



First illustration of the Orpheus BOr.12

# ORPHEUS

## A VERSATILE AND LIGHTWEIGHT TURBOJET

**P**OLITICALLY the history of the Orpheus turbojet is unique. Planned as a private venture, it has now become virtually a world standard in the 5,000 lb-thrust class, yet practically none of its development has been sponsored by the British Government. Few engines have developed as rapidly and achieved such universal success in such diverse applications as supersonic interceptors, basic trainers, transports, research aircraft and ground attack machines, and in the years to come the Orpheus is certain to prove itself even more versatile.

All design and development of the Orpheus has been handled by the great organization at Filton and Patchway which has successively been the Engine Division of the Bristol Aeroplane Company, Bristol Aero-Engines Ltd. and the "Bristol" portion of Bristol Siddeley Engines Ltd. After gaining experience with the B.E.17 pilotless-bomber engine, their first essay into the medium-thrust field evolved around the B.E.22 Saturn. During 1952, however, the Ministry of Supply requirement for this engine lapsed and its development was accordingly abandoned. This was a blow to Mr. W. E. W. Petter, managing director of Folland Aircraft, who had visualized the engine as the powerplant for his Gnat light fighter, then on the drawing boards. During 1953, therefore, Bristol's Engine Division and Folland Aircraft collaborated in the design of a private-venture engine originally known as the B.E.26 and later given the name Orpheus.

Like the Saturn, the Orpheus was planned as a single-spool axial unit of relatively low pressure-ratio. After choosing 4,850 lb as the design rating it was found possible to restrict the weight to an estimated figure of 850 lb, by employing only two bearings combined with novel structural principles and extreme simplicity in the overall design of the engine and its control and accessory systems.

During 1953 the Supreme Headquarters Allied Powers Europe instituted a specification for a lightweight fighter and ground attack aeroplane, to be designed, produced and operated as a standard type among the NATO air forces. Virtually all the design studies prepared by the interested companies were based upon the Bristol Orpheus, and as a result a substantial contribution towards the cost of the initial engine development was made available from the Mutual Weapons Development Programme.

During January 1954 the first drawings and manufacturing instructions were issued to the shops, and all detail drawings were cleared by the end of June. So rapid was the first-build that the complete engine was started and run on the bench on December 11, 1954 (probably the first time in history that a gas-turbine was designed and run in a single calendar year). To some extent the design was

hastened by employing a compressor very similar to the low-pressure spool of the B.E.25 Orion turboprop.

By the end of 1954 Folland had completed a fair amount of flying with the Midge (geometrically similar to the Gnat but powered by an Armstrong Siddeley Viper), and the Orpheus was urgently needed to enable the true Gnat to take the air the following year. It was accordingly decided that, as an initial target, the Orpheus should be cleared for flight at the restricted rating of 3,285 lb. A declared type test at this rating was successfully completed in May 1955, and the engine first flew (as the powerplant of the Gnat) in July. Five Orpheus were running by April 27 of that year and during the first six months of bench-testing over 2,000 hr were run without a single major problem being encountered. It is particularly worth noting that these early engines weighed only 760 lb, some 90 lb under the original estimate. Even at the reduced 3,285-lb rating the thrust/weight ratio was better than that of any other type-tested engine in the world at that time.

The original Orpheus carried the Ministry of Supply rating designation BOr.1, and by January 1956 it had successfully completed a declared type test at its design rating of 4,050 lb. As designed for the Gnat, the fuel-flow requirements could be met by a single B-size pump and the accessory gear casing was tailored accordingly. At heights above about 12,000ft it was possible to achieve fuel flows—and hence thrust—equal to the values required by the more powerful BOr.3, specified for the NATO strike aircraft. The BOr.3 however was designed to have a sea-level rating of 4,850 lb and was therefore fitted with the larger D-size pump. In order to gain experience at the higher thrust it was decided to fit twin B-size pumps on an Orpheus 1, the additional pump being mounted on the hydraulic-pump attachment face.

Throughout the early part of 1956 ground-running of these engines was accomplished at the full brochure rating of 4,850 lb

and the engine for the Gnat, the BOr.2 with a rating of 4,520 lb, began its flight development in pods mounted under the wings of an Avro Ashton test bed. On August 9, 1956, the prototype Fiat G.91, the first of the NATO aircraft to take the air, flew for the first time on the reduced power of a BOr.1. The next milestone was the full type test of the BOr.2 in November 1956.

Three BOr.1s were delivered to Fiat during 1956 and additional engines were delivered to Dassault, whose Etendard VI flew in January 1957, and Bréguet, whose Type 1001 Taon first flew in August 1957. Differences between the BOr.1 and the production engines are slight. The most significant change was the introduction of a compressor incorporating blading which was redesigned to take

### ORPHEUS-POWERED AIRCRAFT

|                               | Category        | Engine  | Remarks                            |
|-------------------------------|-----------------|---------|------------------------------------|
| Aerfer Leone (Italy) ...      | Interceptor     | BOr.12  | Supersonic                         |
| Avro Ashton (G.B.) ...        | Test bed        | Various | Orpheus pods under wing            |
| Bréguet 1001 Taon (F.) ...    | Tac. strike     | 801     | BOr.12SR in later version          |
| Bristol 205 (G.B.) ...        | Transport       | ?       | Four on rear fuselage              |
| Canadair Sabre ...            | Test bed        | 801/803 | Used by Bristol Siddeley           |
| Dassault Etendard VI (F.) ... | Tac. strike     | 801/803 |                                    |
| Fiat G.91/91A (Italy) ...     | Tac. strike     | 801/803 |                                    |
| Fiat G.91R (Italy) ...        | Recce.          | 803     |                                    |
| Fiat G.91S (Italy) ...        | Tac. strike     | BOr.12  | Supersonic                         |
| Fiat G.91T (Italy) ...        | Trainer         | 803     |                                    |
| Folland Gnat Mk 1 (G.B.) ...  | Fighter/strike  | 701     | First aircraft to fly with Orpheus |
| Folland Gnat Mk 2 (G.B.) ...  | Fighter/strike  | Reheat  | Supersonic                         |
| Folland Gnat T.1 (G.B.) ...   | Trainer         | BOr.4   |                                    |
| Fuji TIF-2 (Japan) ...        | Trainer         | 805     | Production engine is BOr.4         |
| Handley Page H.P. 113 (G.B.)  | Transport       | ?       | Two engines                        |
| Hawker P.1127 (G.B.) ...      | Tac. strike     | ?       | Orpheus fan derivative?            |
| Hindustan (India) ...         | Fighter/trainer | BOr.12? | Two engines?                       |
| Hispano HA-300 (Spain) ...    | Fighter/trainer | BOr.12? | Probably Mk 703 initially          |
| Hunting H-107 (G.B.) ...      | Transport       | ?       | Two engines                        |
| Ikarus B-12 (Yugoslavia) ...  | Fighter         | 701     |                                    |
| Lockheed Jetstar (U.S.A.) ... | Transport       | TJ-37   | Two engines; or four JT-12         |
| N.A.A. Model 249 (U.S.A.)     | Trainer         | BOr.4   | Alternative powerplant to J34      |
| Short SB.5 (G.B.) ...         | Research        | 802     |                                    |
| Sud Baroudeur (F.) ...        | Tac. strike     | BOr.12  | Alternative to Atar                |