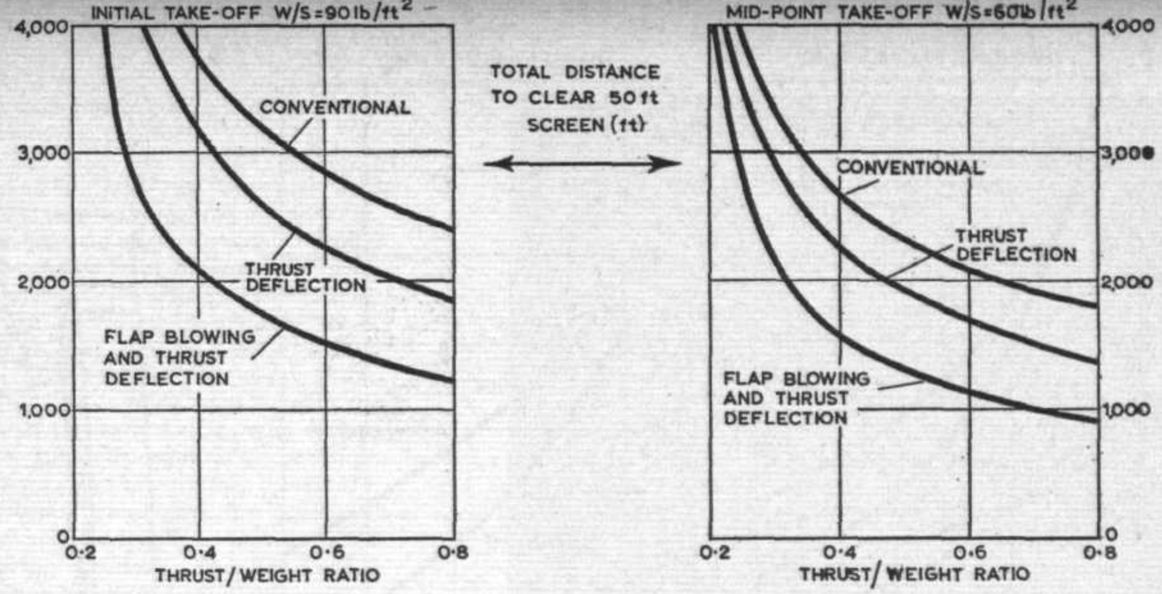

Fig 3 Take-off performance of typical V/STOL medium-range, high-speed tactical transport

Considerable overloads are possible by accepting field lengths of some 300yd. The take-off technique is to accelerate with nozzles fully aft and then rotate the nozzles to an intermediate position at a speed pre-calculated for a given overload. The time to nozzle-rotating speed—say, 50kt—is extremely short, but the P.1127 has a pre-selector device which enables the correct angle to be applied without the pilot having to look into the cockpit.

Undoubtedly the P.1127 is the simplest V/STOL aircraft possible. It is easier and safer to fly than any comparable jet fighter, with no electronics or autostabilization in its control system. The Tripartite evaluation trials will allow the particular operational and logistic problems associated with V/STOL strike aircraft to be examined. In simulated operational conditions the support required to operate and have aircraft at a state of readiness will be assessed, and the simplicity of the P.1127 will show that a squadron of such advanced machines requires no more maintenance and support than current ground-attack aircraft. Major highlights in the programme were: September 1959, first Pegasus run; October 1960, P.1127 initial hovering tests; March 1961, P.1127 first conventional flight; September 1961, P.1127 full transition completed; May 1962, first Pegasus 5 engine run; July 1963, 50hr type-tests completed on Pegasus 5, the rating for the Tripartite programme.

Transport Aircraft

Current tactical transports require fields of at least 1,000yd; new transports are required to operate from 500yd fields with semi-prepared surfaces. The take-off distances are shown in Fig 3 for a conventional military transport (turbofan-powered, medium-range cruising at 450kt) and for one using thrust deflection and flap blowing. At a wing loading of 90lb/sq ft, the former requires field lengths around 3,000ft even with a thrust/weight ratio as high as 0.8. At the mid-mission point, with W/S of 60lb/sq ft, distance is still 2,000ft. For a moderately swept aircraft designed to cruise at about Mach 0.7, C_{Lmax} would be between 2 and 2.20, but this can be increased to between 3 and 3.5 using flap blowing. Mission requirements call for STOL at the forward base; it is seen that take-off distance is only 1,100ft at the forward base, where W/S falls to 60lb/sq ft and T/W rises to 0.60lb/lb.

There are various ways of achieving thrust deflection (Fig 4). In the Pegasus and twin-elbow arrangements the turning of the gases and the cascades cause losses during the whole flight regime. The switch-in deflector suffers during take-off due to the "egg-box" deflector and thrust-splay; in the cruise there will be some leakage through the nozzle system. Profile drag and skin friction will be minimal with the switch-in deflector. Pod drag penalties would be associated with the switch-in deflector where, due to the rearward location of the nozzle arrangement and extended jetpipe, the cowl would tend to retain maximum diameter towards the rear and have a large wetted area. Moreover the extension of the jetpipe and the deflector would add weight, configuration, and the non-alignment of the structural and thrust loads would require strengthening of the pylon spar attachments.

From extensive studies, the performance achieved with the various deflection schemes, and the resulting aircraft weights, are very similar. In long-range missions fuel penalties with Pegasus-type systems become significant. However, detailed design studies demonstrate that the simplicity of the Pegasus nozzle configuration, whilst incurring small inherent penalties in other parts of the flight regime, is a significant factor in producing an efficient and economic STOL transport.

VTOL Development

Full awareness of the military and civil advantages of V/STOL aircraft will become readily apparent when such aircraft enter service. In 1958 design studies were initiated at Bristol of lift engines for VTOL transport applications. The requirements of low exhaust velocity to give reduced noise, ground disturbance and VTOL fuel consumption, biased the choice of engine towards the turbofan. Fig 5 shows calculated T/W ratios for a turbojet and a turbofan against a base of fuel burnt. In the bare-engine case, above 1min fuel the fan engine is superior, and at 5min the T/W is 30 per cent higher. The two lower (dashed) curves assume the installed weight to be twice the bare engine weight; at 5min fuel the fan has an installed T/W some 20 per cent higher. The volume occupied by the lift engine and fuel must be kept to a minimum, and the fan occupies a lower total volume.

Studies have been made of front and aft fan configurations, and the choice of thermodynamic cycle involved consideration of by-pass ratio, pressure ratio and turbine entry temperature. Ultimately the company undertook the development of the BS.59 front-fan engine (Fig 6), on the grounds of simplicity of layout and installation, and reduced vulnerability to damage from foreign matter (which would be expelled directly through the cold duct rather than contained in the gas-generator system of an aft fan). Rig testing of BS.59 components has begun, and target performance is being achieved.

Bristol Siddeley have investigated VTOL transport lift-pod intakes. The programme measured the velocity distribution and total pressure-recovery at various axial positions in the duct when the intake duct centre-lines were, in the majority of cases, nearly normal to the free-stream direction. At the start of transition for landing, during lift-engine start, the free-stream intake velocity ratio will be abnormally high, and high pressure losses and severe maldistribution will be experienced in the intakes. It is thus

Fig 4 Alternative methods of achieving thrust deflection