

FILE COPY
NO. 3

AIRCRAFT CIRCULARS
NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 69

THE "GLOSTER IV" SEAPLANE (BRITISH)

FILE COPY

To be returned to
the files of the National
Advisory Committee
for Aeronautics
Washington, D. C.

Washington
March, 1928

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

AIRCRAFT CIRCULAR NO. 69

THE "GLOSTER IV" (BRITISH)

Ever since the earliest days of flying, the question, monoplane or biplane, has been a controversial one, and it is rather interesting to find that the problem remains unsettled right up to the present time. In this country by far the largest percentage of aircraft are biplanes, and this applies both to civil airplanes and service types. In Germany, on the other hand, the preference is for the monoplane, as witness the Junkers, Dornier, and Rohrbach seaplanes. In France one finds both types represented, although probably with the biplane, or rather the sesquiplane in the majority. In the United States there has been, of recent years, a tendency to choose the monoplane for intermediate size commercial airplanes, although in American service aviation one finds practically no monoplanes.

When it comes to racing, again there is no marked preponderance of one type over the other. If we take the Schneider Trophy race, for example, there have been monoplanes and biplanes in approximately even numbers, and although the world's speed record stands to the credit of a monoplane, and the Schneider Trophy race was won last year by a monoplane, he would be a bold man who would assert definitely that the monoplane is necessarily the

*From "Flight," March 1, 1928.

fastest type. In commercial and service aviation it is usually considerations other than those connected with performance which determine the choice of type. In racing planes the conditions are somewhat different, and low drag is the chief feature aimed at, although there are necessarily many other considerations which have to be taken into account.

In the case of the "Gloster IV" B, designed and built by the Gloster Aircraft Co., Ltd., for last year's Schneider Trophy race, it is of interest to study the considerations which led to the adoption of the biplane type of seaplane, and a short article by Mr. H. P. Folland, the firm's chief engineer and designer, which appeared in the "Gloster Magazine" Christmas number, outlines briefly his reasons for making the "Gloster IV" a biplane. Before proceeding to a study of these, it may be as well to point out that up to the present moment there is probably no one who can claim to know quite definitely which is the faster plane, the Supermarine S.5 monoplane, or the Gloster IV biplane. The lap speeds of the race appear to indicate that the Gloster was faster than the direct-drive Supermarine, but slower than the geared S.5. That, however, is not necessarily definite proof, and the probability is that in point of speed there is little to choose between the biplane and the monoplane.

And now for the considerations which led Mr. Folland to choose the biplane. "Can a biplane be as fast as a monoplane, given equal horsepower and same design specification regarding perform-

ance?" This is the question Mr. Folland asks in the article referred to. He then proceeds to outline the manner in which he and his assistants examined the problem. Comparison was made on three chief points: Speed, wing rigidity, and application to service requirements.

Of these the first was the most important, and Mr. Folland concluded that, with the "broad arrow" type of engine it was possible to fair the top wing into the cylinder blocks, to get all wires leaving the surfaces at large angles and thus reduce interference, to use a small-chord, thin-section bottom wing, the roots of which could, by curving them, be fitted into the fuselage with a minimum of interference, and finally by having surface radiators on both wings, to get a larger percentage of the radiators into the slip stream from the propeller. From the structural point of view, doubtless Mr. Folland was also influenced in his choice by the fact that torsional rigidity, or in other words guarding against wing flutter, is, perhaps, rather more easily achieved with a biplane structure than with a monoplane. Finally, although we doubt that it weighed very heavily in coming to a decision, the Gloster Company has had years of experience in building fast biplanes.

In the number of the "Gloster Magazine" already mentioned, there is also an article by Mr. H. E. Preston, assistant chief engineer and designer, in which certain interesting information relating to the development of the "Gloster IV" of 1927 from the

"Gloster III" of 1925 is dealt with. In this article Mr. Preston points out that, on the two items offering the greatest head resistance, the fuselage and the floats, by reducing the area and revising the lines, in other words the form, a saving of 45 per cent of the 1925 plane was effected. Careful and smooth blending of the wings into the fuselage not only resulted in a reduction of the drag, but also gave an increase in lift of 15 per cent. The total reduction in resistance of the whole seaplane as compared with the "Gloster III" amounted to about 40 per cent on the latter. By way of comparing the relative efficiencies of the two Gloster racing seaplanes, Mr. Preston takes as his criterion the ratio of maximum lift to minimum drag, and how great was the improvement on this basis will be realized when it is stated that the ratio for the "Gloster III" was 26.2, while in the "Gloster IV" this ratio has been increased to 42.3.

Mr. Preston, in his article, tabulates the increase in speed attained with the "Gloster IV" as compared with the "Gloster III" as follows:

	Resulting increase in speed (M.P.H.)
Reduced head resistance of seaplane	37
Increased engine power	20
Increased propeller efficiency	9
Increased landing speed	4
Total increase	70 M.P.H.

This table brings out fairly clearly the relative importance of the various main items.

Constructional Features

Having now outlined briefly the main considerations in aerodynamic design, we may turn to the constructional features of the "Gloster IV." The fuselage section used practically precluded the more usual forms of construction, and ultimately a form was chosen which was regarded as giving the best solution of the somewhat conflicting requirements of good aerodynamic shape and reasonable ease of construction. This took the form of what is known in boat-building practice as the "double-diagonal" system, in which fairly narrow planks are laid on at an angle of about 45 degrees to the center line and the planks of the two skins crossing each other at approximately right angles. In the "Gloster IV" these planks are of spruce, about 3 inches wide and 1/16 inch thick. Generally speaking, there are two skins, but in places where the loads are more intense, the number of laminations is increased. The fins are built integral with the fuselage, and like it are covered with laminated spruce. The wooden tail plane is adjustable on the ground, and can be set to any desired incidence, although it is to all intents and purposes integral with the fuselage.

In designing the engine mounting of the "Gloster IV," rigidity was a first consideration, but the question of accessibility

was not overlooked, and in the end a type of mounting was evolved which proved very satisfactory from both points of view. This is shown in Figure 9. Two box section duralumin engine bearers are supported on a system of steel tubes. Welding is entirely avoided, and all main joints are fitted with stainless steel taper bolts of ample dimensions to secure a good fit.

Under the engine bearers is mounted the oil tank, which incorporates the oil cooler, the tank being made to the contour of the fuselage, and the cooler taking the form of corrugations through which the oil passes after leaving the engine. Auxiliary coolers are mounted on the sides of the fuselage (Figs. 3 and 5).

The gasoline system is somewhat complicated by the fact that the tanks are all contained inside the fuselage. Thus, it might be said that in all there are seven gasoline tanks, although it would, perhaps, be more correct to say that there is one main tank divided into three, one auxiliary tank also divided into three, and a service tank placed in the top deck fairing of the central cylinder bank. The general scheme of the tank installation is shown in Figure 7. Webs are provided for lifting the tanks out of the seaplane, and the division into three has been made necessary in order to get the tanks in and out through relatively small openings in the body.

The wing construction of the "Gloster IV" is unusual in that the skin or covering is made part of the stress-bearing structure. Built up of laminations similar to those employed in the

fuselage, the thin and almost symmetrical airfoil sections used were formed by building up the skin on formers of the required contour and secured to the skeleton, which consisted of multi-spars, leading and trailing edges, and intermediate contour pieces in place of the usual ribs. On load tests the wings were found to support a load equivalent to 13 times the weight of the seaplane before signs of failure were observed. Thus, there was a good margin of safety in hand to take care of the increased acceleration possible in such a high-speed seaplane.

Reference has already been made to the wing bracing from the aerodynamic point of view. The excellent angle of the lift wires has the further structural advantage in that they impose but a very small compression load in the top wing spars (Figs. 1 and 2). The angle of the landing wires, or as they are more usually called nowadays, "anti-lift" wires, is not quite so good, but is still better than usually found. To prevent the landing wires from going slack and vibrating when relieved of some of their load, a neat shock-absorbing or compensating arrangement has been employed. The internally placed ends of the "anti-lift" wires have large nuts which, when the wire is taut, bear on the edges of a cup, inside which are a number of rubber discs. When some of the load on the wire is reduced, these rubber discs expand and in so doing keep the wire reasonably taut. The arrangement is illustrated in Figure 4.

Mounted on the wings are the surface type radiators specially

developed by the Gloster Company. These radiators are made of thin corrugated copper sheet with waterways of brass at leading and trailing edges (Fig. 10). Additional surface radiators are mounted on the decks of the floats, and as these are practically water-cooled during prolonged taxiing on the surface, they are very effective at a time when the engine is most likely to overheat (Figs. 1, 2 & 3).

The floats are of duralumin, of the single-step, curved deck type, and from the side elevation and the side view (Figs. 1 and 3), it will be seen that they are slender and tapered to reduce air drag. They are supported on two pairs of struts, both pairs meeting on the center line of the fuselage, and depending on the wire bracing for their stability. Horizontal wires connect the two floats, in place of the struts usually employed some years ago.

In order to reduce to an absolute minimum the frontal area of the inter-wing struts, they are made of duralumin forgings, lightened out inside, and the frontal area of these struts (which are less than 1 inch thick) is only one-half of the frontal area of the equivalent struts built in wood.

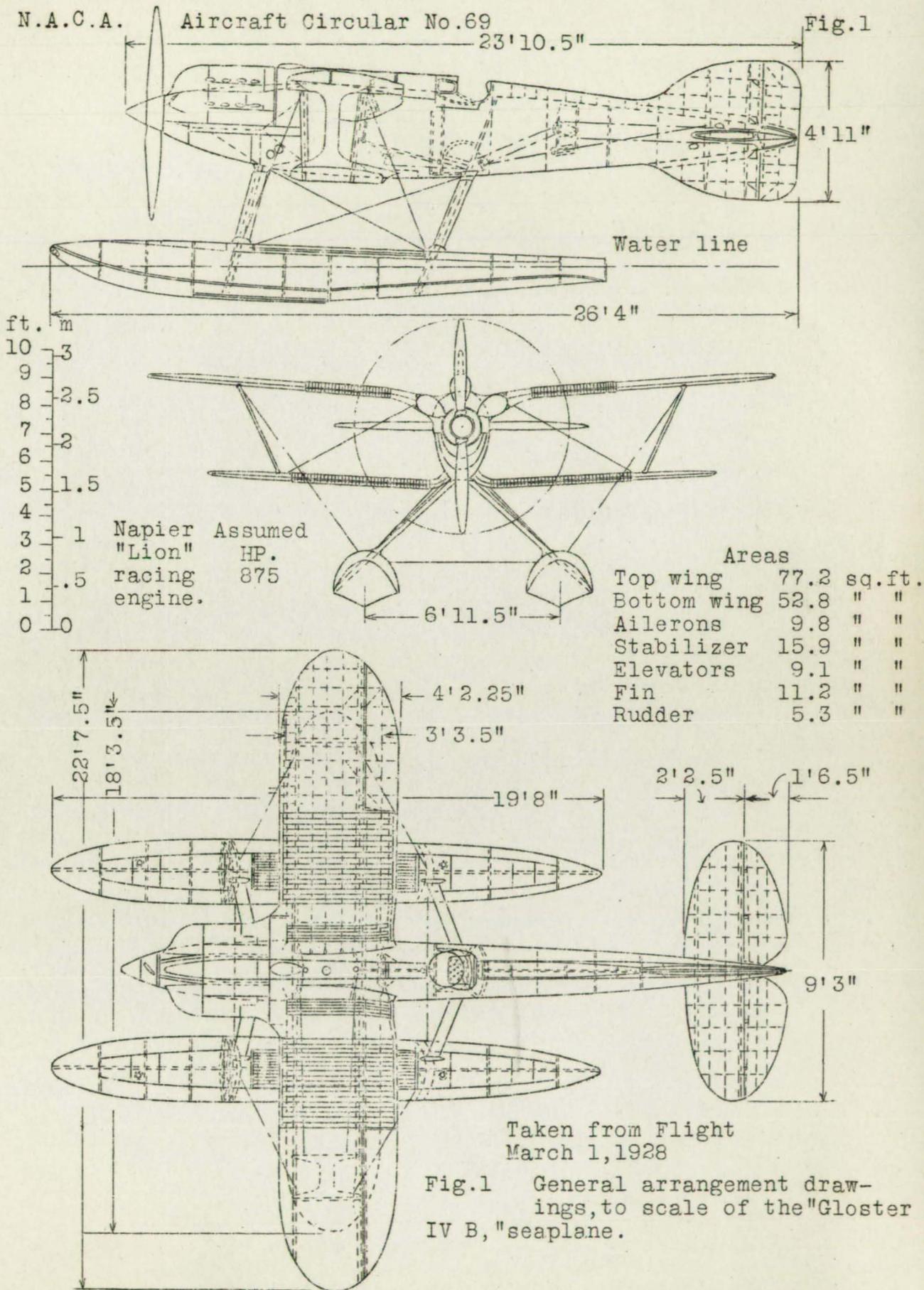
C o n t r o l s

The controls are all internal. The ailerons are actuated by torque tubes running inside the top wing, while the elevator and rudder controls are inside the fuselage. These controls are

fitted with a special variable-gearing device, giving a ratio of approximately 3 to 2 for the initial movement of the control column, and a ratio of 2 to 3 for the final movement. This gives the pilot a control which is not only light and effective at high speeds, but also at low speeds and when alighting or taxiing.

The propeller was made by the Gloster Aircraft Company, and is a duralumin forging milled on a special machine to the correct contour and pitch. Thus, no twisting of the metal is required, and it is claimed that adequate stiffness and a minimum of blade distortion under load are attained.

Finally the weight empty of the "Gloster IV" is 2,300 lb., while the useful load is 710 lb., including 11 gallons of water, $5\frac{1}{2}$ gallons of oil, 55 gallons of gasoline, and 15 lb. of instruments. As the wing area is 130 sq.ft., the wing loading is 23.2 lb./sq.ft. The power loading = 3.44 lb./HP.



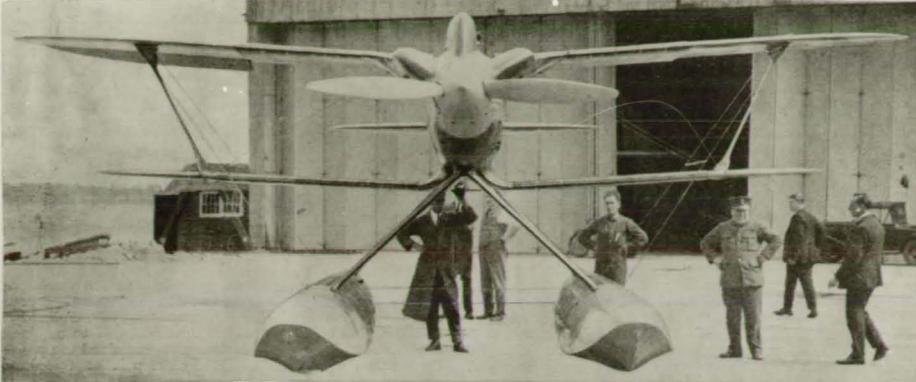


Fig.2 Front view of the "Gloster IV B" seaplane. Note the excellent angles made by the bracing wires.

← Flight photographs

↓ Fig.3 Side view of the "Gloster IV B" seaplane is shown below.

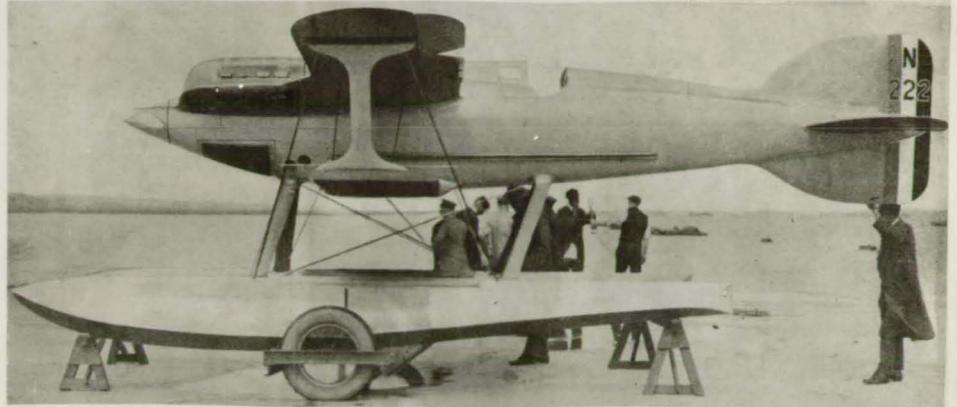


Fig.4 Details of the "Gloster" IV B seaplane.

1, Shows how anti-lift wires are prevented, by rubber buffers from going slack when relieved of load.

2, the "double-diagonal" method of planking the fuselage.

3, showing how rivets are finished off flush with skin of float to reduce air friction. (Flight sketch).

Copyright, used by permission

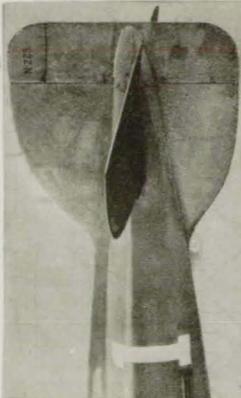
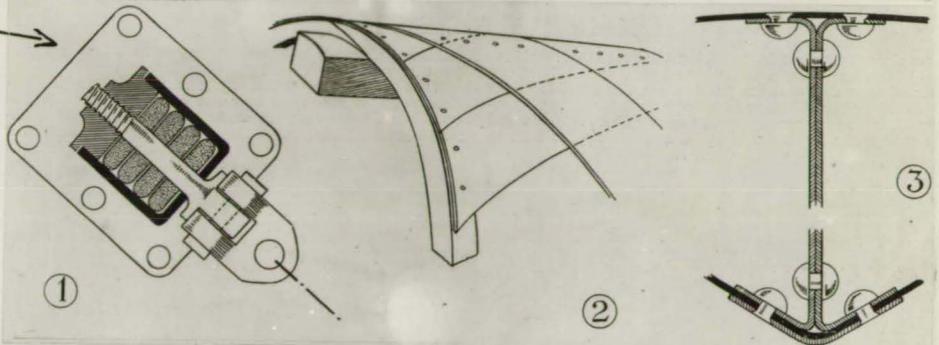


Fig.6 The IV B tail surfaces. Note the nearly symmetrical design
Flight photographs

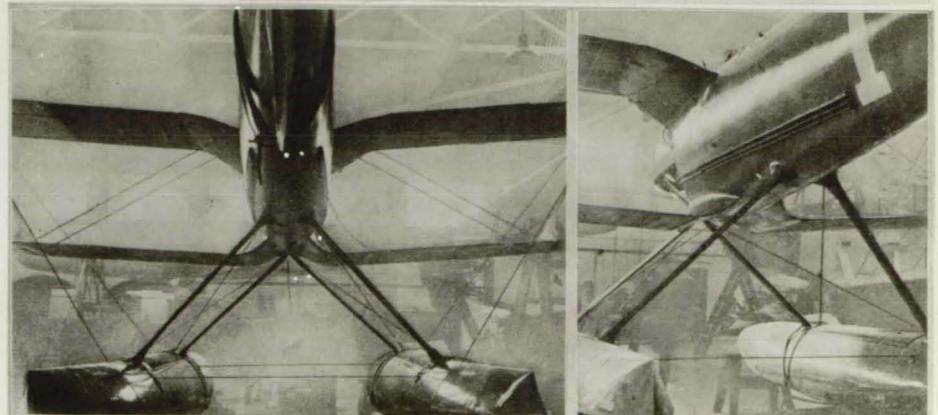


Fig.5 Reduction of interference was one of the great problems in the design of the "Gloster VI B". These photographs indicate how interference between wing roots and fuselage was reduced by avoiding sharp angles. The top wing fairings into the outer cylinder blocks, and the lower wing roots curve down and outwards, being initially at right angles to the surface of the body.

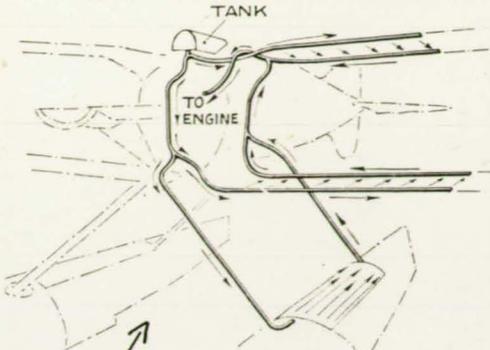


Fig.7 Arrangement of the seven gasoline tanks in the fuselage, of the IV B. There are three main tanks, and three auxiliary tanks, and one service tank.

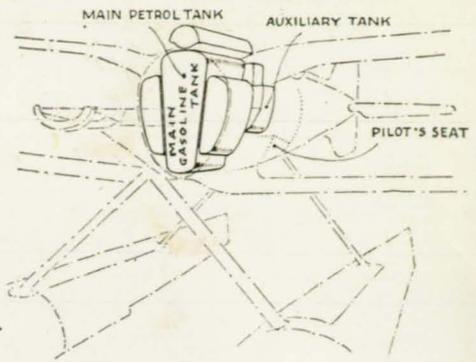


Fig.8 Diagrammatic perspective representing the water system, one-half only being shown. Note the radiator on the port float.

"Flight" sketches.
Copyright, used by permission.

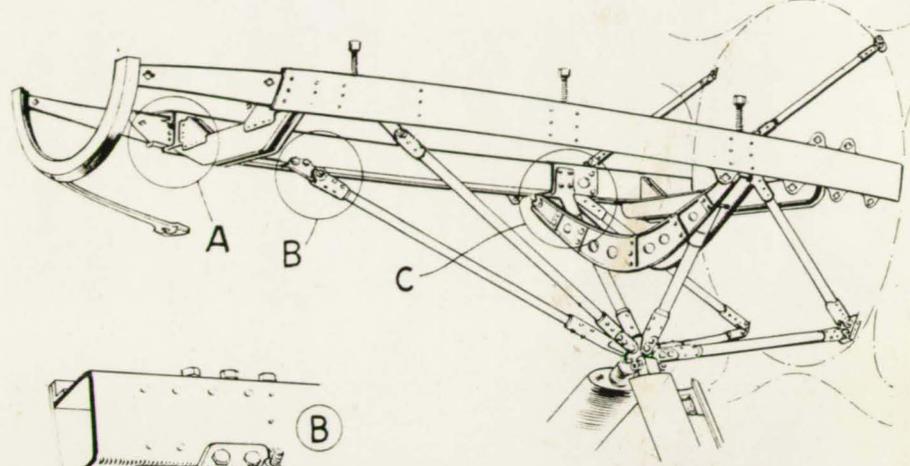


Fig.9 Some constructional details of the IV B. Above, shows assembly and general view of the engine mounting and below, some details

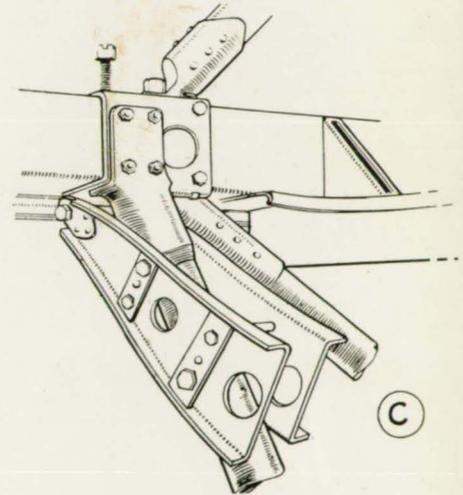
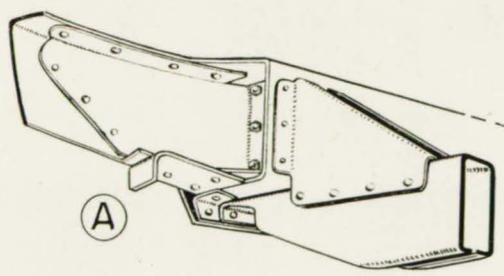
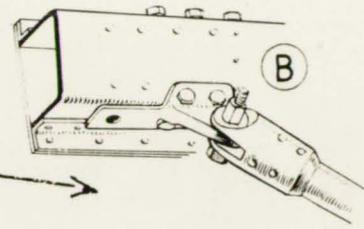


Fig.10 Wing surface radiators of the Gloster "IV B" racer sea-plane. On the left, the outer end of the lower wing radiator and the duralumin I strut is shown. The water piping, entering, the fuselage at the trailing edge of the lower wing, is shown on the right

