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AIRCRAFT CIRCULARS

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 110

THE LIORÉ-OLIVIER "Le O.240" COMMERCIAL SEAPLANE (FRENCH)

A High-Wing Cantilever Monoplane

Washington
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THE LIORÉ-OLIVIER "Le 0.240" COMMERCIAL SEAPLANE (FRENCH)*

A High-Wing Cantilever Monoplane.

The "Le 0.240," which recently made its first flights in excellent form at Antibes, France, is the final outcome of a long series of experiments and improvements by the Lioré-Olivier Company, covering a period of over three years.

Each half of the cantilever-monoplane wing has an approximately trapezoidal plan form. The total span is 26.2 m (85.96 ft.), and the maximum chord is 5 m (16.4 ft.) (Figs. 1, 2, 3, 4, 5). The wing contains a large number of water-tight compartments which render the seaplane nonsubmersible. The wing is made in three sections. The central section is 9.5 m (31.17 ft.) long and supports the floats which are placed relatively near the hull. Its leading edge is formed by the fuel tanks. The end sections of the wing are joined to the central section by ball-and-socket joints (Figs. 6-7), which eliminate all play and vibration and enable an automatic centering of the axes. After alighting on the water or on a ship, the end sections of the wing can be removed by the simple procedure of unscrewing. (Experience has shown that conical or cylindrical axes, even when properly adjusted, yield only to repeated blows of a hammer.)

*From L'Aeronautique, December, 1929, pp. 396-403.

The profile is progressive and convex at the joint, where it is about 1 m (3.28 ft.) thick, but is concave at the tips. The designers did not seek a profile with a small C_{m_0}, since the plywood covering offers a great resistance to torsional stresses. The wing structure consists of two main box spars, with auxiliary spars and interrupted ribs. The spar flanges are spruce with birch plywood webs braced internally. The wing weighs about 11 kg/m² (2.25 lb./sq.ft.) including various fittings and the paint. This value represents a remarkable achievement.

The fuel tanks, made by Poite from the drawings of the Lioré-Olivier Company, constitute structural parts, in that they bear their share of the local air forces. It is important, however, that each tank shall not participate in the actual work of the wing, all the more because wood and duralumin have very different moduli of elasticity (about 1000 and 7000, respectively). For example, let us assume a tank to be rigidly attached to a wing spar. During an upward bend (case of flight) the plates situated above the neutral axis of the spar are compressed (Fig. 8), while the plates below are subjected to considerable tensile forces. Although the deformations are small in the case of the "Le O.240," the stresses in the flanges are of the order of 100,000 kg (about 220,400 lb.), which no present method of tank construction would be capable of withstanding. When at rest, the stresses on the plates are reversed, the tension being transferred to the upper side. Even assuming a specially reinforced structure, these alternating stresses would soon result in shearing of the rivets and hence in leaks.

The method adopted in the "Le O.240" is extremely interesting. Each tank is attached to the spar at only two points, both situated on the neutral axis. Two 35 mm (1.38 in.) bolts 9 (Fig. 9) pass through the spar and are screwed into the fittings 11 attached to the tank. These bolts are supported on the after side of the spar by collars and are guided on the forward side by a steel plate 6 exactly fitted to their diameter. During the stresses of bending, the plate can slide parallel to the neutral axis in a duralumin channel 5 integral with the spar. The result is a certain degree of articulation between the tank and the spar. The supporting bolts follow the deformations elastically, due to their great length and the play provided between their diameter and that of their lodging in the wood of the spar about 5 mm (0.2 in.). This solution, which would seem insufficient at first thought, is really quite ample, since each attachment can support 15,000 kg (33,069 lb.). The upper and lower edges of the tanks rest against the protective fittings of the spars with the intermediation of the rubber bands 2.

The ailerons (Figs. 10-11) have a large aspect ratio and cover the trailing edges of the outer wing sections. They are balanced by two auxiliary surfaces or balancers, which are prac-

tically vertical in the position of rest. Each aileron is connected with its balancer by a rod and a bell crank. These balancing surfaces, functioning in a plane parallel flow, cause less interactions than those arranged parallel with the wing.

The hull is made of wood. A duralumin hull will be substituted ultimately. The bow of the hull, which has only one step, was specially designed to avoid splashing. The problems of the angle between the keel and the chines have been well solved, since the take-offs and landings are smooth, the bow wave having been eliminated. A movable step, represented by dotted lines in Figure 1, is designed for experimenting with modified shapes of the after hull bottom.

The hull is divided into three large compartments by two water-tight bulkheads, one of which is provided with an instantaneously closing door. The forward compartment contains the anchor, cordage, etc., the navigator's and pilot's seats, the radio outfit which can function after alighting. The pilots' cabin has glass windows. The central compartment contains the large and luxurious cabin over 2 m (6.56 ft.) high for ten, or possibly 15 passengers, and a lavatory. The after compartment is reserved for baggage and freight. It can be entered through a slide door during flight.

It was sought to increase the comfort of the cabin, not only by the interior arrangements but also by the deadening of the noise, so that it is possible to converse without raising the voice. Under the engine bed there is, first of all, an empty chamber, which constitutes a remarkable silencer. The wing is then placed on the hull with the intermediation of a rubber pad. Lastly, the noise is reduced by the elevated position of the engines and the upward direction of the exhaust. The distance from the fuel tanks makes it permissible to smoke in the cabin. The two water-tight compartments in the hull, together with those in the wing, render the seaplane strictly nonsinkable. This quality constitutes part of the "safety first" program of Mr. Benoit.

An important point in the design of the "Le 0.240" is the shape, volume and disposition of the wing floats. They are intermediate between the floats of a Dornier and the customary wing-tip floats. The nearer the floats are to the hull, the easier it is to alight on them both simultaneously. On the other hand, their large volume, 1.59 m^3 (56.15 cu.ft.) makes it difficult for large masses of water to submerge them and thus create disturbing moments. Its maneuverability on the water is thus improved. It is possible, by reducing the carrying capacity, to install a water propeller, driven by a small electric motor, for facilitating evolutions on the water (Fig. 12).

The vertical empennage (Fig. 13) comprises a high fin and two auxiliary surfaces, also vertical and serving as correctors. These surfaces, which are approximately shield-shaped, can turn about their axes of symmetry during flight.

The horizontal empennage comprises a fixed plane or stabilizer imbedded in the fin and supported by a Y strut. An auxiliary surface or corrector is likewise provided for the stabilizer. It is actuated by the bell crank which controls the elevator, the length of the rod connected with the bell crank being adjustable during flight. In the normal adjustment, the angular motions of the corrector are parallel to those of the elevator, but different adjustments of the auxiliary stabilizer can be made to correspond to a given deflection of the elevator.

The central portions of both the fin and stabilizer are extended aft, forming a sort of cross. The two parts of the rudder and of the elevator adjoin the four branches of this cross. This arrangement eliminates the cutaway in either the rudder or elevator, which is a source of poor aerodynamic efficiency and important interferences.

The power plant comprises two 500 hp reduction-gear Renault engines, placed tandem above the wing. The duralumin members, which compose the engine bearers (Fig. 14), are made from 20/10 sheet metal, standard fittings of a unique type and section metal, and are assembled by riveting in a manner very similar to that of the engine bearers in the hull of a ship.

The engines are perfectly accessible during flight. The mechanic, when standing in the shaft of access, 2 m (6.56 ft.) high and 0.5 m (1.64 ft.) wide has, before and behind him at the height of his shoulders, all the auxiliary parts of the engine: fuel pumps, water pumps and magnetos. A ladder affords access to each engine. Both engines can be uncovered alternately by sliding the top cowling. There is a total length of 5.7 m (18.7 ft.) between the propeller hubs. Access is afforded to the shaft during flight, through a passage in the wing. When at rest, a side door affords more convenient access. The box construction gives the engine bearers a remarkable resistance to the vibrations at all speeds. The registration of the deformations by the seismograph shows, in the most unfavorable case, no vibrations of more than 2 mm (0.08 in.) at 1.5 m (4.92 ft.) from the engine housing.

The Poite fuel tanks, with a total capacity of 1500 liters (396 gallons) are provided with Mauve quick-action cocks, which can empty them within a minute. The oil tanks, holding 90 liters (23.8 gallons) each, are between the engines. The Vincent Andre radiators are mounted on the engines forward and aft of the engine bearers. No diminution in the cooling qualities of the second radiator has been found, doubtless due to the spiral motion of the slipstream behind the forward propeller. Flight with one engine stopped is facilitated by the possibility of using both radiators for the same engine. The tests with this device were very conclusive.

The Viet and Schneebeli starter is used, but the small auxiliary Bristol engine, which is employed when the seaplane is at rest to drive the 1200 watt generator, can also be used for starting. The interposition of a free Sensaud de Lavaud wheel between the windmill and auxiliary engine controls of the generator makes it possible to pass readily from one manner of starting.

All the controls are rigid and mounted on ball bearings. Between any two joints they rest on only two supports, in order to obtain straight shaft lines in case of deformation of the framework.

Not only the engines, but all the flight controls (Fig. 15), all the pipes and even the radio generator are accessible during flight. For example, the fuel pipes (Figs. 16-17) pass through a central control and inspection box accessible to the mechanic and then continue through the vertical shaft leading to the engines. The water and oil pipes can likewise be inspected during flight.

C h a r a c t e r i s t i c s

Span	26.20	m	85.96	ft.
Length	18.50	"	60.70	"
Height	6.25	"	20.51	ft.
Wing area	105	m^2	1130.21	sq.ft.
Weight empty	4400	kg	9700	lb.
Full load	7230	"	15939	"

Translation by Dwight M. Miner,
National Advisory Committee
for Aeronautics.

Legends for Figures

Fig. 1.- General arrangement of the "Le 0.240" commercial seaplane.

Fig. 2.- "Le 0.240" on truck, showing verticality of hull and location of floats.

Fig. 3.- "Le 0.240" on water, showing opening to shaft under engines.

Fig. 4.- "Le 0.240" taking off at Antibes.

Fig. 5.- "Le 0.240" on truck, showing graceful shape of bow.

Fig. 6.- Spar connections. The parts designed to be encased in one of the spars are shown in the upper right-hand corner screwed to the ball-and-socket joints.

Fig. 7.- Plan and vertical section, showing junction of end portion of spar with central portion.

Fig. 8.- Deformation, during flight, of tank rigidly attached to leading edge of wing.

Fig. 9.- Liore-Olivier method of attachment: 1, Fitting to protect spar; 2, Rubber to prevent vibrations (Similar protecting pieces are used at the base of the spar.); 3, Tank; 4, Wall of tank to which is fitted the piece 11 held externally by the nut 10, with the interposition of a metal washer and a gasket 7; 5, Duralumin guide integral with spar. The guide enables sliding, parallel to neutral axis of spar, of the steel plate 6, which supports the bolt of fixation 9. This bolt, of 35 mm diameter, is screwed firmly into the piece 11 and secured on the rear side of the spar by the supporting collar 8 and a brake bolt.

Fig. 10.- Aileron attachment (inverted).

Fig. 11.- Central part of aileron.

Fig. 12.- Longitudinal section of hull. From bow to stern: shock compartment and anchor, navigator's seat, seat for two pilots, radio outfit, the cabin 3.95 x 2.2 x 1.85 mm (12.96 x 7.22 x 6.07 ft.), normally equipped for ten passengers, toilet and baggage room. Note the small water propeller toward the stern.

Fig. 13.- Tail surfaces: 1 and 10, upper and lower parts of rudder; 2, stabilizer; 3, elevator; 4, prolongation of fin between two halves of elevator; 5, bell crank of elevator control; 6, elevator control; 7, auxiliary fin controlled by rod 11; 8, auxiliary stabilizer controlled by rod 9, the length of the latter rod (attached to the same bell crank as 6) being adjustable in flight, so that the different positions of the auxiliary stabilizer will correspond to equal "or no) deflections of the elevator; 12, Y strut; 2, stabilizer; 3" and 3, right and left parts of elevator; 3', prolongation of stabilizer.

Fig. 14.- Parts of engine mount. The exterior sliding semicylindrical cowling of 10/10 sheet metal is lacking.

Fig. 15.- Accessibility of controls. The controls are grouped in two channels A on both sides of a passageway 7 m (23 ft.) long and about 1 m (3.28 ft.) high, through which the mechanic can easily crawl. This passageway extends above the pilot room, passenger cabin, toilet and baggage rooms. Aft of the last bulkhead B, the controls are arranged along the walls of the hull and can be inspected by the mechanic standing.

Fig. 16.- Fuel system. This figure does not show, in the vicinity of the mechanic's instrument board, the drain cock permitting the emptying of half the fuel, the cock for the total emptying of both tanks, the two levers for cutting out the pumps (the pumps of each engine being cut out by a single lever), and the two distance-controlled indicator cocks on the pipes of the mechanically operated pumps.

The arrangement in the vicinity of the board being practically symmetrical, the references are given only for the left side: 1, pipes going to the port pumps; 2, cock with distance control, at tank outlet; 3, pipes going from port pumps to starboard filter; 4, filter cock; 5, indicator cocks on intake of left pumps; 6, manometer; 7, Zenith filter; 8, hand pump for starting and for emergencies. The Zenith filters are demountable during flight. By closing the cock of the right-hand tank and the forward cock 4, the filter 7 is completely isolated and can be cleaned. The hand pump delivers fuel for priming the mechanically driven pumps. It also serves as an emergency pump.

Fig. 17.- Control board of fuel system. The hatched areas represent plates containing instructions for the mechanic. 1, air pipe with orifices communicating with the inside of the box, draining the condensed fuel vapors toward 9; 2, 4, 5, 7, origin of intake pipes running to the forward starboard pumps, after starboard, forward part, after part; 3 and 6, Le Bozec and Gautier fuel-circulation indicators in the four inlet pipes; 8, one of the four milled nuts for closing the cover; 9, end of air pipe; 10, fuel inlet for hand pump; 11, inlet for filtered fuel controlled at the top by an indicator cock; 12, collector with clap valves; 13, 14, 16, 17, indicator cocks on each intake pipe; 15, intake pipe for hand pump; 18, delivery of filtered fuel (filter at right of figure), likewise controlled at the top by an indicator cock. The control box for the fuel circulation is closed by a cover held by four milled nuts. Rubber gaskets insure the tightness of the cover and of all the openings for the passage of the pipes and controls.

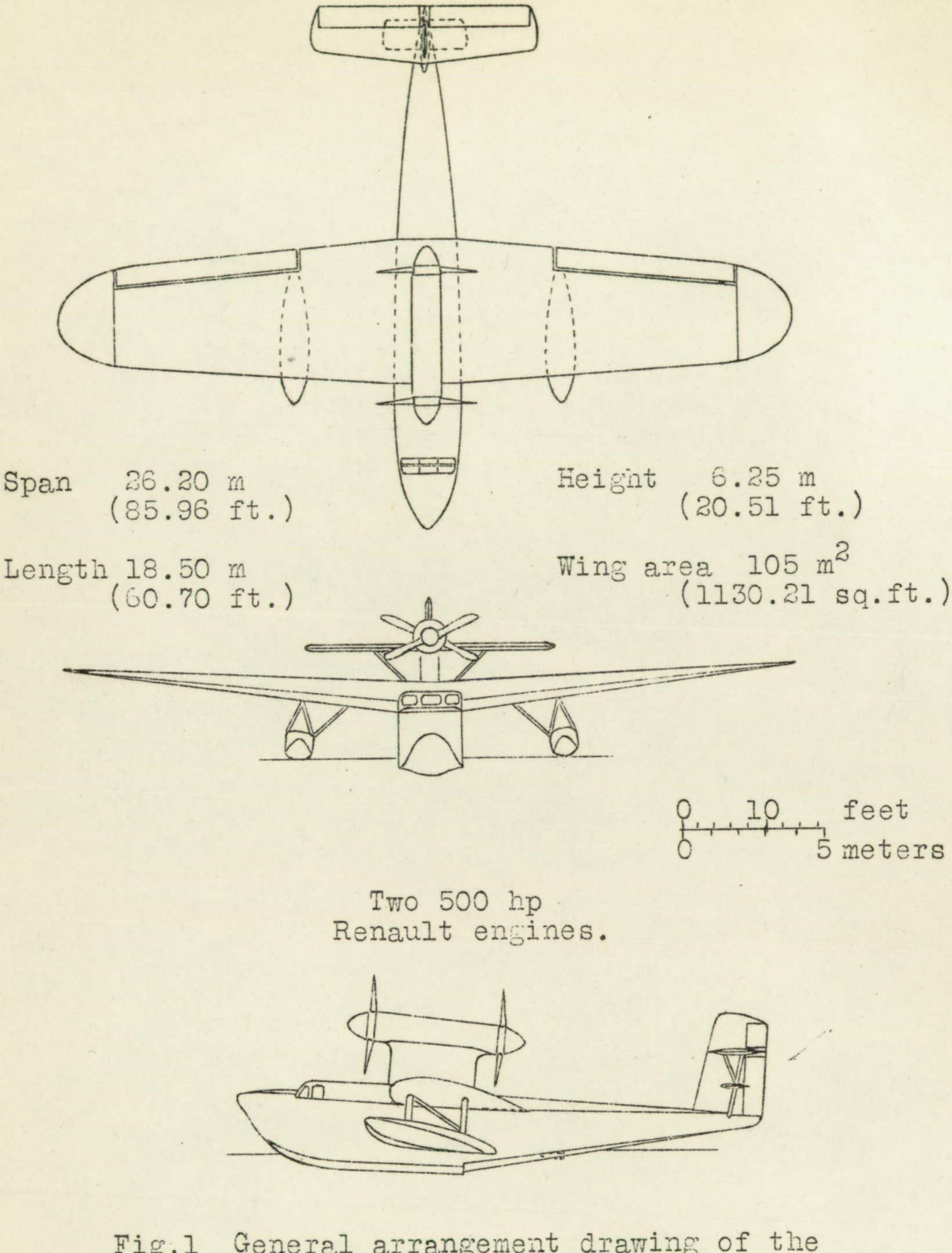


Fig.1 General arrangement drawing of the "Le O 240" seaplane.

Views of the "Le O 240" seaplane.

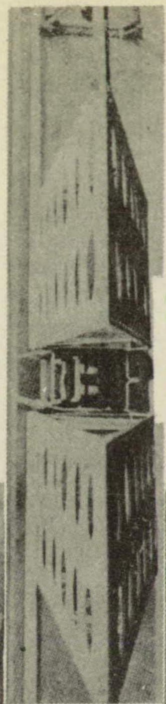


Fig.11

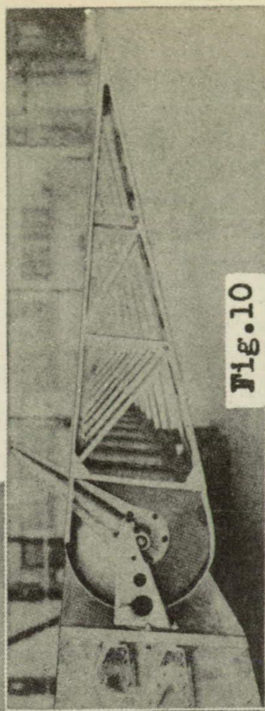


Fig.10

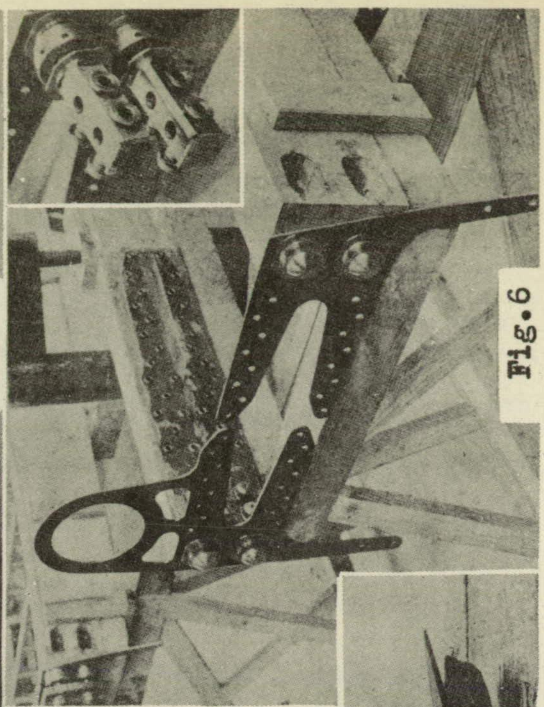


Fig.6

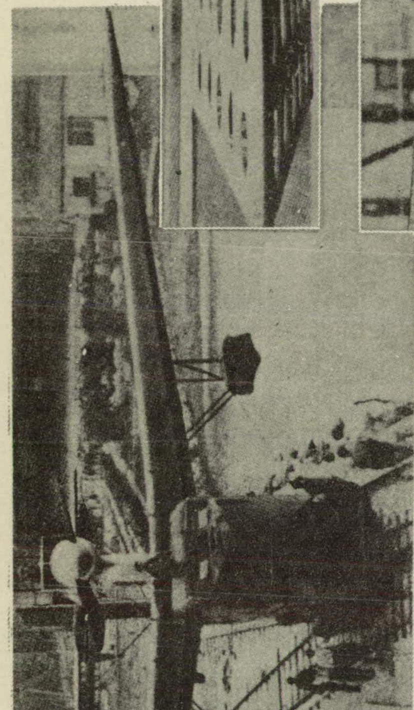


Fig.2

Fig.3

Fig.5

Fig.4

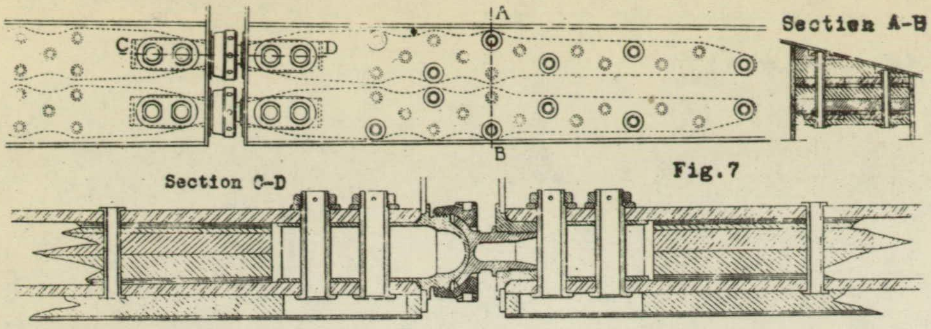


Fig.7

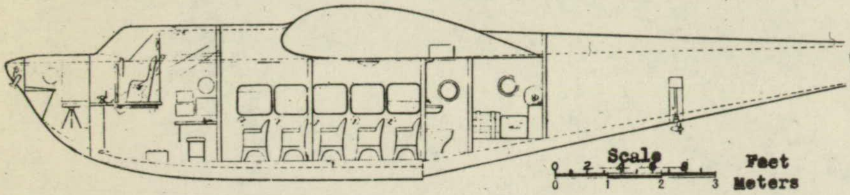


Fig.12

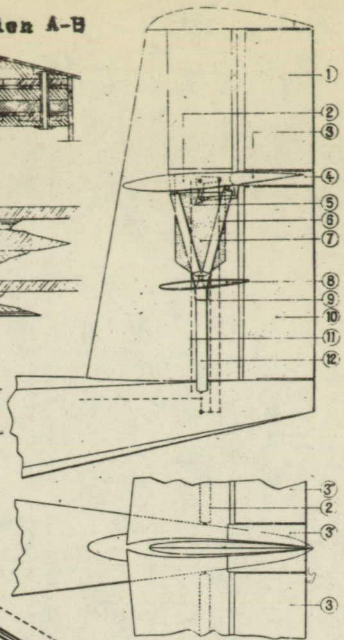


Fig.13

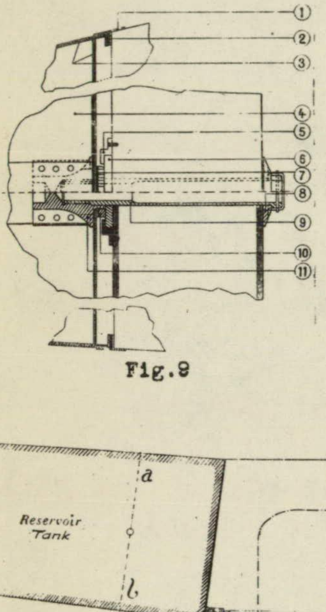


Fig.9

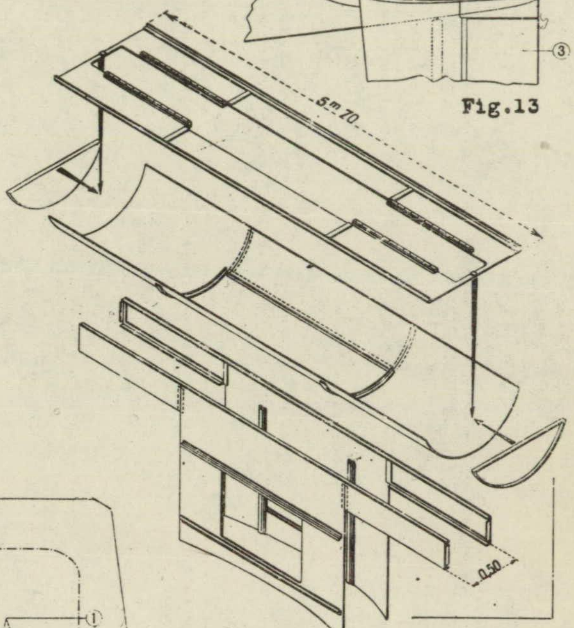


Fig.14

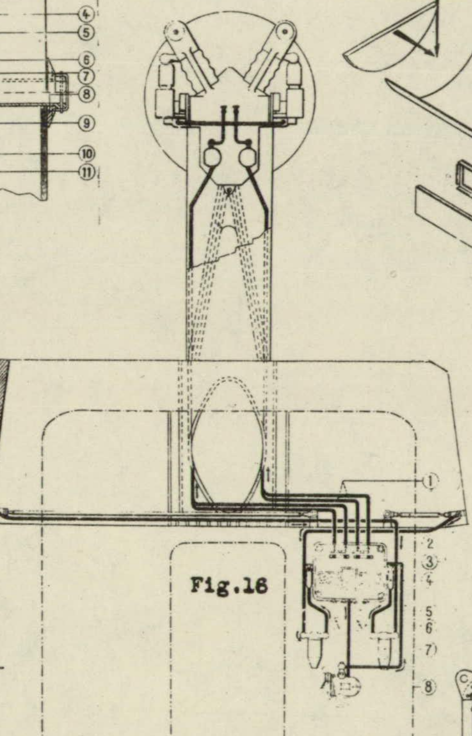


Fig.16

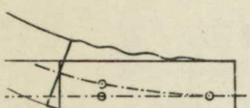


Fig.8

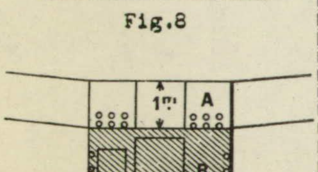
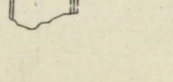


Fig.15

Section a-b of Fig.17



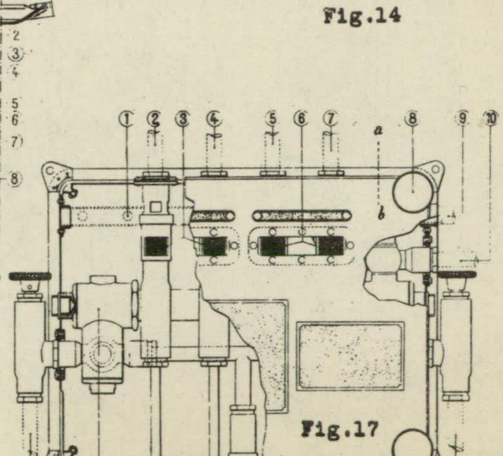


Fig.17

Structure and diagrams of the "Le O 240" seaplane.