AIRCRAFT CIRCULARS

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 82

THE ARMSTRONG WHITWORTH "STARLING" (BRITISH)

(Single-Seat Fighter)

Washington
September, 1928

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THE ARMSTRONG WHITWORTH "STARLING" (BRITISH)

(Single-Seat Fighter)

Armstrong-Siddeley Supercharged "Jaguar" Engine.

Among the group of single-seat fighters recently produced, the Armstrong-Whitworth "Starling" is of particular interest not only on account of its general aerodynamic design but also because of its metal construction, one form of which has become extremely well known in the "Siskin," of which large numbers have been and are being built for the British Royal Air Force.

The "Starling" has been designed for use not only as a day fighter but also as a night fighter, being equipped with the usual navigation lights, Holt flares, etc., although in our photographs it is shown with the short exhaust pipes of the day fighter, i.e., without the collector ring commonly used on night fighters to prevent the open exhaust being seen in the dark.

In general design, the "Starling" resembles previous types of Armstrong Whitworth airplanes, such as the "Siskin" and "Atlas." (Figs. 1, 2, 3, and 4.)

The wing section employed is a biconvex one, and more particularly that known as R.A.F. 30, which is symmetrical, that is, without center-line camber. In the design of the airplane, advantage has been taken of this fact by placing the top wing at

*From Flight, August 2, 1928.

a larger angle of incidence to the center line than is usually found. This was desirable in order to get a large angle with the tail skid on the ground, the angle of no lift of the symmetrical wing section, of course, being at 0° incidence. But in placing the top wing at this large angle, the pilot's view is at the same time improved, as his eyes are approximately level with the center line of the section, so that he can look both above and below the wing. Added to this is the fact that although the top wing is built in two halves, there is not the usual cabane for the support of the wing roots, the upper wings being supported from the body by outwardly raked struts. This absence of a cabane also slightly improves the view, while the slight sagging of the fabric covering over the center-line joints in the top spars has the effect of slightly reducing the wing thickness, thus again improving the view.

Although a structural rather than an aerodynamic feature, reference may be made here to the somewhat unusual form of wing bracing employed, and which has been made possible by the use of symmetrical wing section: the main lift wires, instead of running to front and rear spars, as is usually done, are both taken to a point on the front spar, the rear spar having no lift wire. This arrangement, which at first sight looks a little alarming, has been chosen so as to concentrate as much of the wing strength as possible in the front spar, which is located in a part of the wing section which has ample depth to accommodate it, the rear spar being quite a light affair, and little more than a strong stringer. In the more usual wing section such an arrangement could not well have been used, the travel of the center of pressure under certain conditions throwing a considerable load on the rear spar. With the R.A.F. 30 section, however, the C.P. is almost stationary, and is, moreover, situated fairly far forward, so that this form of bracing has been rendered possible. Any small loads that may be thrown on the rear spar are transferred to the front bay bracing via the interplane struts, which are of "N" formation.

In the model form of the R.A.F. 30, the maximum lift coefficient is not very high (about 0.45 or so at VL = 100), but the section appears for some reason to be subject to considerable scale effect, so that the full scale lift coefficient of the "Starling" is in the neighborhood of 0.6, which enables this section to be used for a reasonably heavy wing loading without the landing speed becoming unduly high. The minimum drag is low, the section thus being suitable for a wide speed range.

Constructional Features

The airplane is built of metal as regards its structural parts, although the covering is in the form of doped fabric and the wing ribs are of wood.

The fuselage, like the wings, is of steel construction, but whereas the wing spars are built up from rolled and drawn strip, the fuselage members are in the form of circular section steel tubes. At the fuselage joints the longerons are reinforced with tubular sleeves at the points where the longerons are pierced by the bolts. The sleeves are merely lengths of tubing of a size to slide over the longerons. The general arrangement of a typical "Starling" fuselage joint is shown in Figure 5. Bracing is by tie rods in the usual way. To the main fuselage structure is added a fairing composed of hoops or formers of channel section to which are riveted stringers made from rolled strip (Fig. 8). The fuselage is built in two main sections, front and rear, bolted together aft of the pilot's seat.

The wing construction takes the form of steel box spars carrying wood ribs, the spars being composed of webs and flanges rolled to corrugated sections from flat strip and riveted together. The wood ribs are held to the spars without any form of fastening, the blocks in front of and behind the bars being so proportioned that a slight pressure on the spar flanges is produced, which is sufficient for locating the ribs. The details of the rib posts and blocks are shown in Figure 6, from which it will be seen that posts and blocks are taped together. The front spars are of large dimensions, although even so they do not "fill" the wing section, while the rear spars are, as previously mentioned, relatively small and light. The normal spar flange is a single thickness, corrugated for stiffness, but locally, such as at the ends and at the strut attachment points, several laminations are employed, that nearest the main flange being the longest, thus gradually tapering off the thickness of metal. The internal struts of the drag bracing are circular-section steel tubes. The two halves of the top wing are joined together on the center line by fork-end joints, the small gap left between the two end ribs being covered over with fabric.

The lower wings are joined to the fuselage longerons in the manner shown in Figure 5, the rear landing gear legs having their points of attachment adjacent to the wing root joints.

The tail surfaces of the "Starling" are partly of tubular and partly of strip construction, fabric covered. The stabilizer has a variable incidence gear of the worm type, with the rear spar movable, the trunnions and other details being shown in Figure 8.

Internal Arrangement

Mention has been made of the fact that the "Starling" was designed both for day and night fighting. Consequently it carries a large equipment, including navigation lights, Holt flares, etc., in addition to the day fighter equipment of wireless, oxygen apparatus, etc., as well, of course, as the usual two machine guns synchronized to fire through the propeller. The guns are mounted on a tubular steel framework, with a quick-thread adjustment for aligning the guns. The latter are accessibly placed inside the fuselage covering, with their mechanism readily within reach for clearing any jambs (Fig. 2).

The pilot's seat is supported on a system of parallel link movement, with a handle and notched quadrant for raising and lowering the seat. This movement has been made "instinctive," i.e., the pilot depressing the handle to raise himself.

As distinct from many single-seat fighters, the gasoline tank is placed, in the "Starling," inside the fuselage, and the present installation is slightly complicated by the fact that a greater capacity has been asked for, requiring the addition of an auxiliary tank.

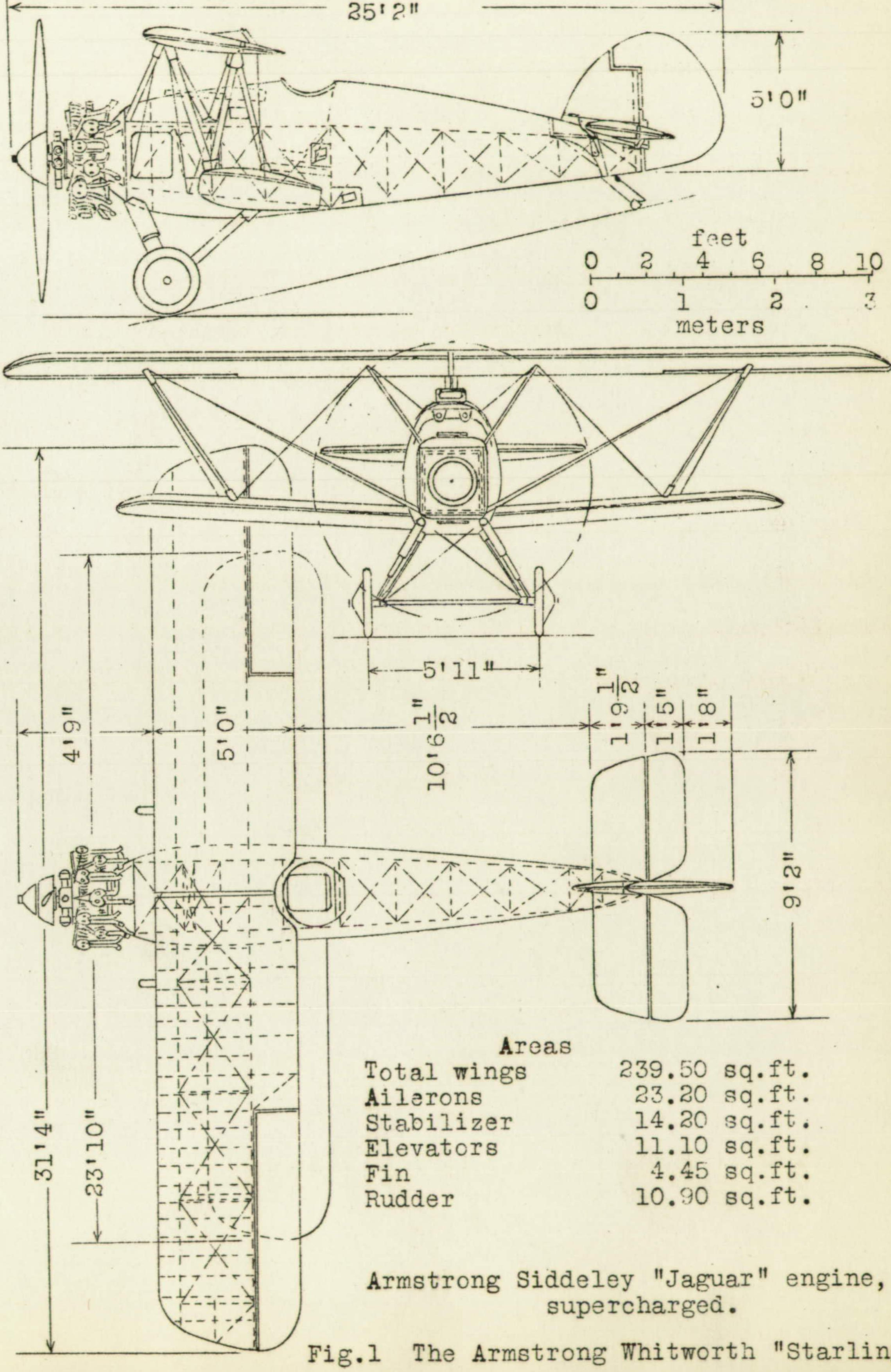
A very neat tail trimming gear is provided (Fig. 8). In order to facilitate the work of trimming the tail it is necessary to have a low "gearing" between the operating wheel and the stabilizer spar. But if the wheel has to be turned through more than one revolution for the complete range of tail settings, the difficulty arises that the pilot is uncertain as to the exact angle at which the tail is placed. To overcome the difficulty the designers of the "Starling" have produced a tail trimming wheel incorporating an epicyclic gear arrangement, so that although the wheel is turned through several revolutions, the pointer moves through a few degrees only.

The Armstrong-Siddeley "Jaguar" fitted in the "Starling" is of the supercharged type for work at great altitudes, and is, needless to say, provided with the usual interrupter gear for the machine guns. A rather neat spinner has been produced, which takes the form of a truncated cone of plywood surrounding the propeller boss. To the front of this is secured the small metal spinner which just leaves the claws for the Hucks starter free. It has been found that the plywood spinner stands up remarkably well, and its use avoids the annoying cracking which is, unfortunately, only too common with metal spinners.

We regret that the makers of the "Starling" do not wish any detailed weights to be published, nor actual performance figures. It may, however, be stated that the airplane carries full service equipment in addition to over 50 gallons of gasoline and 5 gallons of oil, and that with full load it is capable of a speed of 150 M.P.H. at 15,000 feet, while the ceiling is approximately 30,000 feet. The landing speed is in the neighborhood of 50 M.P.H.

Characteristics

Span, upper wing	31 ft.	4 in.
" lower wing	23 "	10 "
Length	25 "	2 "
Total wing area	239.5 sq.ft.	
Area of ailerons	23.2 "	
" " stabilizer	14.2 "	
" " elevators	11.1 "	
" " fin	4.45 "	
" " rudder	10.9 "	

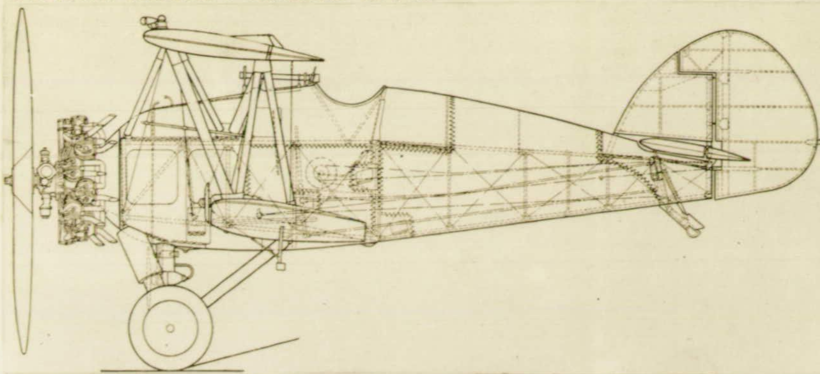


Areas

Total wings	239.50 sq.ft.
Ailerons	23.20 sq.ft.
Stabilizer	14.20 sq.ft.
Elevators	11.10 sq.ft.
Fin	4.45 sq.ft.
Rudder	10.90 sq.ft.

Armstrong Siddeley "Jaguar" engine, supercharged.

Fig.1 The Armstrong Whitworth "Starling



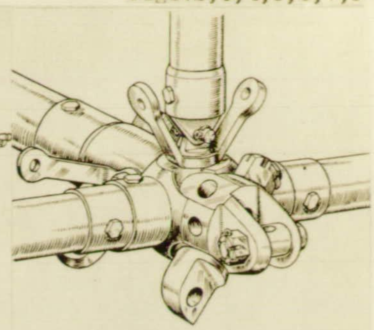
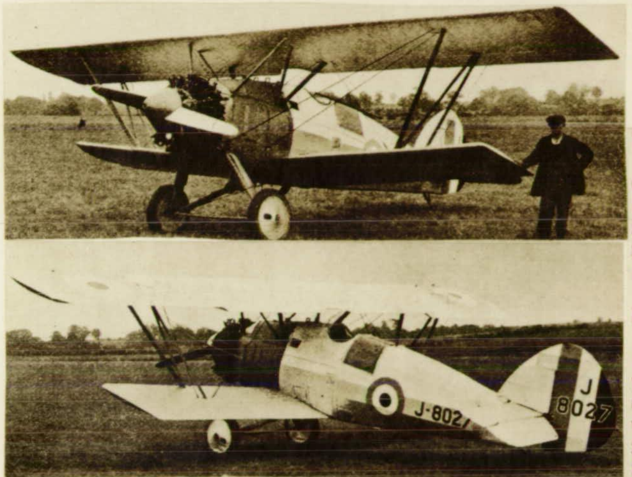


Fig.2 Sufficient detail has been retained to show the main structure. An unusual feature is that the wing is symmetrical and the main lift wires, are both attached to the front spar.



Figs.3 & 4 Three-quarter views of the "Starling"

Fig.5 Attachment for lower wing, with fuselage joint above.

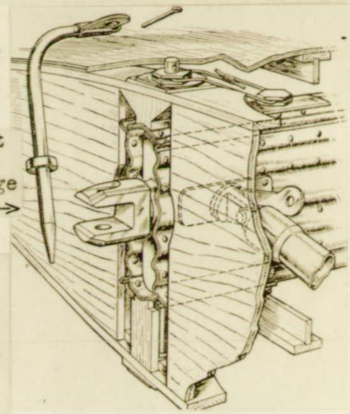


Fig.6 The wing ribs are of wood. There construction and method of attachment to steel spars is shown.

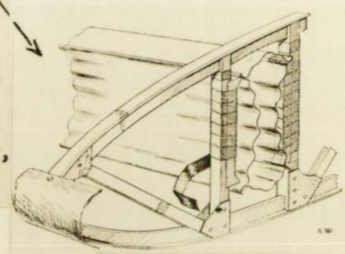
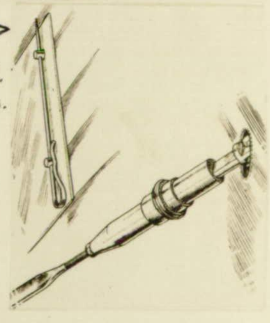
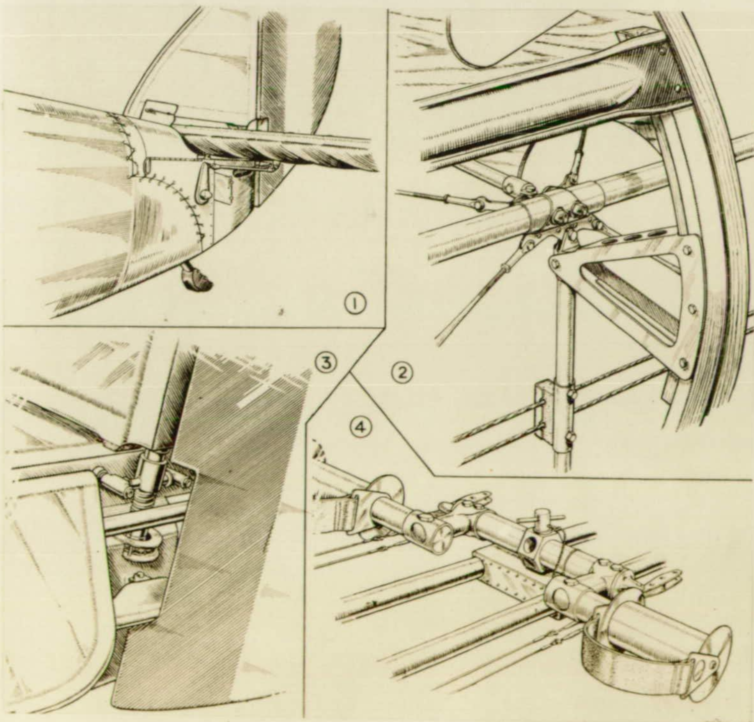


Fig.7 An anti-vibration device which prevents slacking of anti-lift wires, with a skewer for fastening cowling, inspection doors, etc.





SKETCHES AND VIEWS TAKEN FROM "FLIGHT" 8-2-28.

Fig.8 Constructional details of the "Starling" 1, shows the stern of the fuselage, with elevator controls, tail skid, etc. Details of the fuselage construction are shown in 2. The main structure is tubular, but fairings are added in the form of channel sections hoops carrying crinkled strip stringers. The trunnion arrangement of the tail for trimming is shown in 3. The adjustable foot bar is shown in 4.(Pivoting in the central hexagonal fitting, the foot bar can be fixed in the position shown, or in the fully forward, or in a number of intermediate positions).

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