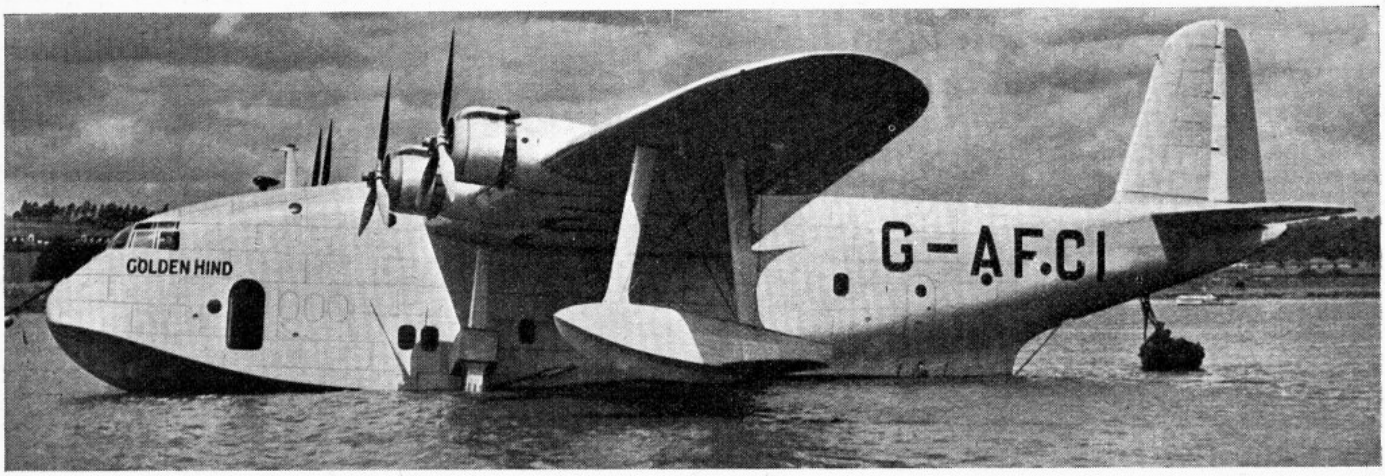
AERONAUTICAL ENGINEERING

The Latest Short Flying-boat, "The Golden Hind"



OUR BIGGEST.—"The Golden Hind," first of the Short G-class flying-boats built for Imperial Airways. The all-up weight is 73,500 lb. or nearly 33 tons. The cruising speed on the four 1,375 h.p. Bristol Hercules sleeve-valve motors should be 180 m.p.h.

SHORT BROS. (ROCHESTER AND BEDFORD) LTD. must quite certainly be given the credit for the introduction of the formula for the modern commercial flying-boat. The Short Empire Boat was the first commercial seaplane to demonstrate that the proper way to get high aerodynamic efficiency with a commercial flying-boat was to make a high-wing monoplane of it and arrange the wings through the top of the hull.

The lead thus clearly given has been followed on the other side of the Atlantic. To-day, the arrangement has been universally approved,—if one is to judge by the flattering likeness of competitive designs.

The latest and biggest of the Short products is *The Golden Hind*, the first of the G-class flying-boats, which has recently been launched at Rochester. This has been designed for an all-up weight of 73,500 lb. or 32¾ tons. It is thus more than 20,000 lb. heavier than the Cabot-class, or 33,000 lb. heavier than the Empire Boat.

The new G-class boats have a span of 134 ft. or 20 ft. more than that of the Empire Boats. The wing area is 2,160 sq. ft. as against 1,500 sq. ft. In each instance the area given is the net area, that is, the area of the wings plus that of the ailerons but without the portion of the hull which joins them.

The wing loading of the G-class boat is 34 lb. per sq. ft. as against 27 lb. for the Empire Boat.

The G-boat has been designed to carry a load of 5,250 lb., including a crew of up to five, for 2,500 miles against a head wind of 40 m.p.h. The four Bristol Hercules IV air-cooled radial sleeve-valve motors which each develop 1,380 h.p. for take-off require something like 3,470 gallons for this range. For purposes of calculation the weight of a gallon of the 87 octane fuel used is assumed to weigh 7.45 lb. Consequently the boat has to take-off with 25,860 lb. (11½ tons) of fuel.

Imperial Airways, in their original specification, desired that the new boat should not only be suitable for carrying a heavy load of mail for this enormous range but also that the new boat should be suitable for the carriage of passengers over the ordinary Empire routes. To this end the G-class boats are admirably suited by virtue of their vast interior.

The lay-out of the boat naturally results in a hull of great depth. This is not obvious when the boat is on the water, or flying, because of the proportions of the boat as a whole. Actually the height from the top of the wing to the keel is something like 19 ft. The maximum beam of the boat is 12 ft. and the overall length of the big hull is 103 ft.

No doubt, on the sound basis that passengers may be delayed but must never be lost, and that mails may be lost but must never be delayed, Imperial Airways did not foresee the immediate carriage of passengers across the Atlantic. If the decision had been made to carry passengers as well as mail, Short Brothers could easily have modified the design of the G-class boat for this purpose. These new boats are so efficient that they could readily get off at a loaded weight of 80,000 lb. (35½ tons), but to meet the original specification the boats were actually designed from the structural side for an all-up weight of 73,500 lb.

If the G-class boats are required to carry the increased weight of 80,000 lb., the wings and other flying surfaces would require strengthening. This has already been done in an earlier class, the wings of the Cabot-class boat, designed to be refuelled in the air, have been strengthened to carry a loaded weight of 53,000 lb., against the original 40,500 lb.

An interesting point which arises out of this discussion concerns the take-off of flying-boats. Short Brothers have always been particularly strong in the production and designing of boats able to take-off with very high overloads. For instance, the Cabot-class boats, originally designed to get off at 40,500 lb. now have a Certificate of Airworthiness take-off at 50,500 lb.

The recent trials with the Sunderland have shown that this big boat, designed to get off with a loaded weight of 45,700 lb., can also get off at an overload of substantially the same order. Thus there is not likely to be much question of the ability of the G-class boats to get off at 80,000 lb.

The three G-class boats, *The Golden Hind*, *The Grenadier*, and *The Grenville*, are straightforward developments of the Empire Boats. As a result of the very successful service experience with the Sunderland flying-boat, the G-class boats have the new shape of planing bottom. There is a single vee-shaped step with the point facing aft. Behind this the planing bottom tapers off to a vertical knife-edge.

In view of the fact that practically all seaplane floats and the early types of flying-boat hulls had single steps one is not sure whether the termination of the after planing surface should be described as the rear step or stern-post, or what. The primary purpose of this arrangement is to reduce the drag of the step in the air. The success of the arrangement from this point is illustrated by the excellent performance of the Sunderland. Experience has also shown that the arrangement improves the performance on the water.

An interesting point about the G-class boats, and one which is not generally known, is that the original idea was to design them without any steps at all. A good deal of preliminary work had shown that a successful flying-boat bottom could be designed without a step and that such an arrangement would have very much less drag in the air. Mention of these facts was made by Mr. H. Mason Garner in his lecture before the Lilienthalgesellschaft in Berlin last year. This was reported in THE AEROPLANE for Nov. 16, 1938, and some of Mr. Garner's illustrations were given.

But there was not time to complete the model experiments before work on the G-class boats had to start, so Shorts were not able to go ahead with this development. Nevertheless, one may assume that work along these lines is going on.

As a result of the increased size of the G-class boats, the designers have been able to improve the lines even further. A cleaner sweep has been given to the nose of the boat. The junction of the wings with the sides of the hull is particularly

clean. Also, as the result of the increased thickness of the wing, the motor-nacelles for the Bristol Hercules radials which have a diameter of only 52 ins., fair more neatly into the wings.

Structurally, the new boats are practically identical to the Empire Boats apart from such differences as are made necessary by the change in size and, consequently, by the loads that are carried by the various members. The only major difference in the structure is in the use of extruded sections for stiffeners on the bottom of the hull and for the flanges of the keelsons.

As we have earlier pointed out, in spite of its enormous size, *The Golden Hind* is intended solely for the carriage of mail. As a result, the whole of the vast interior is empty except the upper deck whereon are the crew's quarters and in the nose where is the gear for mooring the boat and so on.

On the upper deck, in the brow of the ship, as it were, are side-by-side seats for the Commander and First Officer. There are the usual control-columns with the wheels and adjustable rudder-pedals. The seats are also adjustable.

In the G-class boat an important step has been taken in removing a load of responsibility from the pilot's shoulders. The pilot is provided with throttles and airscrew controls so that he can be fully in command of the motors and the airscrews during take-off and alighting, but when in the air the whole of the duty of adjusting the mixture-controls, synchronising the motors, controlling their temperature and the temperature of the oil is taken over by the Engineer. He sits in front of a large instrument board.

Numerous controls which have to do with the flow of fuel and of oil and so on are built into the panelled front of the front-spar frame.

Between the Engineer and the pilots' seats is a large space for the Radio Operator. Farther aft is a chart table.

Access to the upper deck is by a ladder which comes up through a hole on the starboard side of the deck, but this is not the only means of access or egress. There is a circular hatch in the roof which is designed to take a transparent dome so that the navigator can take sights on the stars. When not in use the transparent dome is withdrawn into the hull and the gap closed by a hatch, thereby reducing drag.

In the starboard wall to the upper deck is a large door divided in the middle which provides plenty of space through which to load any large objects onto the upper deck. Behind this hatch there are doors in the side of the hull which lead to the leading edges of the wings on either side. Between them is another hatch in the roof with a ladder which provides access to the top of the wings and thereon to the four motors.

Sections of the leading edges beside each motor let down to form working platforms for the mechanics and inspectors working on the motors.

Small hatches through the forward main spar-frame provide access to the space between the front and rear frames and under the top surface of the wing. More doors in this space, four in fact, two in each wall, lead into the main portion of the wing. Through these doors one can see the big fuel-tanks, like enormous pill-boxes, resting on their supports in the middle part of the wing. These tanks are the same type as those used in the Empire boats which are probably the lightest yet built. The largest tank in the G-boat weighs .24 lb. per gallon of fuel carried.

The heating system also lives in this space between the frames. Steam is raised in boilers around the exhaust-pipes and led to a bank of radiators or heat-exchangers through which fresh cold air is led from openings in the wings. After being heated the air is led through flexible pipes to suitable points in the hull and crew's quarters.

In the back wall of this compartment, two other hatches lead out to the upper deck over the back portion of the hull. Here is the gear for the flaps.

We happened to be here during a trial run of the big Gouge flaps. These are driven by a Rotax motor through a reduction gearing. There was a great deal of interest in watching the little motor doing the man-size job of work winding up the big flaps and in noting the ingenious cut-out mechanism whereby the motor is automatically cut-off as soon as the flaps reach the closed or open position.

Going forward again and climbing down the ladder to the lower or main deck one found oneself opposite the main door in the port side of the hull. Opposite this is a lavatory for the crew. Forward is the compartment for the marine gear. Here there is an inward-opening hatch, retractable Harley Landing light, and retractable mooring bollard. We noticed a C.Q.R. anchor stowed in clips.

Turning back and walking aft one passes through a waist-high water-tight bulkhead. To the left is the sink with a supply of hot water from the tank which is part of the heating system to which we have already referred.

Opposite the sink, on the port side, is the mail compartment. One then goes aft through a door in the main spar-frame. This and the bulkhead behind it, that is the rear spar-frame, and another frame at the back of the fuselage, have half-height water-tight doors. These look rather like the half-doors one sees in cottages in village streets which are used to prevent small children from running out into the road. The water-tight doors are normally held in clips out of the way but have to be locked in position during take-off and alighting.

After going through the door in the rear spar-frame one comes into an enormous space 30 ft. long. This is closed by another bulkhead at the far or aft end. There is a door in the port side close up against that bulkhead. There are plenty of windows in either side. Behind this bulkhead again is another space leading up to the tail. There is a big door, in the starboard side this time, through which spare aero-motors can be readily taken in and out.

Besides the Rotax electric motor which drives the flaps and the limit switches for it, a very large amount of electrical gear is supplied by Rotax Ltd. On *The Golden Hind* there are 8 Rotax type N.S.T.-14 14-cyl. Magnetos; 4 Rotax-Eclipse Starters E.160.C.; 2 Engine-driven generators, 24 volt-1,000 watt; 2 Voltage control boxes for same; Navigation lamps; Switchboard; Sundry solenoid and other switches; Rotax-Eclipse airscrew anti-icing equipment; Rotax-Harley landing lights; Rotax-Weston engine cylinder pyrometer equipment; sundry cabin lamps; and a Rotax-M.C. anode converter for radio, etc.

Among other interesting fittings on the G-boats are the Phillips retractable taps fitted to the drinking-water tanks. We hope to describe them next week.

Specification

Power Plant.—Four Bristol Hercules IV air-cooled radial sleeve-valve motors. Max. for take-off 1,380 h.p.; Rated for level flight 1,030 h.p. at 3,000 ft. (914 m.) at 2,400 r.p.m.; Cruising 850 h.p. at 5,000 ft. (1,524 m.) at 2,350 r.p.m.

Weights and Loadings.—Weight empty 37,705 lb. (17,100 kg.); Equipment 2,485 lb (1,130 kg.); Fuel (3,470 gal. for 2,500 miles) 28,060 lb (12,720 kg.); Payload and crew 5,250 lb. (2,380 kg.); All-up weight 73,500 lb. (33,340 kg.); Wing loading 34 lb. per sq. ft. (166 kg. per sq. m.); Power loading (take-off) 13.3 lb. per h.p. (6.1 kg. per h.p.).

Performance (Estimated).—Max. speed 209 m.p.h. at 4,500 ft. (336 km. h. at 1,370 m.); Cruising speed 175-180 m.p.h. at 5,000 ft. (280-290 km. h. at 1,524 m.); Range at 5,000 ft. (1,524 m.) at cruising speed against 40 m.p.h. (64.4 km. h.) headwind 2,500 miles (4,000 km.).

De Havilland airscrews.