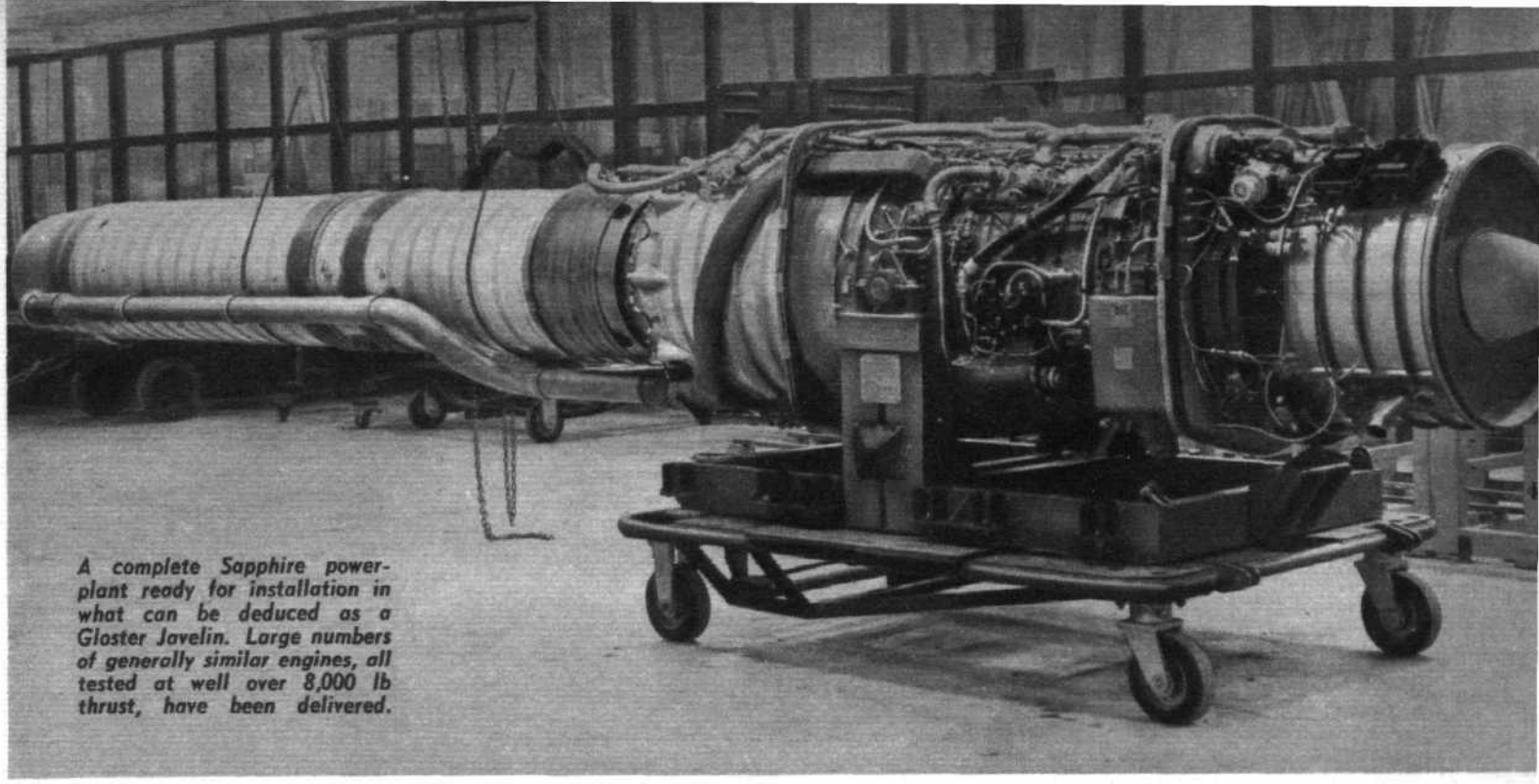

A complete Sapphire powerplant ready for installation in what can be deduced as a Gloster Javelin. Large numbers of generally similar engines, all tested at well over 8,000 lb thrust, have been delivered.

ARMSTRONG SIDDELEY SAPPHIRE

An Outstandingly Powerful and Efficient Single-shaft Turbojet

ALTHOUGH in itself an engine of particularly straightforward design the Armstrong Siddeley Sapphire turbojet has a history which is threaded with paradoxes. Designed by one famous British company it was entirely taken over, developed and put into production by another. A British engine, it is nevertheless flying in much greater numbers in the U.S.A., and it went into service in that country before it did in its own land. And, although it combines high thrust, competitive specific consumption and easy handling to a marked degree, it is one of the simplest large gas turbines ever designed.

Before writing of the Sapphire itself an outline should be given of the work which led up to its original design. The Metropolitan-Vickers Electrical Co., Ltd., were the first non-German company to work on axial gas turbines for aircraft propulsion. On behalf of, and in co-operation with, the Royal Aircraft Establishment, this Manchester firm began research on axial-flow compressors in 1937, and the following year started bench tests on the first of a series of such units.

In 1940 the R.A.E. invited Metrovick to build a turbojet to a basic design which had been formulated at Farnborough by a team working under Hayne Constant, the present director of the N.G.T.E. The compressor used was of an R.A.E. design which had been given the appellation "Freda," and the resulting engine was accordingly designated Metropolitan-Vickers F.1. Various forms of F.1 were built, the first being put on the bed late in 1941. Later F.1s successfully completed special-category flight-clearance tests in 1942 and the first flight took place on June 29th, 1943, the turbojet being mounted in the bomb bay of an Avro Lancaster. This was the first non-German axial engine to fly.

Following the F.1 came the F.2, also built in a number of versions and one of the most advanced turbojets of its day. The original F.2/1 was rated at 1,800 lb thrust, and two of the first flight engines were flown in Meteor DG 204/G on November 13th, 1943, this being the first aircraft outside Germany actually to be propelled by axial gas turbines. Progressive development brought forth the 3,500 lb-thrust F.2/4 which first ran in 1945 (later named Beryl, in conformity with the Metrovick policy of taking the names of precious stones), the F.3 ducted fan turbojet and the F.5 turbofan. Descriptions of these engines were published in our issues dated April 25th and November 28th, 1946.

While long-term research and development was going ahead with these, and other, units, the company began to investigate a high-thrust turbojet designated F.9. Throughout 1945 study of the F.9 project progressed, the work being purely of a research nature without Government support. In the following February, however, the company received a Ministry of Supply project contract, which was backed up by an order for prototypes in May 1946. The F.9 design study was thus transformed into the Sapphire turbojet, with the first Ministry rating MVSa.1. The first prototype ran in 1947.

The small drawing overleaf depicts the MVSa.1 as it was in that year. As might be expected it was a singularly straightforward engine, with a 13-stage compressor, an annular combustion chamber and a two-stage turbine. Yet each component was significantly more advanced than current practice at that time. It is obvious that the pressure ratio was considerably higher than that of contemporary axial units, and the overall design of the combustion chamber—employing the typical Metrovick system of low-dispersion burners injecting upstream into a primary airflow—was also inherently ahead of the can-type chambers of most gas turbines of 10 years ago.

In spite of its advanced conception the Sapphire ran relatively well from the outset. This reflects Metrovick's extensive axial experience and ability, and it could have placed the company in a very strong position in the aircraft gas-turbine field. Nevertheless the company decided in 1947 to cease their association with aero engines entirely.

It would have been tragic had so promising an engine as the Sapphire been allowed to fade away; furthermore it was—at that time—the policy of the Engine Research and Development branch of the M.o.S. to sponsor two designs of engine to each major requirement, largely as an insurance. Rather than go through all the uncertainties of ordering a completely new engine the M.o.S. decided to find a company capable of taking over the Sapphire as a "going concern" so that, as an alternative to the Rolls-Royce Avon, it would remain a possible future engine for British military aircraft then projected.

The obvious choice for a company to take over the Sapphire was Armstrong Siddeley Motors, Ltd., who were the only other firm in Britain with axial experience anything like comparable to that of Metrovick, and who had the development capacity available. Late in 1947, therefore, they agreed to accept responsibility for all future development of the new turbojet. At the Ministry, the designation MVSa.1 changed to ASSa.1, and the Coventry company actually took over work at the beginning of 1948.

As already stated, the original F.9 project was intended primarily as a research tool, and the Metrovick programme had not been aimed directly at producing an engine capable of entering military service. Nevertheless there is no doubt that it was, when taken over by Armstrong Siddeley, one of the most promising large turbojets in the world. It had already shown that it could develop something over 6,500 lb thrust with a low specific fuel consumption and with remarkably easy and trouble-free running.

Unfortunately it was impossible to avoid losing many months during the change-over, and bench running did not start at Armstrong Siddeley until October 1948. Nevertheless the engine's new masters had not been idle. By that month drawings had been issued for a considerably revised and cleaned-up version, designated ASSa.2, which, it was intended, would form a starting point for the development of future, operational versions. In the original F.9 the compressor comprised discs welded together at their peripheries (as shown in detail on p. 20), each disc having