbine and 2-stage l-p. turbine.	Redesigned to higher mass flow and pressure ratio. New 6-stage l-p. compressor, 9-stage h-p. compressor, single-stage h-p. turbine and original l-p. turbine.	Conversion of RCo.5 with improvedair-cooling system to permit operation at increased flame temperature.	New design, with zero-stage on l-p. compressor, new h-p. compressor and new l-p. turbine. Completely new exterior suited to nacelle installation. RCo. 12 (uprated) succeeds defunct RCo. 10 rating.	Closely related to RCo.10/12. Tailored to wing installation, accessories not being mounted on engine but on airframe.	Increased diameter zero-stage on l-p. compressor, and improved h-p. compressor with higher efficiency.	Extensive revision to increase C/H ratio to 0.6. A completely new l-p. compressor increases overall diameter to 45in, and numerous other changes have been made.
Basic weight (lb)	3,385	3,473	3,500	4,542	Restricted	4,582	5,001
Performance:							
A, Guaranteed minimum thrust (lb)	—	—	—	17,500 } 9,980*	17,250	18,500 } 9,895*	20,250 } 9,955*
B, Average achieved thrust (lb)	9,250	13,000	14,500	18,000 }	—	19,000 }	21,000 }
C, S.f.c. (average)	0.67	0.735	0.75	0.725	—	0.701	0.622
D, S.f.c. (cruise)	—	—	—	0.874	—	0.842	0.785
History:							
First bench run	August 1952	July 1953	January 1956	November 1957	Restricted	January 1959	—
First 25hr test	April 1953	January 1954	January 1956	March 1958	—	January 1959	—
First 150hr test	Not run	December 1954	May 1956	June 1958	—	July 1959	—
First type-test	Not run	July 1955	Not required	June 1958	—	—	—
Total bench time	133hr 52min	3,064hr	2,312hr	16,000hr	—	—	—
No of dev't engines	1	13	9 (RCo.5 converted)	—	—	—	—
Production delivery	Not produced	Not produced	Not produced	September 1958	—	Early 1961	Early 1962
First flight	Not flown	October 1955	Jan. 1957 (Ashton)	October 1958	—	1960	—
Flight time	Nil	980	2	—	—	—	—
Applications	Vickers Pathfinder	V.1000	Victor B.2	DC-8 707-420	Victor B.2	DC-8 (CPAL)	VC10 707-520

Notes: Performance A, B and C are sea-level static ISA standard day; performance D is 475kt at 36,000ft; asterisked figures are high-pressure r.p.m.