The H.S.125 and Dominie

by R. A. Cole

Externally the Dominie differs from the civil 125 in having the wing-fuselage fairing extended forward and a ventral fin (Author's photos)

THE GENERAL SPECIFICATION for a miniature airliner that can be used for executive transport, special charter or as a pilot and navigational trainer, is one that has received a great deal of attention. To date nine variations on the theme have appeared and each displays at least one characteristic feature. It is instructive to make a note of them before studying the Hawker Siddeley 125 in detail.

North American were first in the field with their Sabreliner which drew heavily on experience gained with the Sabre fighter. Despite the relatively early date of the design (*circa* 1956), and the fact that it was backed by military orders, it has made little impact on civil markets. Similar remarks may be made about the Lockheed JetStar, which features four rear-mounted engines and an unusual method of tailplane adjustment; as the tail is rigidly fixed to the vertical surface the whole fin and rudder assembly is tilted back or forward to change the tailplane angle. Designed to the same specification as the JetStar, the McDonnell 220 also features four engines but mounted in pods under a swept wing.

The Jet Commander is an obvious extrapolation of late models of the Aero Commander. A straight tapered unswept wing was undoubtedly dictated by the forward cabin position and the sharply swept tailplane helps to lengthen a short moment arm. It seems also that this layout was adopted to utilise as much existing tooling as possible and to minimise redesign work. The Lear Jet programme derived impetus and economy through the use of the wing designed for the Swiss P.16 fighter.

Douglas and Piaggio pooled financial and technical resources to produce the PD.808, which has recently appeared in Italy well behind its original schedule. A lot of rethinking has been applied to the Dassault Mystère 20 since the prototype, which was derived very largely from the fighter of the same name. It has been re-engined with fan-jets, but it is not known if the powered control system has been dropped. The Hamburger Flugzeugbau HFB 320 Hansa utilises a forward-swept wing and is the most unorthodox of them all. It appears to have a very strong airframe.

Although the H.S.125 has its share of unusual features, it appears to be of a more balanced conception than many of the others. This has been brought about by striving to attain the most practical machine and one that will not involve its owners in unduly high maintenance charges. To this end peaks of performance have been abandoned in favour of utility, economy and wide application.

A major difficulty met in the design of small aircraft lies in providing an internal volume which is big enough to be useful and devoid of obstructions to be flexible. One can compress an aircraft but not its payload, and the most practical small types do not therefore have the sleek lines of their bigger sisters. A great deal of emphasis was placed on this feature so that the whole design panders to the provision of a useful cabin which can seat six in executive comfort or eight in airline-style seats.

The layout embodies a central aisle with a flat, unobstructed floor from the flight deck through to the pressure dome. Entrance is gained through a doorway ahead of the wing on the port side, the door sliding up and over on the inside. A main stowage compartment in the vestibule area opposite the doorway is big enough to take most baggage and there is a smaller space available at the rear of the cabin. Thus all baggage and effects are stowed within the pressure hull and are easily accessible in flight, an important feature for an executive transport.

Layout

All rear-engined jet airliners have an inherently short tail moment arm which is partly compensated for by placing the stabiliser high up on the fin. Even so, the tailplane of the 125 has an area of 100 sq. ft., which is large in comparison with the main wing area of 353 sq. ft. This followed from the choice of a fixed surface and conventional elevators. An all-moving tailplane of smaller area was rejected on the grounds of complication and cost. This is in keeping with the general philosophy of simplicity and the avoidance of anything that might require development before being employed.

Only a moderate degree of sweep is employed on all surfaces, being just sufficient to delay the compressibility drag rise to a little beyond the normal operating speed. Wing profiles are of the usual laminar entry type and have thickness-chord ratios varying from 14 per cent at the root to 10 per cent at the tip. Aspect ratio is 6.25 : 1, the taper ratio is around 3.3 : 1, and the dihedral angle about $3\frac{1}{2}$ deg. The fuselage sits not quite entirely on top of the wing and a large fairing is employed to reduce mutual interference drag. The volume within the fairing is usefully employed to house various pieces of equipment and plumbing.

Flying and controls

It is a pre-requisite that training aircraft must have good flying and handling characteristics and in this direction the H.S.125 is no exception. A good straightforward stall free of any wing-dropping tendency has been obtained through the use of leading-edge "stall triggers" and fences which contain the initially disturbed region. No difficulty has been experienced in the course of several thousand stalls and no super-stall troubles have been encountered. Fore-and-aft stability is quoted as being remarkable while cruising at high altitude and on the approach. Characteristic cruising speed is Mach 0.725 true and no real compressibility vices are encountered until Mach 0.8 is exceeded.

All the flying controls are conventional and manually operated. The rudder, elevators and ailerons embody back-set hinges

and trimming tabs, while the elevators and ailerons have exterior mass balances. Air brakes open from the upper and lower surfaces near the trailing edge and they incorporate an inching control for fine adjustment. Large-span double-slotted flaps rotate about hinges carried on brackets well below the wing and are operated by a single jack situated centrally beneath the fuselage.

The engines are carried on stub planes and positioned with their intakes above and forward of the wing trailing edge, a position which provides natural shielding from debris thrown up by the twin-wheel units of the main undercarriage. Their nozzles have been "toed" out slightly to direct the efflux clear of the structure and to reduce the thrust moment if one engine fails. Despite this it was found that the control loads with one engine inoperative were very close to the maximum stipulated by A.R.B. requirements.

A simple device, which may be termed an "automatic rudder trimmer", has been developed to overcome this shortcoming and it is the subject of a patent specification. It consists of a floating piston in a cylinder to which air is admitted from either end. Each air supply is provided by the compressor of one of the engines so that in the event of an engine stopping or losing power the piston deflects from its central position. Since it is connected to the rudder *via* linkage it automatically produces a bias which is proportional to the loss of power. With this device an engine may be taken from fully open to fully closed while approaching to land and with the pilot's feet off the rudder bar.

Structure

Fail-safe and long-life features have been incorporated in the structure, which has a crack-free life of 10,000 hours. In other words, the 125 can make a return journey each day of the year for almost fourteen years before a crack may be expected. Additional guaranteed safety stems from the use of low stress levels, crack-stopping features and the use of metals known to have slow crack-propagation rates. The maximum *G* loading for which the structure caters is 3.75, with the usual ultimate factor of 1½ times this amount; it corresponds to the 50 ft./sec. gust case. In all aspects the aircraft meets both F.A.A. and A.R.B. certification requirements.

A feature of the cabin is the generous headroom of 69 in. above the cabin floor and this is responsible for giving the fuselage a deep appearance. The hull is akin to a parallel boiler shell to which shaped front and rear portions have been added. It sits as an entity over the wing centre-section, which is dished locally to minimise frontal area. Because the wing loads are entirely contained within the mainplane, the cabin is free of the heavy frames, bulkheads and spars which seriously limit several other designs. Continuity of the pressure-hull skinning, the absence of sealing strips, minimum weight and lower costs have all followed from the non-integration of the two structures.

The usual monocoque method of hoops and intercostals forms the basis of the fuselage, the skin being attached by Redux bonding and, where necessary, riveting. Two shallow but heavier hoops carry attachments which mate with points on the front and rear spars *via* link fittings. These connections are exterior to the skin line to ensure load-path continuity and simple construction. Two deep shear beams, spaced about 17 in. apart, act as keels along the length of the cabin. With the shell they support low shelves upon which the seats are mounted. A single vertical pin on the underside of the fuselage mates with a socket on the rear spar and transfers all horizontal loads between the wing and fuselage.

A light-alloy beam passes right across the rear fuselage between a main- and sub-frame and carries the main engine attachment points which are in high-tensile steel. Another fitting of the same material provides a forward steady for the engines and this is attached to another frame member. The entire mounting structure is of course aft of the pressure dome.

Having a span of 47 ft. the wing is a one-piece unit based on three spars out to the mid-span position and thereafter only two. Across the centre-section where the top surface is dished two additional reinforcing spars are added; quite heavy members, they are sculptor-milled from billets of light alloy. Each semi-span is utilised as a fuel tank in which there are five compartments. These feed into the innermost section where a single booster pump supplies the engine on its side. With this system no fuel management techniques are required. Over-wing refuelling is catered for at rates up to 100 gal./min. A skid member on the centre-line beneath the wing protects the structure in the event of a wheels-up landing at the maximum rate of descent.

The Dominie

As initially ordered for the R.A.F. the Dominie represents only one of many H.S.125 variations. Details of its place in the service were given at a recent presentation on Hatfield aerodrome by W/Cdr. Grocott of the Navigational School at Manby. He explained that up to now navigational training has been carried out on Valetta and Varsity aircraft at speeds in the region of 150 knots. This was very much slower than front-line aircraft, and to fit a navigator for duty in the Canberra and V-bombers they were given an intermediate course on two-seat Meteors. However, for the obvious reason of space limitation this arrangement left a lot to be desired.

By employing the Dominie for post-graduate training a navigator and his understudy could be introduced into the use of all the modern aids efficiently and correctly under the eye of an instructor. All the standard equipment is installed, including Doppler, Decca Navigator and Quick Fix, cloud-warning radar, HF, VHF and UHF radios, an analogue computer and the CL.11 gyro-magnetic compass which has a drift of only 1 deg./hr. A periscopic sextant is sited over the c.g. to minimise *G* effects resulting from disturbances and manoeuvres. All the associated electrical boxes occupy racks in a large bay on the starboard side of the cabin and are accessible at all times.

So equipped the Dominie is able to exercise well above the airways at 40,000 ft. and it can easily accomplish a three-hour duration. This is about the optimum time for the usual exercise and, in fact, a little less is required when the pupils are looking at radar scopes. The cruising speed of around 400 knots is close enough to the 450 and 500 knots of operational aircraft to be realistic. Exterior differences between the Dominie and the civil machine are minor and few, but the spotter will notice the forward-extended wing-fuselage fairing which houses the Doppler aerial and the small ventral fin which counters its destabilising effect.

Development potential

In their initial forms both the 125 and Dominie employ the Bristol Siddeley Viper 521 turbojet engine which is rated at 3,120 lb. thrust at sea-level. But already one airframe is flying with 3,300-lb. Viper 522 units, and even later marks of the engine may be expected to give 3,600 lb. thrust. Since the aerodynamic layout more or less limits the cruising speed, this additional power will be used to restore performance for high-altitude and hot-aerodrome operations and allow greater operating weights.

The already favourable power reserve has allowed a high electrical power generating capacity which is quoted as 18 kW. This is quite sufficient for the radio, equipment and de-icing services. Each engine drives a 3 kVA A.C. generator as well as a 9 kW starter-generator. Battery capacity is sufficient to keep the internal electrics and hydraulic system alive while the aircraft is being turned-round away from base.

A two-crew flight deck with optional dual controls reduces the work load on long flights and while flying the airways. It also fits the design for use as a commercial pilot trainer. Another use is seen as a radio, radar and landing aids calibration aircraft. One development that has been suggested is for carrier-to-shore communications, and for this purpose an arrester hook installation has already been designed.

Swanton Morley display

THE NORFOLK AND Norwich Aero Club are holding their annual "open day" on Sunday, 27th June. Apart from a static display, there will be pleasure flights, and a 3-hour flying display, including famous and vintage aircraft. Visiting aircraft will be welcome to fly-in to visit the Club during the morning between 10.00 a.m. and 1.30 p.m. and 5.30 p.m. to 8.00 p.m. Full details can be obtained from D. J. Hastings, "Westering", Salhouse, Norfolk.