AIRCRAFT CIRCULARS

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 138

THE BLERIOT 110 AIRPLANE (FRENCH)

A Long-Distance High-Wing Monoplane

Washington
March, 1931

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THE BLERIOT 110 AIRPLANE (FRENCH)*

A Long-Distance High-Wing Monoplane

By Pierre Léglise

The Bleriot 110 which, under the pilotage of Bossoutrot and Rossi, flew from Paris to Oran, Algeria, in 67 hours and 32 minutes, was designed by Zappata. It is a wooden airplane designed for long record flights. The two distinguishing features of this airplane as a whole, and of all its parts, are fineness and lightness.

The most noticeable features of the B 110 (Fig. 1) are the heart-shaped cross section of the fuselage, the large wing and the wing bracing. The fineness of the fuselage is due largely to the narrowness of its principal section, which reduces the portion of the lower surface of the wing not utilized on most high-wing monoplanes. The tests showed that this shape gives excellent penetration, even superior to that of a streamlined body of revolution mounted in contact with the wing, probably because, in the former case, the junction is made practically at right angles, while, in the latter case, acute angles are formed which always cause interference.

The frontal area of the fuselage was reduced to that strictly necessary for the honeycomb radiator. Obviously a

*From L'Aéronautique, December, 1930, pp. 431-438.

radiator on the side of the fuselage or on the wing would be preferable from the aerodynamic viewpoint, but this kind of radiator did not seem to be sufficiently perfected to withstand the vibrations during very long flights.

The fuselage section is elongated in height (Figs. 2 and 3) and terminates in a point at the bottom (Fig. 4). This shape enables, by the simultaneous use of a cabane and a system of brace wires, the utilization of a very light wing with a very large aspect ratio. The cabane struts and wires (including the two pairs of wires below the wing) weigh only 90 kg (198 lb.), instead of 240 kg (529 lb.) which would have been necessary if four steel struts with aluminum fairing had been used. The weight of the wing itself is only about 50% of that of a cantilever wing having the same aspect ratio of 8.7. The fineness of the whole airplane is 17 when the wheels are cowled and 16.5 when not. This figure can be increased to nearly 19.5 by eliminating the landing gear. A rectangular model with an aspect ratio of 6, with the same profile, gave a fineness of 20. An elliptical model, like the B 110, gave a fineness of 22. In both cases the maximum C_z is very high ($100\ C_z = 160$). The propeller was lowered as much as possible, so as to bring the slipstream below the wing. The distance between the propeller and the leading edge of the wing is 4 m (13.12 ft.). The wing, with a span of 26.5 m (86.94 ft.), had to be made in three parts, so that it could be transported along the road to the airdrome. Hence it weights a little more than if it were made in one piece.

One device, which contributed to the lightening, consisted in connecting the two wing spars by an oblique aileron-supporting spar (Figs. 5 and 6). In most airplanes the front spar is usually stressed more than the rear spar. It may happen, however, in certain flight cases and in violent maneuvers of the aileron, that the rear spar is more stressed than the front spar. Since the engineer must provide for this possibility, he is forced to adopt a heavy type of construction, unless there is some effective device for transmitting the stress from one spar to the other. In the present case the aileron-supporting spar forms a sort of continuation of the rear wing spar from the point B (Fig. 6) to A, where it is attached to the front spar by a box. The torsional resistance of the wing is thus greatly increased. On the other hand, this aileron-supporting spar, being securely attached at three points (including the box rib at C), can be made much lighter than a spar secured only at one end.

The Fuselage

The fuselage structure has a keel at the bottom and two longerons at the top. The transverse structure consists of bulkheads (Fig. 41) and intermediate frames (Figs. 7, 11, 40). The spaces between the bulkheads and frames are occupied by formers (Fig. 10). The body, thus formed, is covered with a layer of whitewood (Fig. 8) in strips about 5 cm (1.97 in.) wide glued and nailed to the framework. Over this layer there are applied two similar layers (Fig. 9) crossed at 45°, the whole being covered with fabric. After drying and removal of the form wedges, we thus obtain a perfectly smooth covering without any of the bulges frequently exhibited by plywood. The resulting structure offers a remarkable resistance to torsion. The space for the pilots (Figs. 27-28) is inclosed in the fuselage with only lateral views through portholes. The forward view is obtained by a periscope (Fig. 44).

Instruments in the pilot's compartment are: A, oil gauge; B, C, D, fuel gauges; E, F, inlet and outlet oil thermometers; G, H, water thermometers; I, oil manometer; J, tachometer; K, clock; L, altimeter; M, fuel manometer; N, manometer of Saintin starter; 1, second tachometer; 2, carburetor heater; 3, navigator's switch; 4 pilot's switch; 5, wheel for adjusting stabilizer; 6, fire alarm; 7, 8, fuel-cock controls; 9, water-tank control; 10, 11, gas throttles and altimetric correctors of first and second pilot; 14, flight control; 15, Ramondou map holder; 16, pitch indicator; 17, Holt rocket controls; 18, switch for position lights; 19, ignition advance; 20, door lock; 21, support for Bouillon fire extinguisher; 22, starting magneto; 23, dumping control; 24, control of fuel cocks; 25, rings for parachutes.

The streamlined landing gear has a track of 3.5 m (11.48 ft.). Further details are shown in Figures 3, 31 and 37. The shock-absorbing strut consists of telescoping tubes connected by crosspieces on which are wound two elastic cables each forming three rolls. (See also L'Aéronautique, September, 1929, p. 306).

The Wing

<u>Spars</u>.- A wooden spar ordinarily has two flanges connected by two plywood webs (Figs. 12-13). The glues used in making commercial plywood have neither the homogeneity nor strength of the special glues used by airplane constructors. In such a spar, the separating stresses practically affect only the first layer of the plywood, which is joined to the flange by "Certus" glue. The other layers slide more or less on one another. Thus the layers of glue which absorb the principal stresses, are reduced to two in the standard spar.

In the Bleriot 110, the spruce flanges (Fig. 14) were sawed in two and joined by three plywood webs. The number of effective layers of glue was thus doubled. Since this method would have required too thin webs in order to keep down the weight, Mr. Zappata used a plywood of medium thickness and openworked the outside webs throughout their whole length, except at the ends (attachments to the fuselage and to the aileron-supporting spar) and at the center (attachment to the braoe wires). The webs are supported by latticed uprights. These uprights, instead of being simply glued between the webs, are encased in pieces glued to the flanges in the direction of the grain. There is such an upright in the vicinity of each rib. The dimensions of the spars vary throughout the span, being greatest at the points of attachment of the brace wires.

Ribs.- The ribs (Figs. 15-18) consist of three parts. Each part is composed of a wooden body braced by a steel cable. This original system, conceived for a long-distance airplane, is very light and eminently adapted for coating with metal. It is only necessary to join all the brace wires to obtain a veritable metal trellis. This same cable serves as an element of the ribs. After the brace wires of an element are mounted, they are gradually given the desired tension. The cable is then secured by metal wedges (Fig. 19) and bits of solder. The crossings of the cable are secured by brass wires. Some of the ribs form boxes. Details are shown in Figures 15-18.

Tail surfaces.- The fin (Fig. 36) is formed by a continuation of upright members of the fuselage. Its leading edge is covered with plywood; its trailing edge with fabric. The stabilizer can be adjusted during flight. The rear spar 1 (Fig. 20) of the stabilizer and the front spar 3 of the elevator are hinged to a central piece 2.

Power Plant

The duralumin engine bearer (Figs. 21-22) is constructed on new principles. Mr. Zappata, considering that this structure must withstand the forces of gravity and traction on the one hand, and of torque on the other hand, introduced separate elements for these purposes. Gravity and traction are absorbed by a rigid triangularly braced hinged girder, composed of bos-type elements (Fig. 43). The torque is absorbed by the duralumin covering. Since the covering is riveted to the different girders, it might be thought that the elasticity of the hinged part would be destroyed, but such is not the case. In fact the covering can effectively transmit at one point only the stresses in the plane tangent to this point on its warped surface. The other stresses produce a warping component, which is absorbed, however, by the bearer. Hence there is no incompatibility between the two systems.

The front bulkhead is a metal frame (Figs. 23 and 39), to which the stresses are communicated at five points: four (1, 2, 3, 4) in the plane of the engine-bearer longerons (Fig. 23) and one (5) at the point of attachment to the keel (Fig. 42). The stresses at 1 and 4 are transmitted to the bulkhead AB, situated in the vicinity of the front wing spar, by two box strips (Figs. 25 and 26). The stresses at 2 and 3 are transmitted to the same bulkhead by two steel tubes and brace wires. The points A and B correspond to the attachments of the shock-absorbing strut.

The tanks (Figs. 32-34), with a total capacity of 7000 liters (1849 gal.), are six in number: four in the fuselage and two in the wing (Fig. 30). Each tank rests on a duralumin structure with open-worked partitions. The bottoms are connected by brace wires with reinforced attachments. With this system, for a test pressure of 200 g/cm² (2.84 lb./sq.in.) and for large volumes, 1000-1800 liters (264-476 gal.), the weight of the tank is about 3% of the weight of its contents. The new test pressure of 600 g/cm² (8.53 lb./sq.in.) necessitated a stronger structure, the weight of the tank being about 4.75% of that of the fuel for a capacity of 500 liters (132 gal.). For larger tanks the ratio ranges from 5.2 to 5.7%. The oil tanks, containing 300 liters (79.25 gal.) and forming radiators, constitute the leading edge of the central part of the wing.

The Bleriot Company considered it inadvisable to use an engine with a reduction gear for two reasons. In the first place, the reduction gear absorbs 2 to 4% of the power. In the second place, the gears now available have not been tested under the identical conditions of the contemplated flights, 80 hours of continual vibrations. The engine selected is a direct-drive 600 hp Hispano-Suiza with Albert Moulet pumps and a Vincent André radiator.

Characteristics

Span	26.50	m	86.94	ft.
Length	14.57	"	47.80	"
Height to cabane strut	4.90	"	16.08	"
Wing area	81	m^2	871.88	sq.ft.
Empty weight with water	2400	kg	5291.09	lb.
Weight of 6000 liters of fuel	4500	"	9920.79	"
Weight of crew	400	"	881.85	"
Total weight	7300	"	16093.73	"
Wing loading	90	kg/m^2	18.43	lb./sq.ft.

Translation by Dwight M. Miner,
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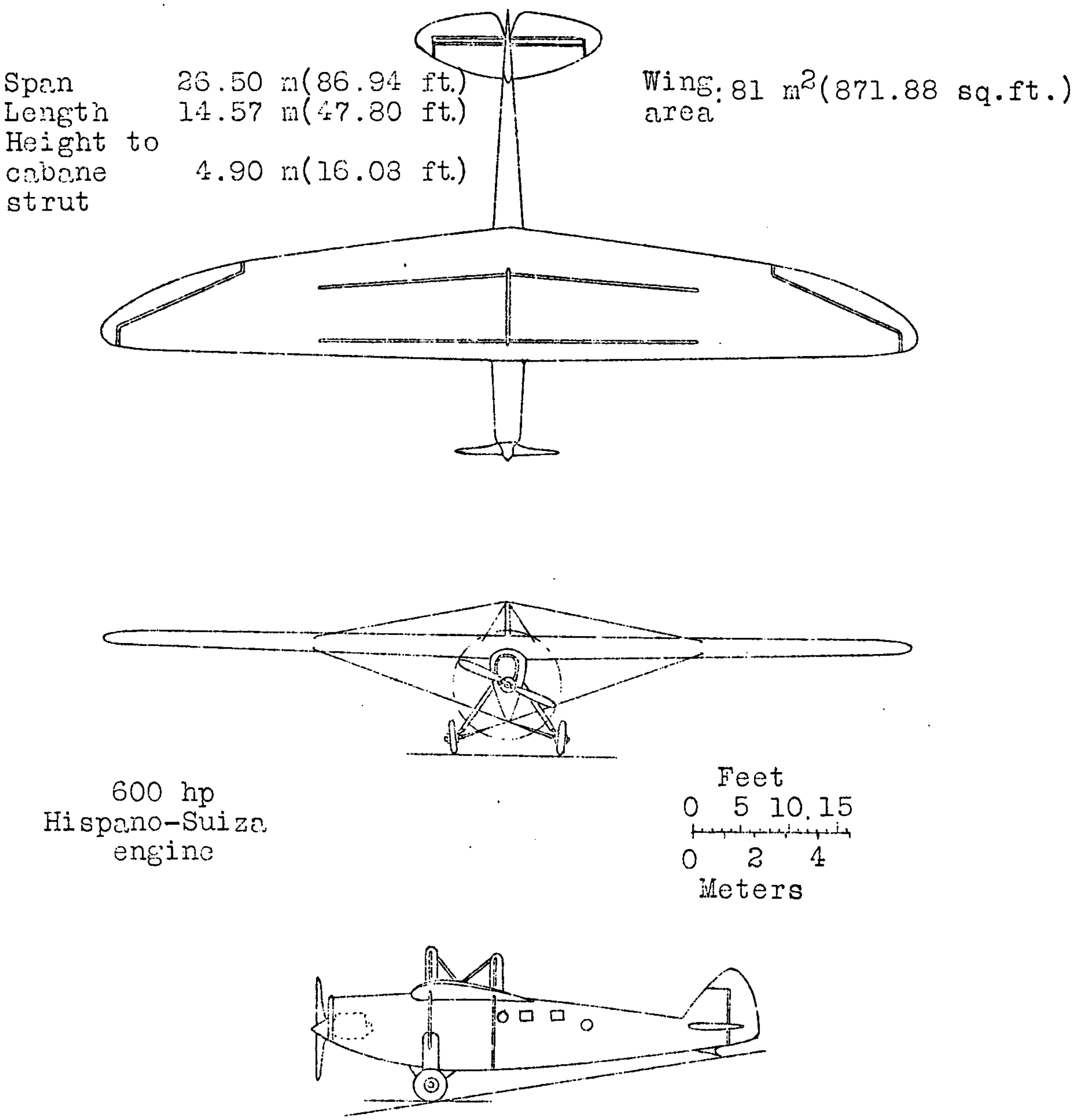


Fig.1 The Bleriot 110 long-distance monoplane.

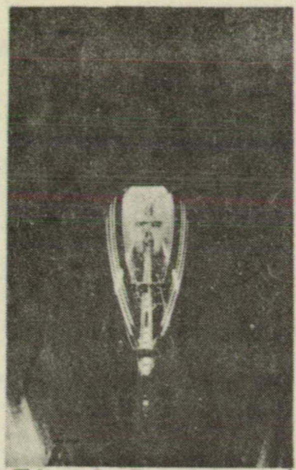


Fig.2 Inside of fuselage.

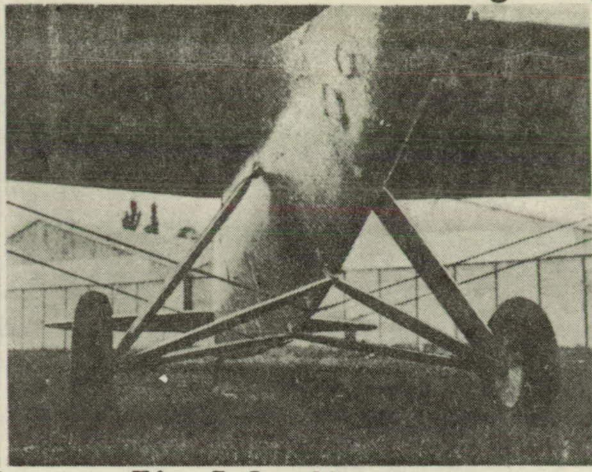


Fig.3 Landing gear.

Fig.4 Couch for crew behind seats.

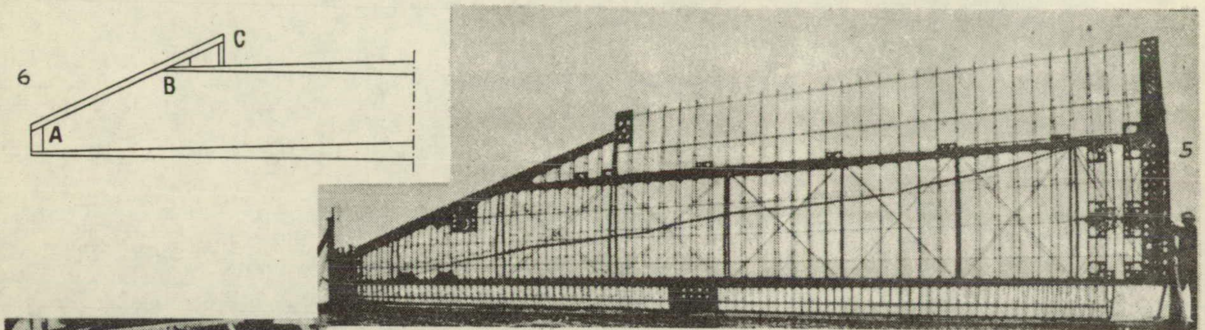


Fig.5 & 6 Wing structure.

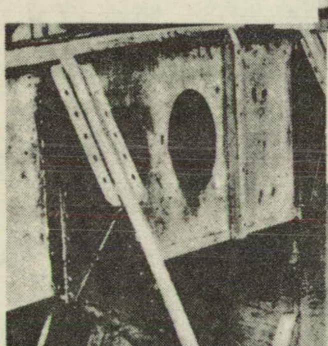
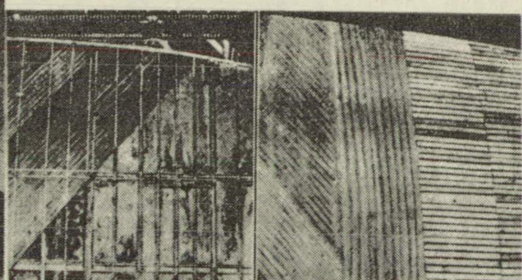


Fig.7 Attachment of intermediate frame to keel.



Figs.8 & 9 Wing covering.

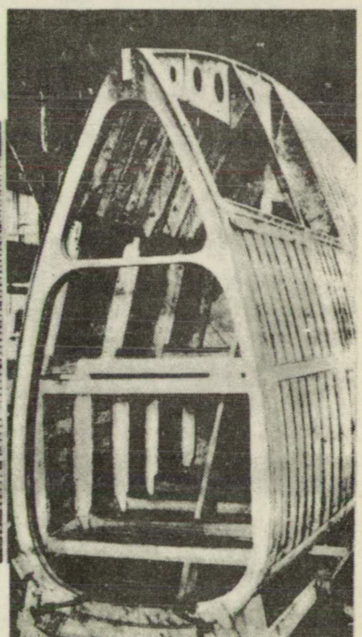


Fig.10 Fuselage structure.

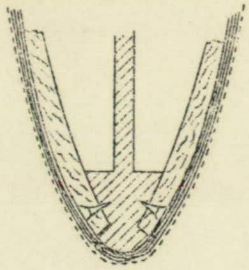


Fig. 11 Bottom of a bulkhead.

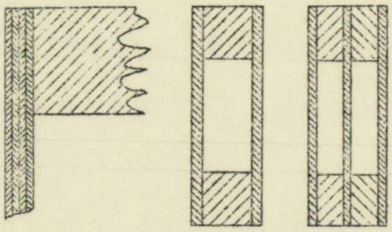


Fig. 12 Fig. 13 Fig. 14
Structure of spars.

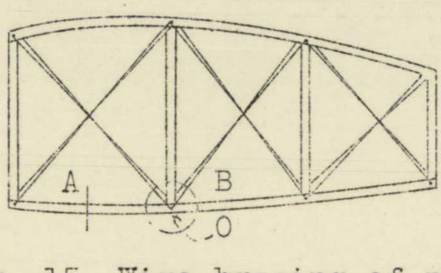


Fig. 15 Wire bracing of rib.

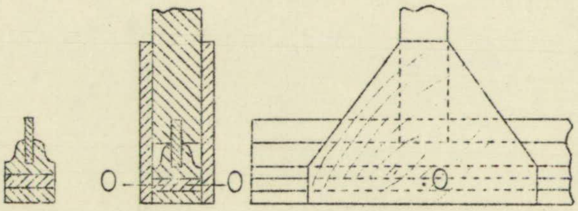


Fig.16 Fig.17 Fig.18

Fig.16 Section at A (Fig.15), flange and web.
Figs.17,18 Section and elevation of assembly B (Fig.15), showing box and gussets, passage for cable at O

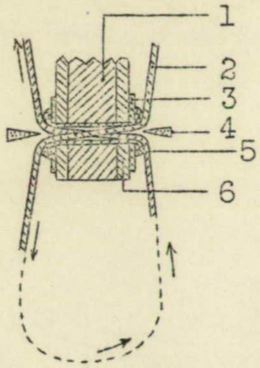


Fig.19 Cable passage through flange: 1, flange; 2, cable; 3, steel band; 4, brass wedge for securing cable in tube 5, of brass with crimped edges; 6, wooden gusset.

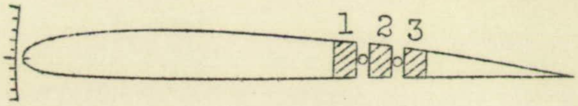
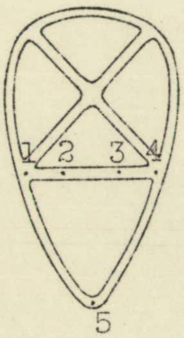


Fig.20 Adjustable stabilizer.

Fig.23

Front bulkhead



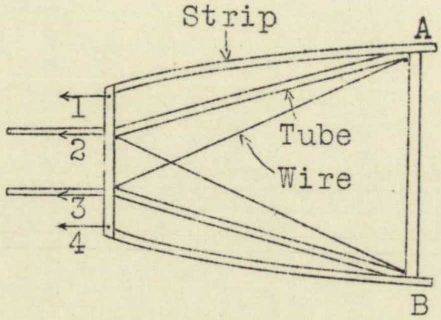


Fig.24 Strips, tubes and wires for transmitting stresses to bulkhead.

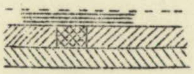


Fig.25

Section xy

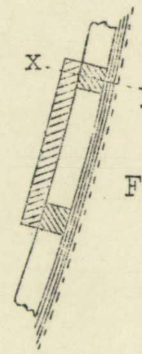


Fig.26

Fig.25,26 Box strips for transmitting stresses to AB at points 1 and 4. Fig.26 shows box structure near a secondary rib. The 3 continuous lines represent the whitewood layers. The dash line represents the fabric covering. Fig.25 shows section xy of Fig.26; rib represented by cross hatching.

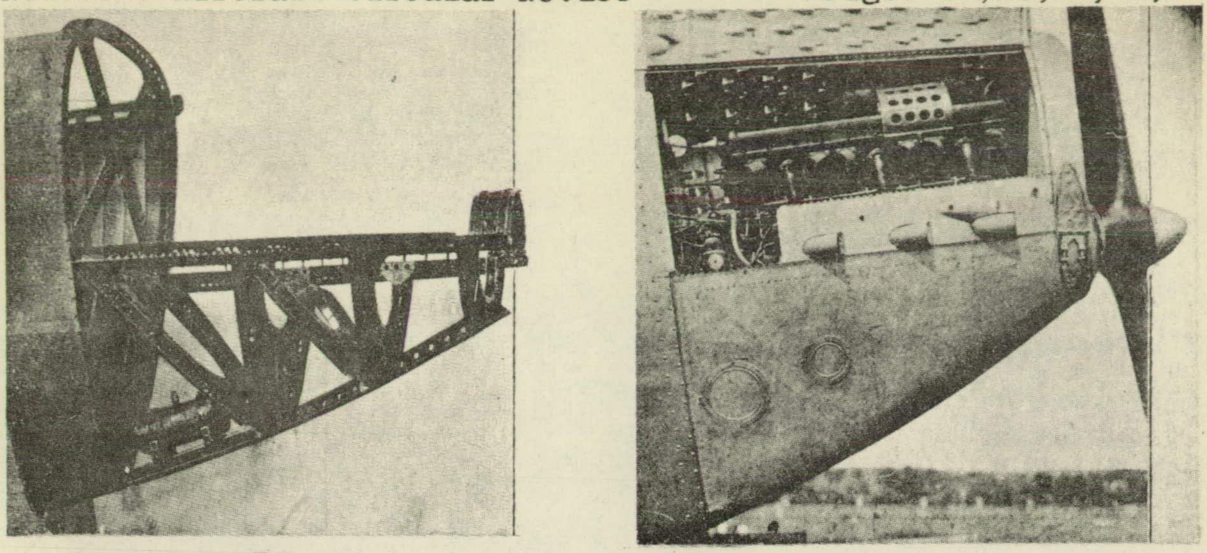


Fig.21 & 22 Engine bearer.

Figs.27 & 28 Pilots' compartment. Seats removed to clear camera field. Lighting through four portholes. Movable overhead window for astronomical observations. Opening clear forward, above navigator's seat opens into the wing, giving view of inside structure and place for stowing food. etc. The two cords with knots over each seat enable occupant to lift and stretch himself.

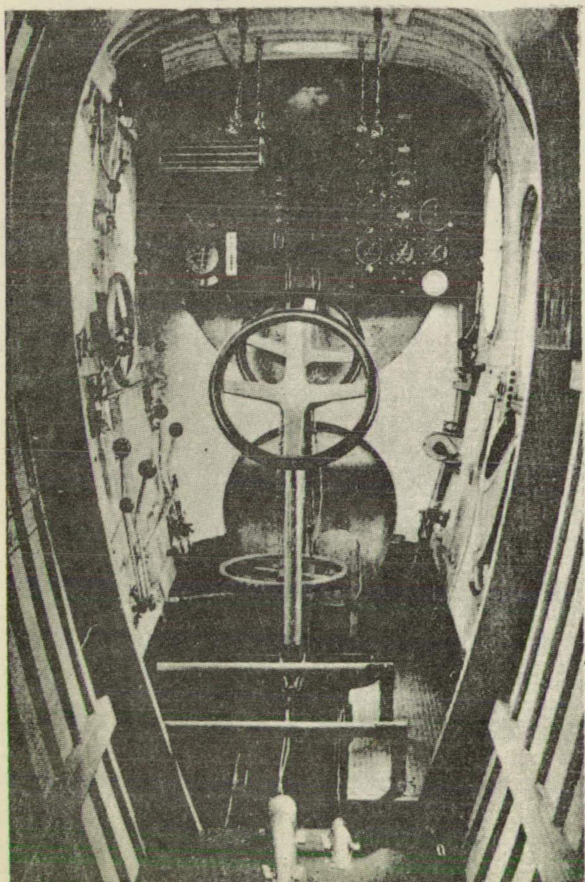


Fig.28

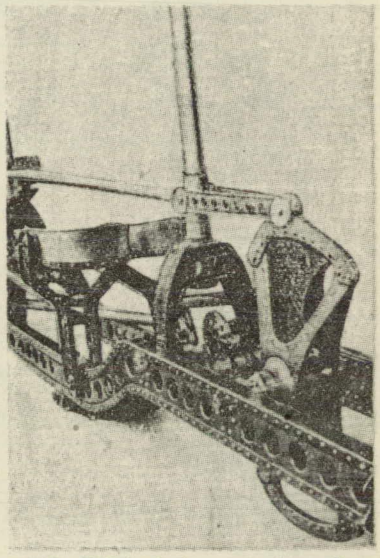


Fig.29 Flight controls.

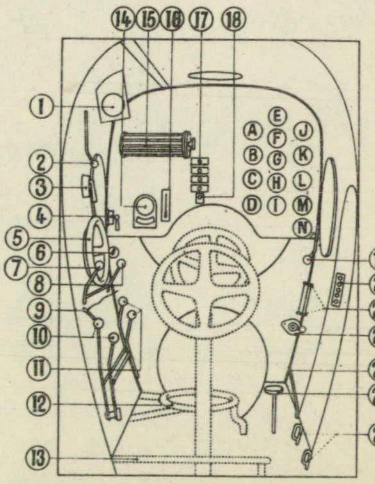


Fig.27

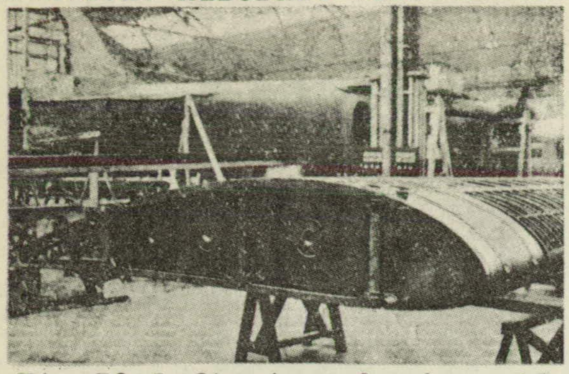


Fig.30 Left wing, showing oil tank, two fuel tanks, brace wires, and fittings of rear spar.

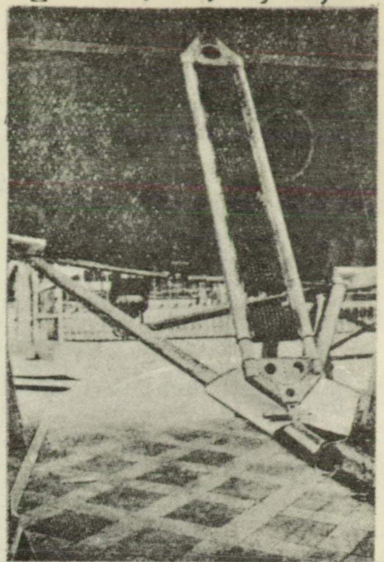


Fig.31 Part of landing gear with shock absorbing strut.

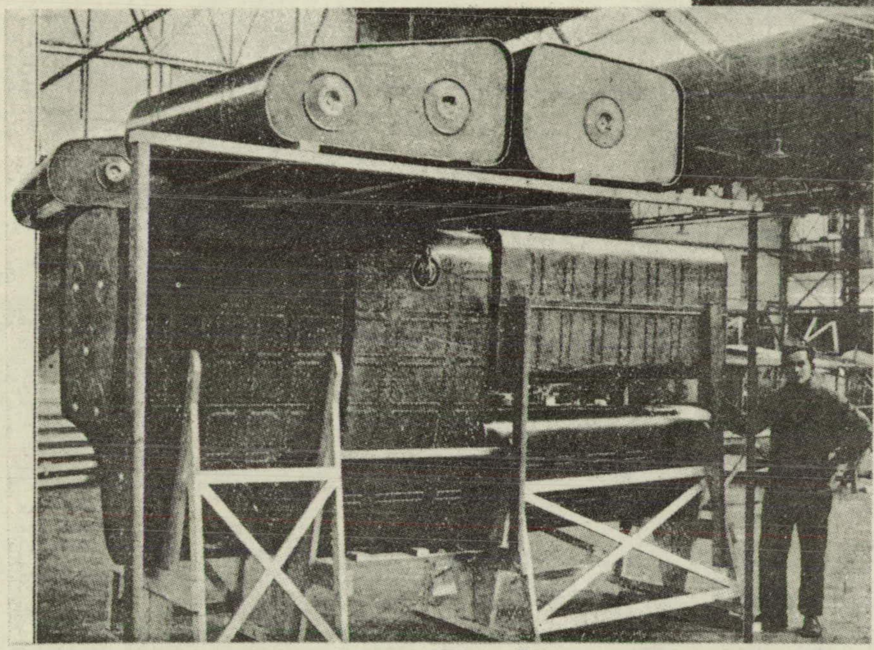


Fig.32

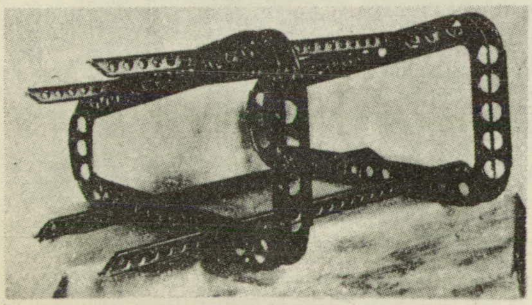


Fig.33

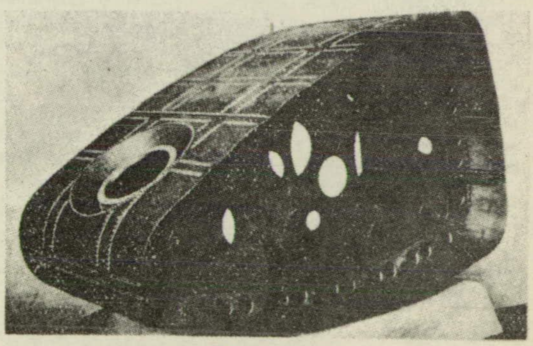


Fig.34

Fig.32,33,34 Fuel tanks and inside structure of one.

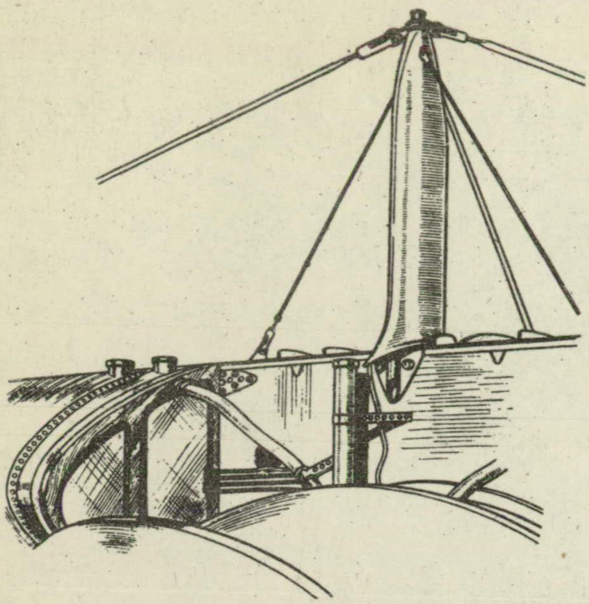


Fig.35 Cabane

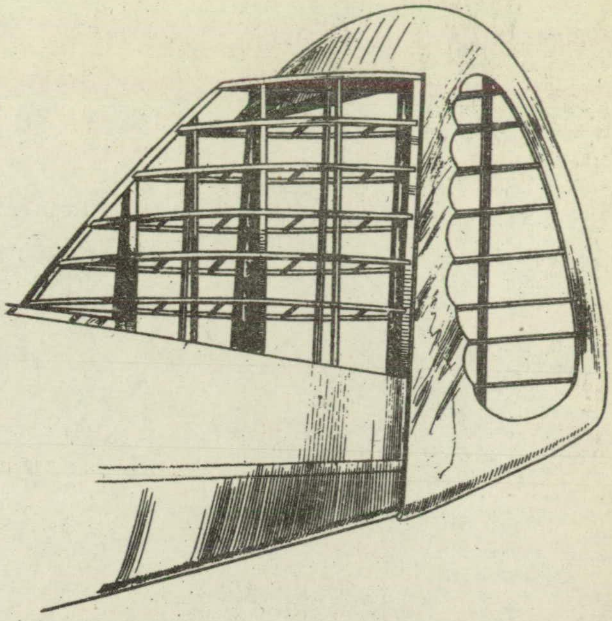


Fig.36 Structure of fin and rudder.

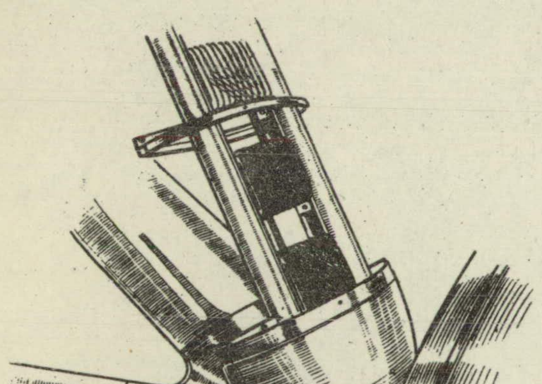


Fig.37 Junction of landing-gear struts. (See Fig.31)

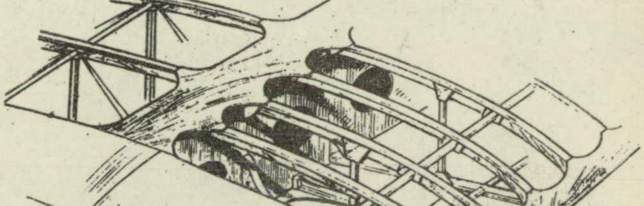


Fig.38 Wing tip. The vertical wall, against which the balancing edge of the aileron abuts, is covered with fabric.

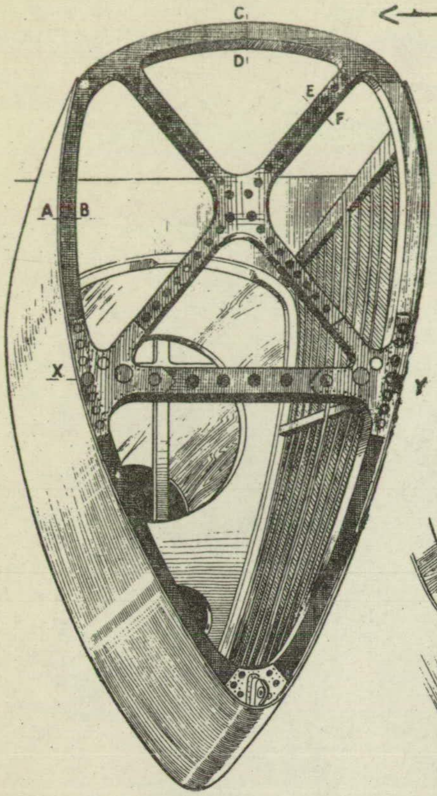


Fig.39 Front metal bulkhead. Sections AB,CD, and EF refer to Fig.39a. Engine bearer is attached at the four points on transverse bar XY.

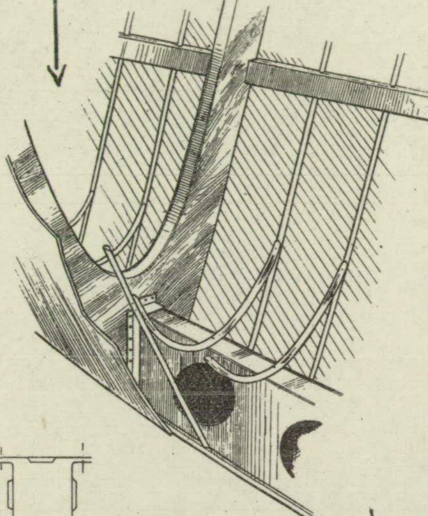


Fig.40 Intermediate fuselage frame.

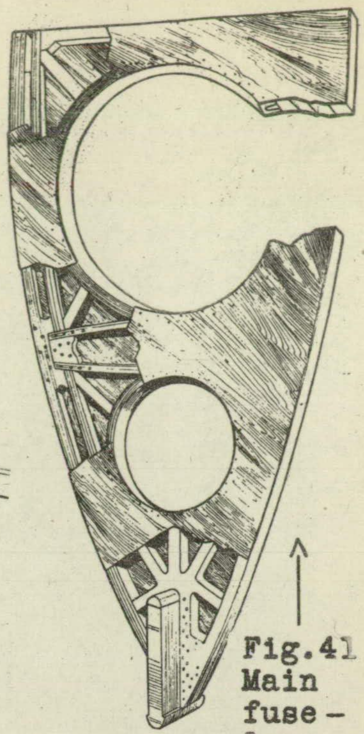


Fig.41 Main fuselage frame or bulkhead.

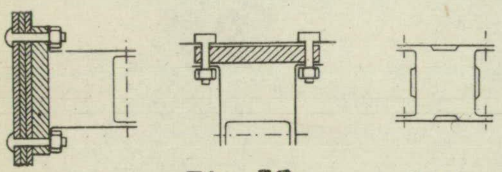


Fig.39a AB, CD & EF.

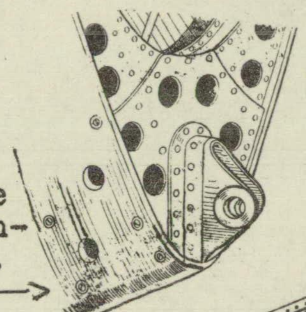


Fig.42 Engine bearer attachment to keel.

Fig.45 Internal structure of Fig.43.

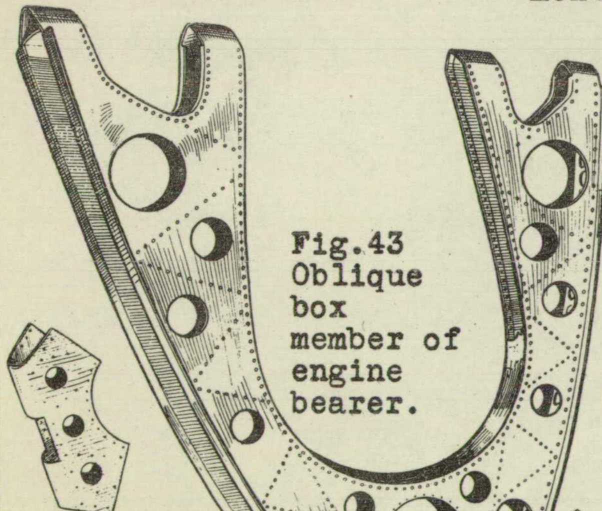


Fig.43 Oblique box member of engine bearer.

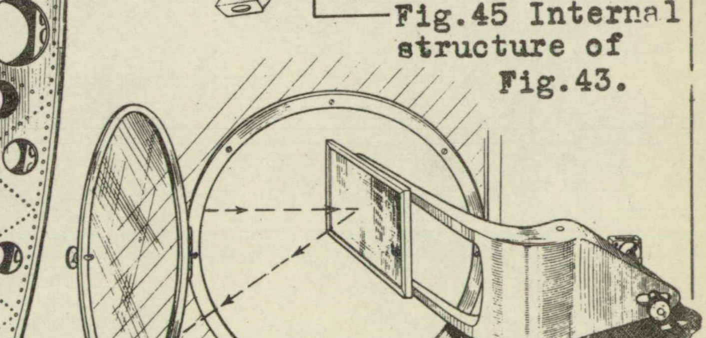


Fig.44 Mirrors forming periscope for forward view.

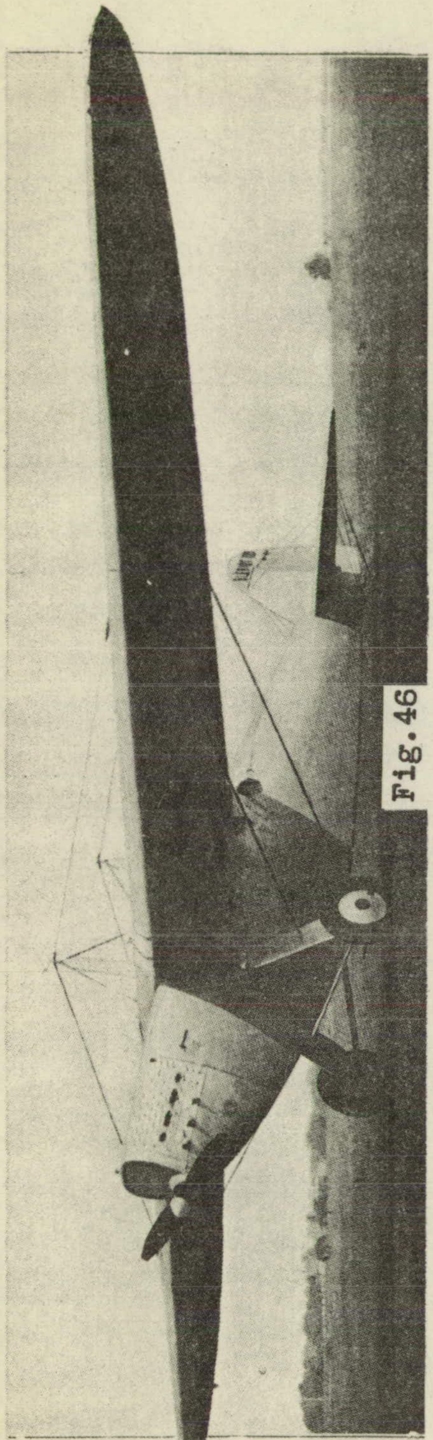
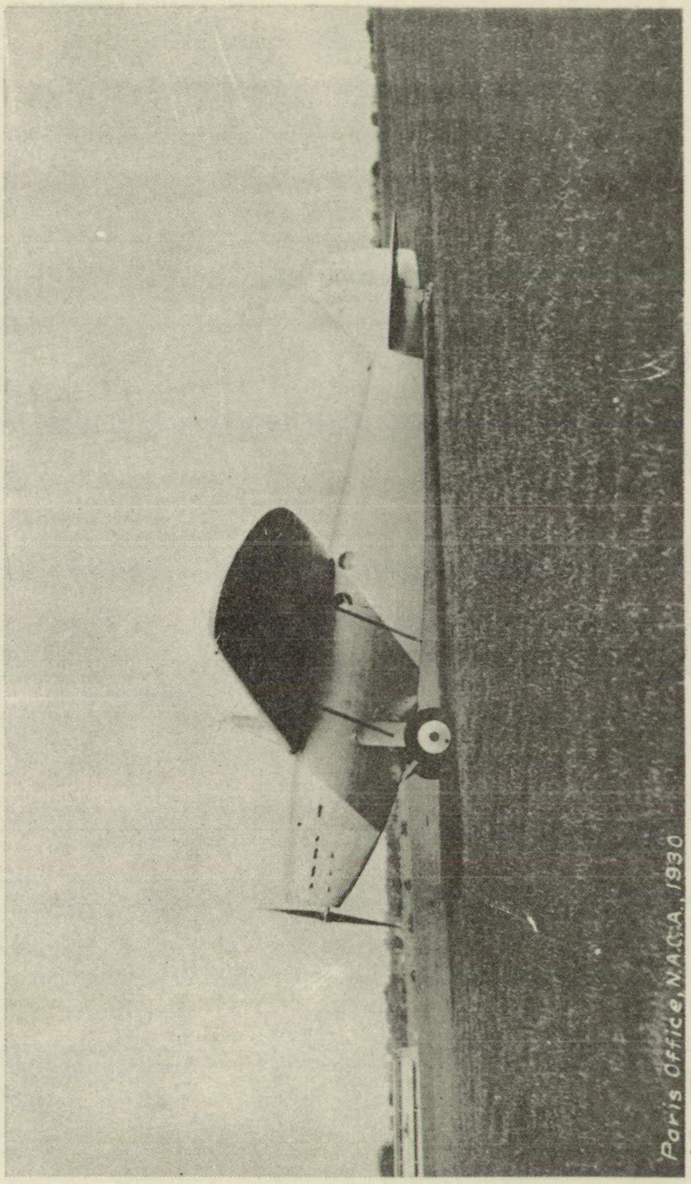


Fig.46



Figs.46,47 Views of the Bleriot 110 long-distance high-wing airplane.