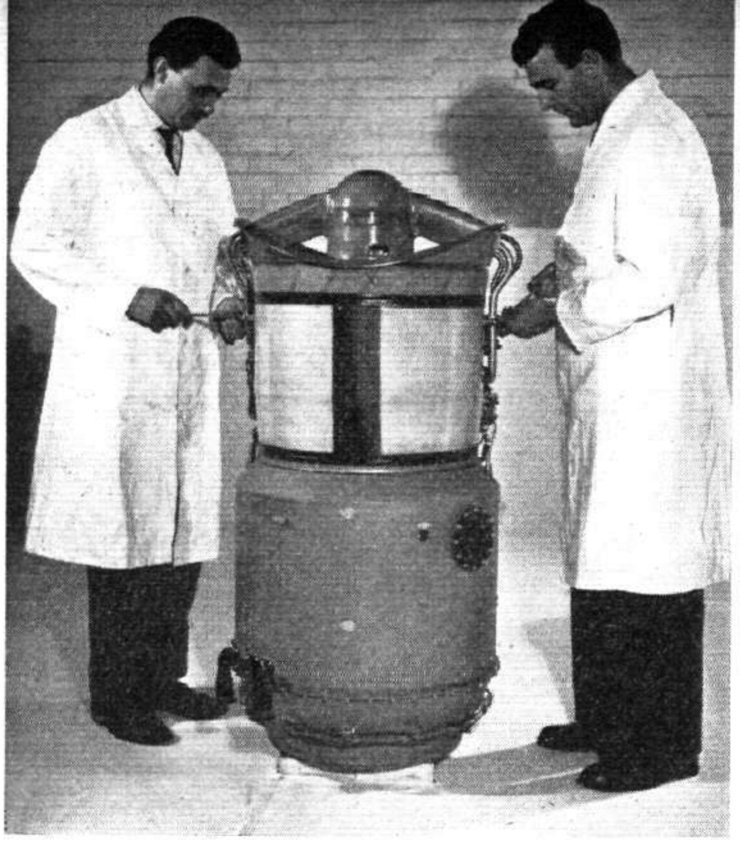


RB.162 First of the Lift Jets

FROM the early days of jet lift ten years ago, when Rolls-Royce Ltd began to operate the first of their free-flight rigs known as Flying Bedsteads, it has been demonstrated that the turbojet can be employed to lift an aircraft off the ground without any assistance from the wings, and therefore without the need for forward speed. The Bedsteads were lifted by two conventional Nene engines, with the then excellent thrust/weight ratio of 3.2, arranged horizontally but having their jetpipes turned downwards through 90° to provide a thrust vector acting vertically upwards. One jetpipe was aligned with the c.g. and the other was bifurcated on each side, so that no disturbing moment was imparted in the event of engine failure. Most significant of all, these ungainly rigs proved that a basically unstable device can be flown under complete control by using "puff-pipe" jets discharging engine bleed air.

The next major stage in Rolls-Royce's struggle towards operational jet lift was the development of lighter and simpler turbojets optimized not for propulsion but for lift. This process really started even before the Bedstead first flew because, in June 1952, bench tests began on the RB.93 Soar engine. This very small and simple unit was designed for flying bombs and target drones, and it was flight tested on the wing tips of a Meteor. Its thrust/weight ratio was no less than 6.6.

From the RB.93 was evolved the RB.108, and this engine has been the mainstay of all the company's jet-lift experience involving full-scale hardware. As an accompanying illustration shows, it has a single shaft running in three bearings, and carrying an eight-stage compressor driven by a two-stage turbine. It is a very much more refined engine than was the RB.93, and it was constructed in a conventional manner in contrast to the sheet-metal monocoque fabrication of the earlier unit. Nevertheless, despite the apparently heavier carcase, its thrust/weight ratio was even better than that of its predecessor. When it first ran, in May 1955, it developed 2,130lb thrust with a thrust/weight ratio of 7.3; and this was later improved by structural refinement to the design figure of 8.1.

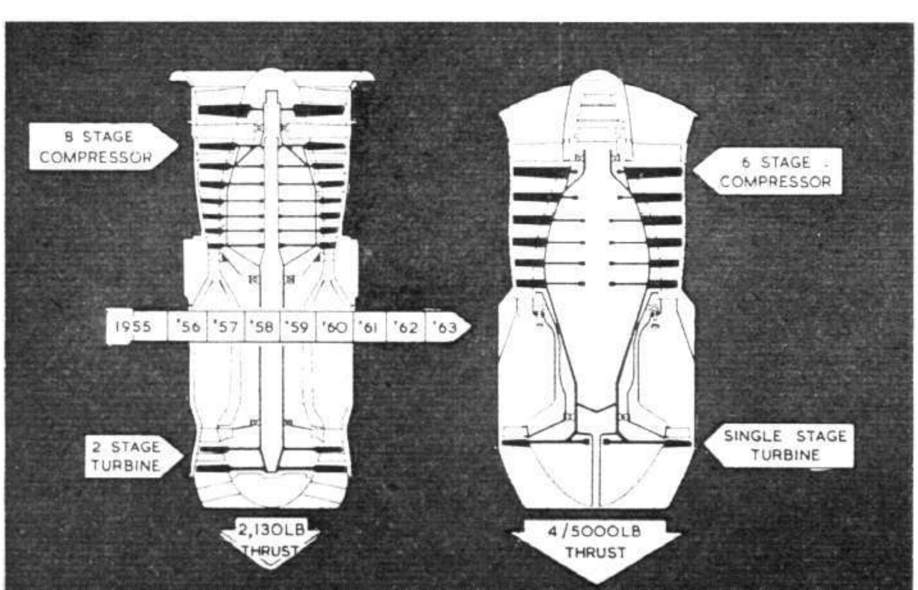
Although it was the first engine in the world ever designed from the start as a lift unit, the RB.108 was never a hot, short-life engine imparting an element of danger into piloted aircraft. In fact, with only slight modification, it was used as the basis of the RB.145 turbojet developed jointly by Rolls-Royce and MAN-Turbomotoren and used for both lift and propulsion in the EWR-Süd VJ 101C aircraft described in this journal last May 23. The RB.108 began its flight trials mounted upright in the fuselage of a Meteor at Hucknall in August 1956. Incidentally, just three months earlier the Ryan X-13 Vertijet, the first jet VTOL aircraft in the world, had begun its jet-supported hovering trials powered by a Rolls-Royce Avon.

Jet VTOL development really moved ahead when, in November 1955, the Ministry of Supply (since superseded, in this field, by the Ministry of Aviation) announced that Short & Harland were to develop a VTOL research aircraft to investigate the problems of the use of separate jet-lift units. Originally known as the Short PD.11, this design has since become famous as the SC.1. Two examples were built, and, although hardly optimized for translational flight, the SC.1 has earned the gratitude of VTOL designers everywhere for its immense contribution to the fundamental technology of the use of separate lift units. Moreover, the same aircraft have been used as vehicles for the development of complete three-channel autostabilization systems, and are now engaged upon research into VTOL blind landing.

A description of the SC.1 appeared in this journal on June 10, 1960, and a review of its flight-control system test rig was published in the issue of August 24, 1961. Lift is provided by two pairs of RB.108 engines, each pair arranged to tilt through 25° fore and aft about a transverse axis in order to provide a horizontal component of the thrust vector to assist in transition to and from wing-supported flight. The engines are mounted in a fireproof bay in the centre of the fuselage, with airflow cascades and doors to improve intake recovery both at rest and at forward speeds up to over 100kt and to fair the bay over in forward flight (with the four lift units shut down and propulsion supplied by a fifth RB.108 in the tail). All four lift engines are coupled to a bleed manifold to serve the control jets at the wing-tips and nose and tail.

As a result of the successful experience gained with the SC.1, GAM Dassault decided to go ahead with a composite-powered VTOL development of the Mirage III (which itself owed a great deal to the successful flight performance of the Fairey FD.2). Designated Mirage IIIV, the VTOL machine was at an early stage accepted by the French Government both as a firm national programme for the future equipment of the Armée de l'Air and as the French entry in the NATO NBMR-3 competition for a standard tactical fighter/bomber.

Preceding the IIIV Dassault decided to build a less ambitious subsonic research aircraft, designated Balzac V, consisting essentially of a rebuilt Mirage III prototype airframe fitted with a Bristol Siddeley Orpheus propulsion engine and eight RB.108 lift engines. The resulting aggregate lift of some 17,500lb was more than suf-



The RB.108 (far left) was the first engine ever designed specifically for the provision of jet lift, and releasable data include: length, 46.5in; diameter, 20.8in; dry weight, 269lb; pressure ratio, 5.25; and thrust/weight ratio, 8:1. The later RB.162 can be seen to be drastically simplified, and its corresponding data are: length, 51.8in; diameter, 25in; dry weight, 275lb; pressure ratio, 4; and thrust/weight ratio, 16:1