



Rolls-Royce RB.178-61 twin-spool demonstrator turbofan. No design details revealed. Air mass flow, 700lb/sec. By-pass ratio, 2.75:1. Rating, 27,500lb. Diameter, 62.5in

AERO ENGINES . . .

Total civil flying time is more than 3.8 million hours, and maximum t.b.o. is 4,700hr. The 3,600 s.h.p. marine Tyne has also been ordered for the Grumman PG(H) hydrofoil gunboat, this contract being the first for a marinised R-R turbine.

R-R's sole example of a helicopter engine, the Gazelle free turbine turboshaft of Napier origin, continues in production at the Scottish factories as the 1,540 h.p. NGa.13 for the Westland Wessex 30 Series, and the higher-rated 1,600 h.p. NGa.22 constitutes an NGa.13 conversion for Wessex 3 and 32 Series aircraft. No further development of this engine is being undertaken by R-R at present.

Only other production engine is the Avon turbojet, now in its sixteenth year of manufacture. Of its numerous civil and military applications, two are still being delivered, the Sud Aviation Caravelle VI N and R now at the end of their production run and powered respectively by the 12,200lb Mk 531 and 12,600lb Mk 533R variants of the Avon RA29/6, and the BAC Lightning T.5 and F.6, each powered by two RB.146 Avon Mk 301s of 13,220lb basic thrust, rising with afterburning to 16,360lb. Civil Avons have completed more than eight million hours' flying and have a maximum t.b.o. of 6,700hr. In military operation the Avon has more than six million hours to its credit.

Avon gas generators are being supplied for industrial duties, in particular for peaking turbo-generator sets and for gas pumping stations where the engines run on natural gas. In a recent R-R scheme, a marine Avon gas generator has been proposed for energising individual free turbines driving ACV lift and propulsion fans.

Engines under development comprise the RB.153 turbofan, RB.162 lift jet, RB.172 and 178 turbofans, and the RB.193 vectored thrust turbofan. The RB.153 is the subject of a joint development agreement with MAN Turbo, and bench running of the engine continues primarily to provide component operating experience, including the testing of Phantom Spey afterburners, and special designs of cooled turbine blading capable of entry tem-

peratures as high as 1,500°K. The sole application for the RB.153-61R engine with afterburner and switch-in thrust deflector was the EWR VJ101D V/STOL strike fighter which was cancelled during 1965. Basic thrust is 6,850lb, rising with afterburning to 11,685lb. As the RB.153-80, however, the engine was proposed by R-R last year as an alternative power unit for the Anglo-French VG project for which the SNECMA/BSE M45G has been designed. Substitution of the RB.153 would presumably assist in reducing development costs.

Development continues of the RB.162, R-R's second generation lift jet, primarily for the VAK 191B V/STOL strike fighter which is programmed to fly next year. Other applications are the Dornier Do31E which was scheduled to fly last month (without lift pods), and the Dassault Mirage III V, the second prototype of which crashed in November, only five months after its first flight. The VAK 191B will have two later RB.162-1s, the Do31E which is now apparently proceeding on a reduced budget, has eight 4,400lb RB.162-4Ds, and the Mirage III VO2 had eight 3,640lb RB.162-1s. Other possible applications for the lift jet include the Trident 3B, as a take-off and climb booster, and the Dornier Do-HS1 project.

Over 60 RB.162s have now been built out of a total programme of 86, and latest variant to be announced is the RB.162-81 of 6,000lb thrust and around 16:1 thrust/weight ratio. This has the same external dimensions as the lower rated RB.162-30 but introduces an air-cooled turbine for the first time. Development of the RB.162 is funded by the British, French and German governments, and R-R.

Most promising outlet for R-R's many years of lift jet work is likely to be via the US/UK government-to-government agreement of 1965 for development of an advanced lift jet. This agreement took practical shape in March last year when Allison was announced as the American company to partner R-R in the project. Although undoubtedly the resulting design will rely extensively on R-R's third generation lift jet project, the RB.189, the programme is under an Allison manager. Funding is being shared 50/50 by the two countries, and a demonstrator unit is scheduled to be on test this summer. A likely application for the ALJ is the US-FRG V/STOL fighter project to be designed by Republic and EWR-Sud. In addition to two vectored thrust turbofans, the aircraft is to have four 9,000lb lift jets of 20 to 24:1 thrust/weight ratio.

The R-R/Turbomeca RB.172-T260 afterburning turbofan is the power unit for the BAC/Breguet Jaguar advanced trainer/light strike fighter, and is the subject of an Anglo-French government contract for joint R-R/Turbomeca design, development and manufacture. Rated at 4,500lb, rising with afterburning to about 7,000lb, the engine is scheduled to run in April and first flight of the Jaguar is planned for next year. R-R is responsible for design of the combustion system, turbines and afterburner, and Turbomeca for the fan, compressor and external wheelcase.

Named Adour after a river passing near Turbomeca's plant in the Basses-Pyrénées, the engine has considerable potential as a major product for both companies. France plans to order 300 Jaguars, and Britain 150. Germany is also interested in the trainer version, and sales prospects for about 2,000 aircraft have been forecast by Breguet. An improved military version of the Hawker Siddeley HS.125 is also proposed as a possible RB.172 application. In July last year a jointly owned company, Rolls-Royce

Turbomeca Ltd, was formed to be responsible for the development and manufacturing programmes for the Adour.

A civil derivative of the RB.172, designated RT.172 and rated at 4,400lb, has been projected for use in executive and small transport aircraft. One application at present under discussion is the Hawker Siddeley HS.125.

Third in a series of joint R-R/MAN turbines, the RB.193 turbofan is being developed as the lift-cruise engine for the VAK 191B under an £8 million German Defence Ministry contract. Rated at 10,000lb, the RB.193 embodies BSE's vectored thrust principle and the Bristol company is to undertake a proportion of R-R's component manufacture. The engine is scheduled to run this year, and flight standard engines delivered in 1968. The VAK 191B will be powered by a single RB.193 and two RB.162s.

Most recent engine to start development testing is the 27,500lb RB.178-61 twin-spool demonstrator for the RB.178 family of unique triple-spool turbofans. Bench testing started in June last year and much useful data has been gained, this originally being intended to assist with the design of the 44,000lb tri-spool RB.178-51 of 6:1 b.p.r. This latter engine has subsequently been discarded as being rated too closely to the 41,000lb to 47,000lb P&W JT9D turbofan. However, the experience on the -61 is applicable to the full range of R-R's new advanced technology engines, including the Trent, RB.204, RB.205 and RB.207 projects with thrusts ranging from 9,730lb to 52,000lb.

All of these are tri-spool turbofans offering a series of outstanding technical features including low noise-level through independent control of fan speed, a low s.f.c. through the use of a high pressure ratio and high b.p.r., simple mechanical construction through omission of variable stators and blow-off valves; good engine handling through rapid response to control and low starting torque. Pressure ratios as high as 25:1, and b.p.r.s ranging from 3:1 to 6:1, are proposed.

Most important at present of the company's new ATEs is the RB.207. This engine, which has a basic rating of 47,000lb but is capable of covering the 45,000lb to 52,000lb bracket, is on offer for American and European airbus projects, including the Boeing 757, Douglas D-966, Lockheed

Rolls-Royce RB.162-81 single-shaft lift jet. Six-stage axial compressor. Annular straight-through-flow combustion system. Single-stage axial turbine. Rating, 6,000lb. Weight, 375lb. Diameter, 29in

