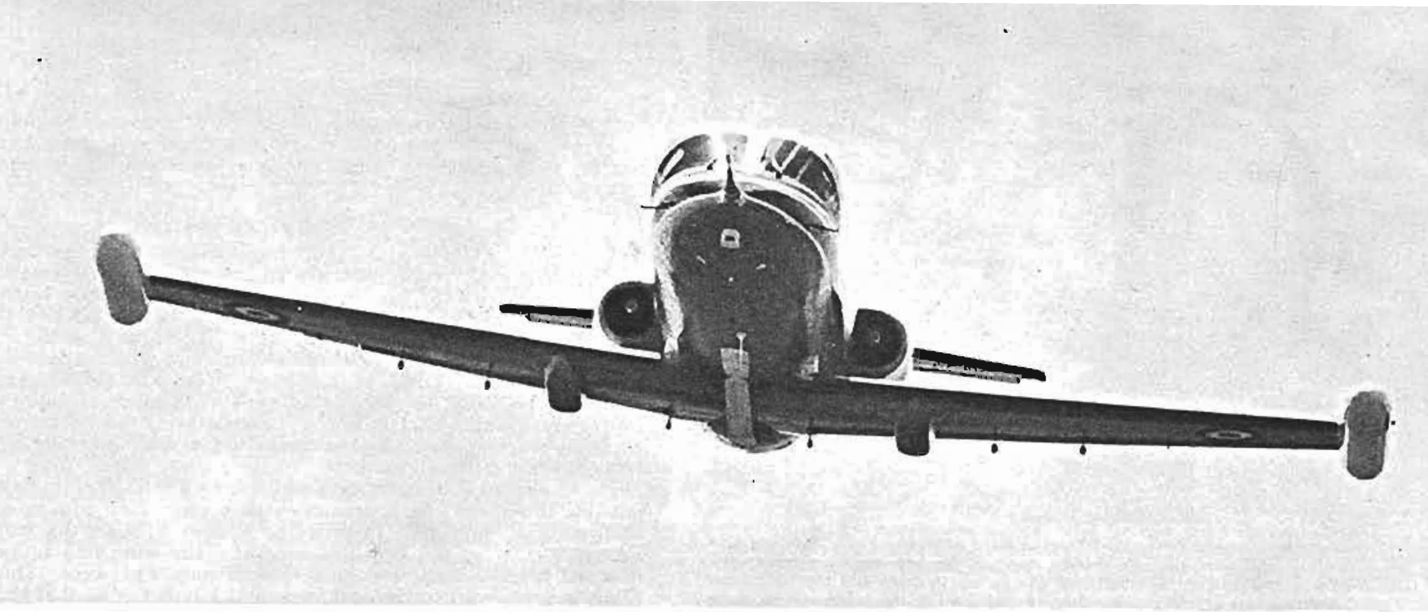


CERTIFICATION of the Piaggio-Douglas PD-808 is anticipated in June this year and production of the first 50 has started at the Finale Ligure factory of Industrie Aeronautiche e Meccaniche Rinaldo Piaggio SpA. Of these airframes, 25 will go to the Aeronautica Militare, where they will be used for command liaison and VIP transport duties, and they should start to enter service during 1967.

The PD-808 project arose out of the Piaggio experience with executive aeroplanes and the company's unusual association with the American market. During the fifties, the neat little P.136-L high-performance amphibian attracted the attention of Mr Francis J Trecker, the machine tool magnate, who has a waterside country house. He bought one for his own use and then formed a company to import the airframes, fit American trim, instruments, Lycoming engines and Hartzell propellers. Known as the Royal Gull, the aircraft sold well as an executive and for charter and special airline work. Mr Trecker's enthusiasm led to his ordering from Piaggio an enlarged landplane version, the P166, using the wing, engine installation and main undercarriage of the amphibian. Owing to serious illness, however, Mr Trecker later abandoned his sales franchise and only three P166s were sold in the USA, to Northrop; but the type (and its derivatives the P166B Portofino and the P166C) is in worldwide service for executive, feederline, charter, air survey and military liaison duties.

In 1960 the Piaggio management was looking round for a successor to the P166. The pusher installation was not readily adaptable for a turboprop engine and the fitting of tractor engines would have entailed complete re-design. The position

ITALO-AMERICAN EXECUTIVE

by James Hay Stevens

of the turboprop in executive flying was—and in fact still is—problematical and the possibility of making the jump to jet propulsion was carefully considered. At this critical time Dott Ing Armando Piaggio, the executive head of the then Aircraft Division of Piaggio & C SpA, met Donald W Douglas and a "gentleman's agreement" was made for the joint development of a Douglas jet executive design. This study was for a slender eight-seater that had been taken by Douglas to the general structural design stage.

Under the Piaggio-Douglas agreement the original Douglas design was passed over to the Italian company, which undertook the full detail design, prototype construction, production tooling and finance. The American company undertook to give full technical assistance whenever called upon—and, in fact, there has been a close and harmonious association. It was agreed that, whoever bought them, rather more than a hundred aircraft would be built in Italy without licence or royalty fee as a return for the capital outlay. After this initial quantity, Douglas is equally free to produce without licence or fee. This agreement was announced in June 1961, when the familiar artist's impression—which is little different from the aircraft flying today—was issued.

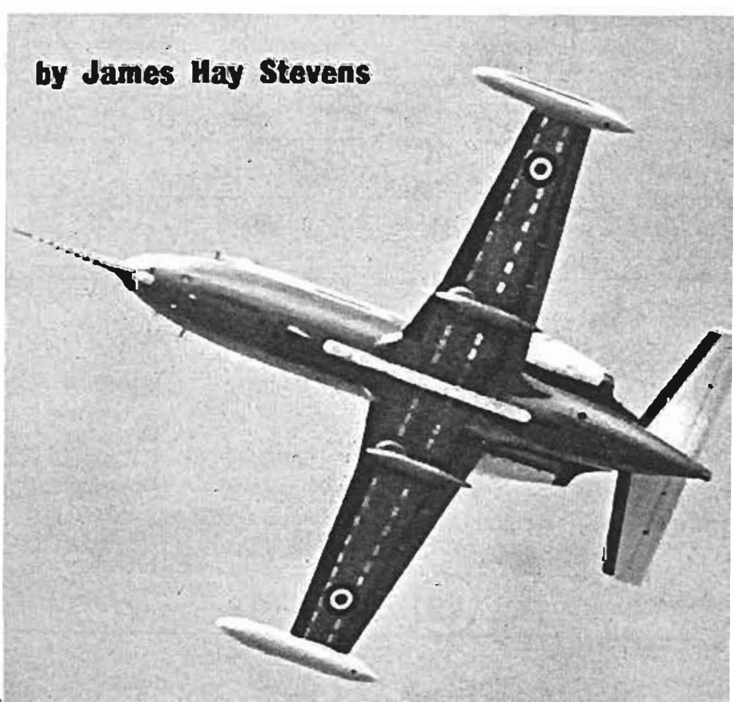
At this time the PD-808 was known as the Vespa-Jet, after the famous scooter upon which the company's post-war prosperity was founded. Since then the Aircraft Division of the half-century old family business has been formed into a separate company from that making the Vespas and the name has been dropped.

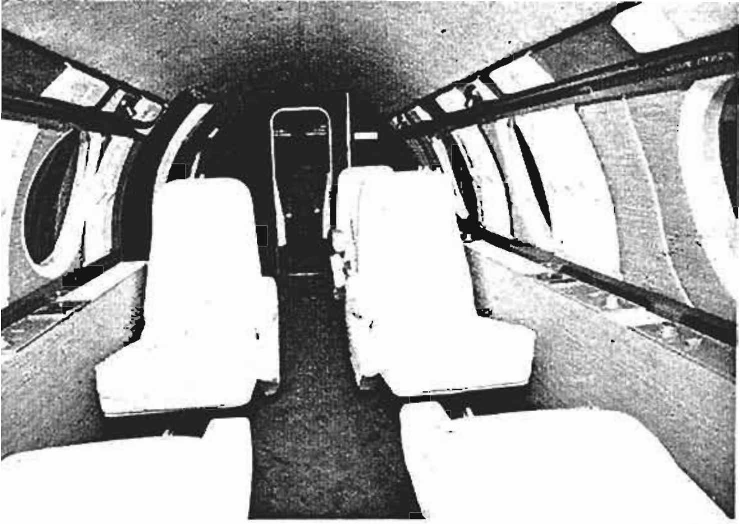
It was during the design and prototype construction stage that the *Aeronautica Militare Italiana* decided that use could be made of the PD-808 and as a result government finance was forthcoming for part of the cost of the three prototypes. This has been most useful for so expensive a project and is the reason why the prototype took the air on August 29, 1964 in air force markings and piloted by Colonel Evasio Ferretti and Flight Engineer Francesco Lanza of the *AMI*.

DESIGN DEVELOPMENT

There has been remarkably little alteration from the original layout, which is a tribute to the care of the Douglas project team which evolved the PD-808. Probably the most significant change was the Piaggio decision to increase the fuselage diameter by 4 in to an external figure of 5 ft 10.5 in (1,78 m), which results in practical internal width and height.

One of the principal features of the design was to make it easy to stretch later models. The essentially cylindrical fuselage is suited to large or small extensions in length without aerodynamic or structural penalties. The wing can be increased by adding area and larger flaps aft of the torsion box, while both the area and the critical Mach number can be increased by forward extension of the leading edge. Although the tip chord is only 4 ft (1,2 m), the span too could be extended to adjust the aspect ratio for optimum cruise performance, since the taper ratio is low.



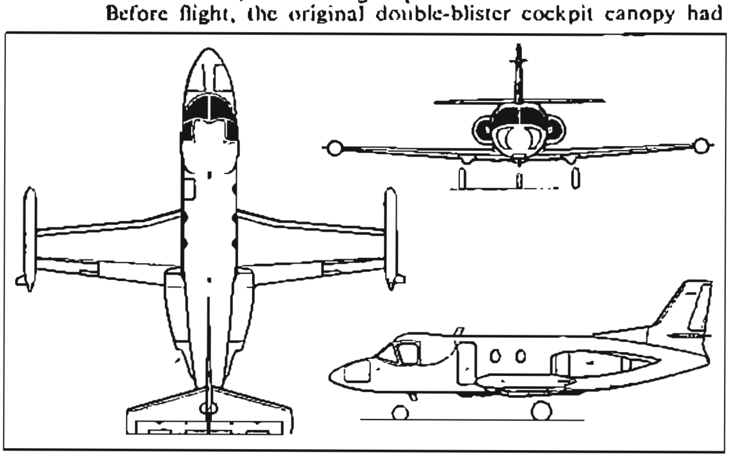


The de luxe interior of the PD-808 when fitted as an executive. Points of note are the level floor, the side shelves incorporating arm rests, ashtrays, cup-holders and jotters. The sectional plastic sun screens and the lights and punkahs above are fully adjustable. At the front of the cabin are the radio rack and a bar unit. Through the door can be seen the instrument panel. This photo is of the full-scale mock-up, since the prototype is still full of instruments.

Simplicity was another key factor in the design. Examples of this are to be seen in the use of aerodynamically balanced controls. Fatigue has also been carefully considered: wing construction is a miniature version of the Douglas airliners with large, thick, crack-stopping panels, while the fuselage has a double skin giving almost infinite redundancy, ie alternative stress paths.

When, after only a few hours flying, one of the Bristol Siddeley Vipers ingested a gull just after unsticking the engine was badly damaged, although Col Ferretti was able to climb to 1,400 ft (427 m), make a circuit and land with the other engine idling. This gave an unexpectedly early proof of good asymmetric handling qualities. While the damaged engine was out some small modifications were made. Toed-out engine nozzles were fitted to eliminate some heating of the fuselage skin due to efflux impinging on the fairing shield. There were some small changes to the tail surfaces. The elevator was inset by removing the tips and extending the tailplane aft where the elevator had been. The opposite process on the top of the rudder added 60 sq in (387 cm²) of area. The embryonic dorsal fin was roughly doubled in area, still making it quite a small surface.

Before flight, the original double-blister cockpit canopy had been modified to have a fabricated metal roof instead of glazing. Even so, this has proved a dragworthy item and there has recently been a further change, fairing it better into the general fuselage lines.



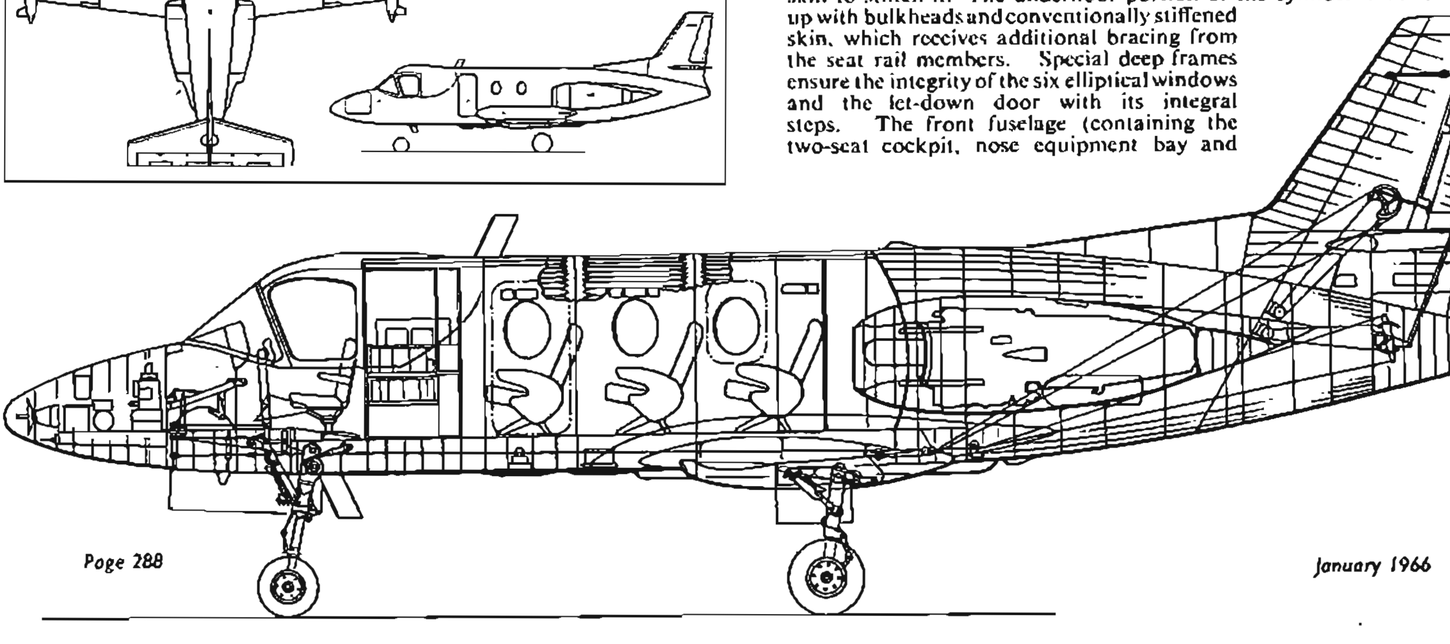
DESIGN AND CONSTRUCTION

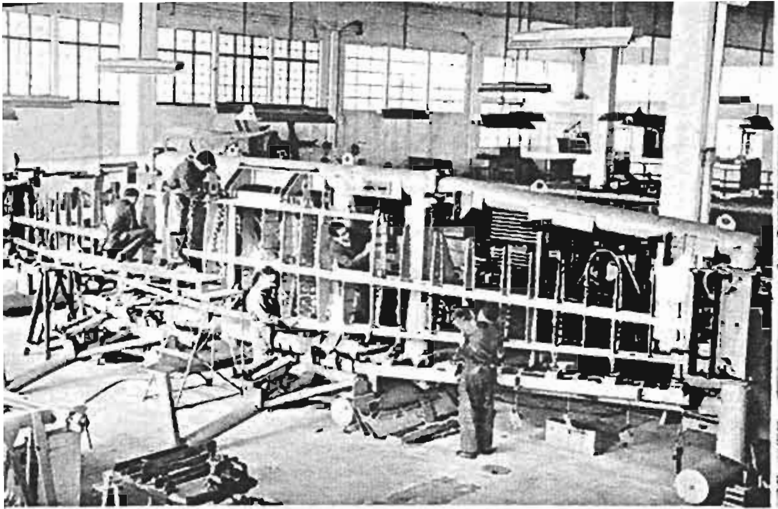
Although the PD-808 is a relatively small aeroplane its high performance and consequent design refinements have made it a big step forward for the Italian aircraft industry. Apart from its speed, it is the first Italian aeroplane with a 40/50,000 ft (12 192/15 240 m) operating altitude, it is the first with an 8.8 lb/sq in (0,62 kg/cm²) cabin differential and it is the first to have integral fuel tanks in the wing. The Rinaldo Piaggio company is sharing its experiences with these modern features throughout the Italian aircraft manufacturing co-operative, which is the way the industry works today with its relatively small military and civil markets.

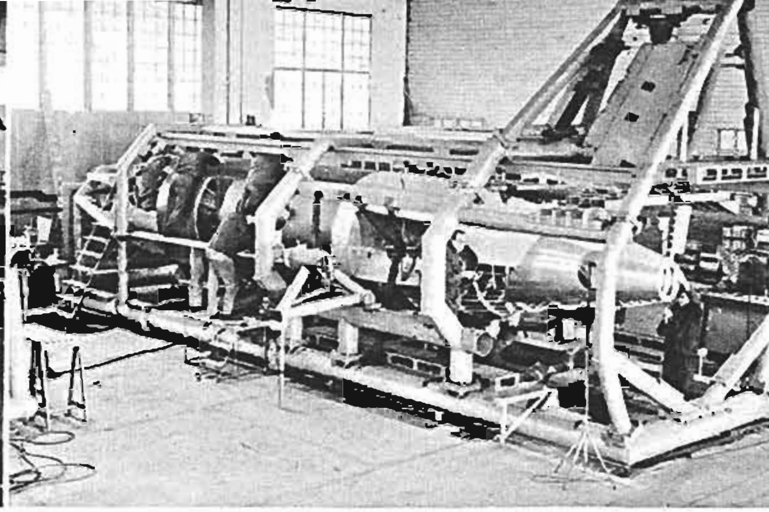
The choice of a straight wing was due to a wish for the best possible low-speed characteristics, with a secondary advantage in structural simplicity. In order to achieve a Mach 0.8 performance without the help of sweepback the wing had to be thin and it has a thickness/chord ratio of only 9 per cent. This thinness provided a reciprocal structural advantage in that the wing passes neatly under the floor, without internal or external bulges in the fuselage or dents in the torsion box. The modest taper ratio of 0.5 is divided almost equally between the leading and trailing edges and at the wing roots there are forward extensions of the leading edge. These last are due to the setting of the engine intakes ahead of the wing trailing edge, since it is essential that the stall must not occur at the wing root. The leading edge extensions cause the breakaway to begin a little inboard of the semi-span and, by reducing the thickness/chord ratio locally, they also raise the critical Mach number to protect the engines at maximum speed.

In order to have maximum fuel capacity in so thin a wing it is almost completely a sealed torsion box, save for the narrow shrouds for the ailerons and slotted flaps attached to the rear spar web. The wing (which has 3° dihedral) is made in one piece, with a sturdy, straight main spar web running from tip to tip at 40 per cent chord. On to this is built a thick D-skin forming the forward half of the wing and upper and lower rear skins which form a box with the rear spar web. Across the central third of the span a third, forward, spar web is inserted to take (with fore-and-aft beams) the undercarriage loads and to compensate for the wheel and fuselage cut-outs. The wing root leading-edge extensions, which are relatively light, are attached to this special beam. Spars and skin panels are of extruded sections with integral stiffening flanges, the material being of dural type with good fatigue resistance. Stiff, closely-spaced ribs are fitted, which are attached to the skin by cleats so as to leave clear fuel passages. The upper, compression, skin is stiffened by additional riveted extrusions and doubler plates.

An unusual construction was chosen for the pressure cabin. For the cylindrical portion, instead of the conventional skin and stringers there is a smooth outer skin which is wrapped round, and riveted to, half-a-dozen sturdy built up C-frames. Between these C-frames, and attached to them by finger plates, is a corrugated inner skin which is also riveted to the outer skin to stiffen it. The underfloor portion of the cylinder is built up with bulkheads and conventionally stiffened skin, which receives additional bracing from the seat rail members. Special deep frames ensure the integrity of the six elliptical windows and the let-down door with its integral steps. The front fuselage (containing the two-seat cockpit, nose equipment bay and







Left, construction of the prototype wing was done on production jigs at the Finale Ligure factory of IAM Rinaldo Piaggio SpA. The two spar webs, the central front spar web, or beam, and the rigid ribs are well shown in this picture. Right, like the wing, the prototype fuselage was built in production type jigs of very rigid design. Note the interchangeability fixtures for the engine and tail unit attachments.

nosewheel stowage) is built with deep-section frames and has a similar "rip-stop" skin to that of the main fuselage. The large, bird-proof glazing panels, which are supported by strong box-section frames, were supplied by D Napier and Son and are anticed by Sierracote gold film electrical heating. After the first prototype the nose dome will be pressurised—to improve the environment for the electronics—and the whole cowling will slide forward to give access to the equipment. The rear fuselage, aft of the pressure bulkhead (which is coincident with the rear spar web) is of conventional light gauge sheet metal construction with flanged frames and extruded stringers. The fin is integral with the fuselage and there are strong frames to take the tail surface loads and two other strong frames for the engine mounting points.

The wing-to-fuselage attachment is by six machined forgings that pick up on the three wing spar webs. The fuselage floor sits directly on top of the wing torsion box, giving simple structural shapes and a good aerodynamic junction.

Tail surfaces incorporate some sweepback: the fin being swept 30° and the tailplane some 12° by putting all the taper on to the leading edge. The latter (which is set approximately in the trouble-free position chosen for the Caravelle) is a fixed surface, longitudinal trim being achieved by tabs on the elevator. The fixed surfaces are of two-spar construction with channel-section profile members except for the solid-web hinge ribs and two forged and machined root ribs on the tailplane.

Flying control surfaces are manually operated through simple cable runs. Despite the large speed and altitude range of the flight envelope, careful design has achieved good balance and effectiveness throughout. Aerodynamic balance is by a combination of inset hinges, close-fitting shrouds over the leading edges and geared tabs. Electrically-actuated trim tabs are fitted to each of the flying control circuits. The surfaces are conventional, with single spars, D-nose leading edge, closely spaced ribs, metal skin and rigid trailing-edge strips. The slotted flaps, which extend from fuselage to ailerons, are of similar construction. Ahead of the flaps are the lift spoilers, which form part of the shrouds. Two door type air brakes are mounted under the fuselage, fairly far forward where there is little effect on trim—the position is similar to that on the G.91.

Alighting gear units and nosewheel steering are French, having been designed and made by Messier. The legs are of the straight piston type, retracting forward to give free-fall in emergency. Wheels, disc brakes and tyres come from the American Goodyear company. The pressure for all three wheels is 115 lb/sq in (8,1 kg/cm²).

ENGINE INSTALLATION AND SYSTEMS

Bristol Siddeley has supplied a special version of the 3,000 lb st (1 360 kgp) Viper 20, the Mark 525, which has a 10 kVA alternator mounted in the nose bullet for the Napier Spraymat and Sierracote anticing services. There are no hydraulic pumps on the engines, because an electrically pumped system in the Piaggio tradition is used, and compressor air bleed is taken for cabin pressurisation and engine intake de-icing. Production aeroplanes will have the new 3,300 lb st (1 497 kgp) version of the Viper, which will aid hot and high take-off and climb, as well as allowing full load take-offs from smaller aerodromes. In the PD-808, the engines are tucked into the sides of the fuselage, so that the nacelles form large blisters instead of being pods on stubs as is usual. The D-shaped nose cowlings and the jetpipe fairings are built on to the fuselage sides and the whole of each engine is laid bare by opening a single door. The fuel system is a simple two-tank one, half the wing torsion box and one tip cell being joined as one unit of 320 Imp gal (1 455 l) capacity. The two tanks can be cross fed to either engine. It is possible that the total fuel capacity may be increased to 820 Imp gal (3 728 l) with larger tip cells.

Dowty-Rotol makes the electro-hydraulic power pack, with integral accumulator, which supplies the 3,000 lb/sq in (210,9 kg/cm²) system operating the landing gear, flaps, air brakes, lift spoilers, nose-wheel steering and wheel brakes. The hydraulic jacks and other system components are made by the Italian company Oleodinamica Magnaghi, suppliers of the well-proven P166 components.

The main electrical system is a 28-volt supply fed by a 30-volt/300-amp Bendix starter/generator on each Viper, supplying through two 24-volt batteries. Static inverters supply the AC flight instruments and there is also the independent heavy-duty alternator supply for the anticing heating.

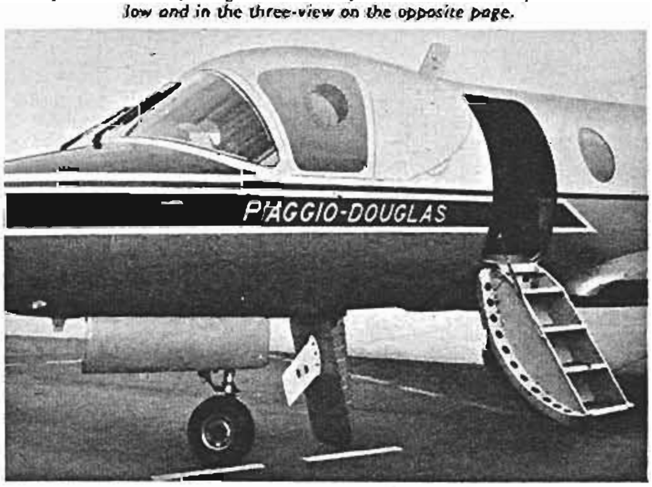
In addition to the Napier Spraymat and Sierracote heating—the former on the wing root leading-edge extensions where airflow is critical and the latter for the cockpit glazing—there are Goodrich de-icing boots on the wing and tail leading edges. These are of a new low-drag high-speed type which is recessed into the wing and which has chordwise inflation tubes. These pulsating boots are fed by compressor bleed air, which also warms the engine intakes.

ACCOMMODATION AND EQUIPMENT

There are several layouts for the PD-808 cabin and the photograph shows the definitive civil executive cabin with five de luxe reclining seats, a small toilet, bar and radio rack. The flight deck is separate, ahead of a bulkhead with a door, and it is spacious for two pilots. Military accommodation for VIP communications is similar, but with rather less luxurious fittings. As a navigational trainer there will be two consoles for pupils

continued on page 293

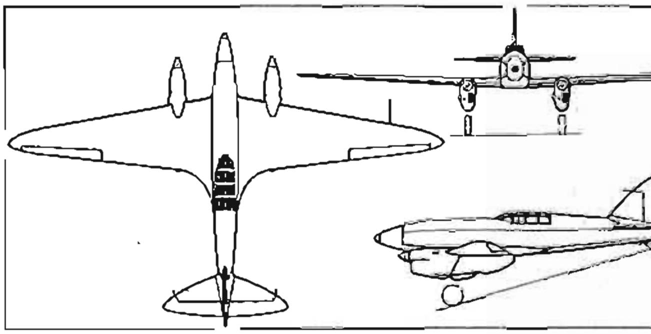
The prototype PD-808 has recently resumed flight trials after drag-reduction modifications to the fairing over the cockpit. The revised shape is shown below and in the three-view on the opposite page.



—32 km/h—in top speed), the aircraft re-appeared as G-ACSS *The Orphan* in a pale blue/grey finish and was flown by Clouston and George Nelson into fourth place in the Marseilles–Damascus–Paris race in August 1937, and into 12th place in the King's Cup Air Race in September, flown by Ken Waller.

In November, Clouston and Betty Kirby-Green took G-ACSS, now named *The Burberry*, to Cape Town and back in 15 days 17 hr. Then, in February 1938, Clouston set out with Victor Ricketts for Australia, the aircraft being re-named *Australian Anniversary*. This flight ended with a broken undercarriage in Cyprus—itself the outcome of a hair-raising forced landing at Adana in Turkey and an early-morning take-off from an un-made road. After repairs, the Comet set out from Gravesend again on March 15, 1938 and flew a total distance of 26,450 miles (42 560 km) to Christchurch, New Zealand, and return (to Croydon) in 10 days, 21 hr 22 min. The flight established 11 official records and the London–New Zealand–London record has never been officially beaten.

G-ACSS returned to Gravesend after this flight, there to lie neglected for 13 years. It re-appeared in 1951 at the Festival of Britain exhibition in London after being restored to the original finish as *Grosvenor House*; further work has recently been done to perfect its appearance prior to presentation to the Shuttleworth Trust, but it has not been found possible to obtain genuine



Ratier propellers with their pitch actuating discs. The structure has deteriorated and there is no question of G-ACSS being made airworthy.

One other Comet was built, in 1935, to the order of Cyril Nicholson. This was G-ADEF, named *Boomerang* and intended for a series of major record-breaking flights. Piloted by Tom Campbell Black and J C McArthur, it made a fast flight to Cairo and back in August 1935, but the following month an attempt on the London–Cape Town record ended over the Sudan when the same two pilots baled out, propeller trouble having made it impossible to continue.

ITALO-AMERICAN EXECUTIVE

continued from page 289

and an instructor's station. There is also a high-altitude air survey proposal, as well as ambulance and freight versions. With the addition of only 60 lb (27,2 kg) weight of stiffening modifications, the wing can have two 1,200 lb (544 kg) inboard and two 500 lb (227 kg) outboard stores points to make a general-purpose "anti-insurgent", or tactical support, armed version carrying gun packs, bombs or RP.

In the cockpit, the pilots have a typical Douglas layout before them. The instrument panel is well laid out and has two sets of basic flight instruments with the engine instruments between. The central console carries the engine, trim and auto-pilot controls. Electrical switches, fuses and circuit-breakers are in the roof. An interesting feature, for American conditions, is the use of two tungsten floodlamps in the cockpit roof which counteract the blinding effect of lightning.

DEVELOPMENT

Because of delay in fixing the selling price and, as yet, firm delivery dates, no orders have so far been announced for the civil PD-808, though there are over a dozen letters of intent. Division of sales responsibility has also not been defined officially: but in view of their success with the P166, it seems likely that Rinaldo Piaggio would cover Europe and Australia and Douglas the rest of the world. Douglas has a vast entrée in the airline world and could offer the PD-808 both as an aircrew trainer and to airlines intending to supply executive jets on contract charter to businesses unable to undertake the heavy cost of maintaining low-utilisation jet aircraft.

Latest news from the Rinaldo Piaggio flight test centre on the Cristoforo Colombo Airport at Genoa is that a level flight Mach number of 0.81 has been achieved at full thrust. Low-speed behaviour has now been fully explored and is said to be good. Maximum lift is better than estimated and there is a natural nose drop at the stall at all times. Even so, the fashionable stick-shaker is likely to be fitted as a stall warning.

Flying hours of the first prototype are now over 200. The second aeroplane is nearly ready and should be doing some of the development flying by February or March.

PD-808 SPECIFICATION

DIMENSIONS: Span over tip tanks, 40 ft 8½ in (12,4 m); length 41 ft 7½ in (12.7 m); height, 14 ft 9½ in (4,51 m); wing area, 225 sq ft (20,9 m²); aspect ratio, 6.25; sweep-back, nil.

WEIGHTS: Operating weight, empty, 10,005 lb (4 538 kg); max take-off weight, 16,500 lb (7 484 kg); max landing weight, 15,700 lb, (7 121 kg); max zero fuel weight, 11,550 lb (5 240 kg).

PERFORMANCE: Take-off distance to 50 ft (15 m), 3,300 ft (1 050 m); initial rate of climb, 4,750 ft/min (24,12 m/sec); max speed 552 mph (888 km/h) at 12,000 ft (3 650 m); economical cruise, 450 mph (724 km/h) at 40,000 ft (12 192 m); service ceiling, 47,500 ft (14 478 m); range, max fuel, no reserves, 1,460 miles (2 350 km); landing distance from 50 ft (15 m), 2,650 ft (1 036 m).

POWER PLANT: Type, two Bristol Siddeley Viper 525 turbojets. Thrust, sea level take-off, 3,000 lb (1 360 kg) at 13,800 rpm; cruising thrust 875 lb (397 kg) at 36,000 ft (10 973 m) at M = 0.70.

The prototype PD-808, showing the low sit of this aeroplane and the convenient integral steps. Taken before the first flight, the photo left shows the original tail layout; that below, taken at the Paris Aero Show, shows the larger dorsal fin. The box in the fuselage tail cone contains the anti-spin chute, which is sometimes streamed as a landing brake.