THE

"CALCUTTA"

ALL-METAL FLYING BOAT FOR PASSENGER SERVICE.

Designed and Constructed by SHORT BROTHERS (Rochester and Bedford), LTD.,
SEAPLANE WORKS, ROCHESTER.

A General Description of the Aircraft,
Extracts from Official Test Flight Reports
and
Reprint from "ENGINEERING," August 17, 1928.

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SHORT BROTHERS (Rochester and Bedford), Ltd.
Seaplane Works,
Rochester.

July, 1929.

The "Calcutta" Flying Boat.

The "Calcutta," fitted with three Jupiter IX Engines, has been primarily designed for long-distance Empire sea routes, and at present three machines are being operated by Imperial Airways on the England-India air route from Genoa to Alexandria. These boats have proved extremely satisfactory, the air performance being a distinct advance on any previous types. The outstanding feature of these boats, however, is their excellent performance on the water, as shown in the Royal Air Force report on the type tests. The large degree of automatic stability which characterises the "Singapore," is also present in the "Calcutta," and the aircraft can be flown for long periods "hands off."

Although the "Calcutta" is fully equipped to allow of the maximum of comfort for the crew, being fitted with a buffet and cooking stove, pressure flushing lavatory and wash-basin, &c., the ratio of the total useful load to the all up weight is 43 per cent., which is a particularly high figure for the type of aircraft.

The payload plus crew is 3·34 lb. per normal horse-power after carrying sufficient fuel (490 gallons) for a range of 650 miles.

The aircraft is constructed entirely of metal, duralumin being largely employed in conjunction with stainless steel fittings, the whole structure being extremely robust in design.

The main cabin is particularly roomy and has accommodation for 15 passengers, who are arranged in rows of three abreast. Comfortably upholstered chairs are provided also constructed of metal and fitted with pneumatic cushions and back-rest, so designed as to permit of them being used as lifebelts in the case of emergency. Each chair is also fitted with a cushioned headrest and a collapsible folding table. The seats and the lower sides of the cabin are furnished in royal blue leather, and the roof is lined with buff felt, the remaining part of the interior being finished with white enamel.

The sides of the cabin are fitted with large plate glass windows giving an excellent view to each passenger, four of which windows being arranged to open.

For ventilation a duct is fitted on the underside of the cabin roof communicating to cowls fitted on the outside of the cabin roof, the supply of fresh air being regulated by valves fitted on the inside of the duct.

Facilities are provided for the carrying of a steward, a fully-equipped buffet being provided complete with oil cookers and ice chest enabling the dispensing of either hot or cold refreshments *en route*.

The lavatory compartment is situated aft of the main cabin, and is fitted with a folding wash-basin and an adequate supply of water for drinking, washing and flushing services.

The aircraft is fully equipped with wireless, both transmitting and receiving, the Marconi A.D.8 set being installed which has a normal transmitter range for telephony of about 250 miles.

The engines fitted in aircraft already constructed are Bristol Jupiter IX Geared 2–1, but any other similar engines can be fitted, for example, the Armstrong Siddeley, "Jaguar," or Wright "Cyclone."

The maximum permissible weight for which a British Certificate of Airworthiness would be granted has been increased to 22,500 lb. (10,235 kgs.) made up as follows:—

Weight of aircraft ready to take payload plus crew ...	17,640 lb.	8,030 kgs.
Payload plus crew	4,860 ,,	2,205 ,,

The undermentioned fuel, oil, and equipment is included in the above tare weight of 17,640 lb. (8,030 kgs.).

Fuel.—Two tanks of 70/30 petrol S.G. 78, each of 245 gallons. Total, 490 galls.

Oil.—Three tanks, each containing 12 galls. Total, 36 galls.

Water—

Drinking water tank, filled	4·5 galls.
Washing or general service tank, filled	14 ,,
Lavatory flushing tank, filled...	3 ,,

Cabin and Cockpit Equipment and Instruments.

5 double chairs, complete with collapsible tables, cushions and covers.
5 single chairs complete with collapsible tables, cushions and covers.
1 Steward's seat, complete with cushion and cover.
4 Pyrene fire extinguishers and brackets.
Usual dashboard instruments.
Aneroid—airspeed indicator—clock in main cabin.
3 recording Tel-tachometers.
Navigator's compass.
Buffet.
Lavatory, complete, with pressure flush tank.
Wash-basin (folding), complete with tank.
Towel box.
Duplex " Primus " oil stove.

Miscellaneous Equipment.

Marconi A.D.8 transmitting and receiving set, complete with chain belt and pulley for emergency gear.
Lighting set for all services.
Riding light.
Cockpit cover.
3 engine covers, complete with stowage bag.
1 hand bilge pump, complete with hose and fittings.
2 Drogues and lines, complete with stowage bag.
1 Mooring pennant.
1 Boat hook and line.
Bristol engine gas starter unit.
Engine hand turning gears.
Engineer's ladder and fittings for engineer's platform.
Yarmouth towing gear.

Performance of Aircraft with Jupiter IX Engines, based on Official Type Trials.

Maximum speed	123 m.p.h.	198 km.p.h.
Minimum speed	60 m.p.h.	96·7 km.p.h.
Rate of climb, sea level	610 ft.p.m.	186 m.p.m.
Absolute ceiling	13,000 ft.	3,970 m.
Time to 10,000 ft. (3050 M)	30 min.	—
Time to take off, flat calm	24½ secs.	—
Range at 95 m.p.h.	650 miles.	1,045 kms.

EXTRACTS FROM ROYAL AIR FORCE OFFICIAL TEST REPORT.

Speed at 5,000 ft. (1,525 metres)	103·8 knots (193 km.).
Rate of climb G.L.	710 ft. per minute (216·5 metres per minute).
Service ceiling	12,650 ft. (3,860 metres).
Absolute ceiling	14,700 ft. (4,480 metres).
Time to take-off with load of 20,817 lb. (9,470 kg.) ...	18·5 seconds.
Ditto with load of 23,500 lb. (10,680 kg.)	29 seconds.
Ditto with load of 24,000 lb. (10,900 kg.)	32 seconds.

"The performance of the aircraft is good, *taking off easily with the two outboard engines only* with no tendency to porpoise in any condition of take-off, the clean and effortless take-off being an outstanding feature of the design of the hull."

"In respect of air mileage per gallon the "Calcutta" compares favourably with other boat seaplanes of similar rating."

"At slow speeds there is no tendency to drop a wing, and the elevator control begins to be ineffective before the aileron control, which is considered a good feature for an aircraft of this type."

"The maintenance of the aircraft is particularly easy, and the accessibility of parts for adjustment and maintenance, in general, is very good."

"The engine installation is good and both magnetos and carburettors are readily accessible."

"The official flight tests revealed no serious defects of either design or construction."

"The windscreening is so good that there is no need for the pilot to wear goggles for ordinary flying."

"The manœuvrability on the water is exceptionally good and in reasonably calm conditions the aircraft is clean at all speeds, the take-off being very easy if the tail is trimmed fully back. On opening up the engines the forward acceleration is remarkably good, and the step position is quickly reached."

"The following remarks concern the stability of the machine :—

Longitudinal stability	Good at top speed, cruising speed, slow speed, and gliding.
Lateral stability	Good at all speeds.
Directional stability	Good at all speeds.

Stability on the Water.

Lateral (static)	Adequate wing-tip float buoyancy.
Longitudinal (dynamic)	Excellent."

Note.—As the above official report states, the "Calcutta" takes off with full load, easily with one engine stopped. Actually it has taken off the water in almost calm air with an overload of 300 lbs., *i.e.*, total weight 21,117 lbs., in 42 seconds. This is a record for a flying boat and proves that in flight the machine has ample power with one engine stopped.

Reprinted from "ENGINEERING," August 17, 1928.

THE SHORT ALL-METAL FLYING BOAT FOR PASSENGER SERVICE.

It will be remembered that a remarkable flight from this country, across Africa and back along the west coast of that continent, was made by Sir Alan Cobham and Lady Cobham, with a crew of four persons, in a Short all-metal flying boat equipped with two Rolls-Royce Condor engines, the flight in which a distance of some 20,000 miles was covered, having been completed as recently as May 31 last. The machine used, named "Singapore," was designed by Messrs. Short Brothers (Rochester and Bedford), Limited, Rochester, mainly for naval work, and its performance during the flight referred to is ample evidence of its suitability for this service. A generally similar machine, named "Calcutta," has been designed by Messrs. Short Brothers for commercial work, the power plant in this case consisting of three Bristol Jupiter Series IX geared aero-engines, each developing 485 h.p. at 2,000 r.p.m., or 525 h.p. at 2,200 r.p.m. Two of these machines have been ordered by the Air Ministry for operation by Messrs. Imperial Airways, Limited, and one of them, which was completed and launched on February 13 last, has since then carried out a considerable number of trial and experimental flights over the Channel and elsewhere, during which, we understand, its performance has been entirely satisfactory to all concerned. As we believe the "Calcutta" is the first all-metal flying boat of British design and construction to be completed for commercial work, the particulars and illustrations of it, which, by the courtesy of Messrs. Short Brothers, we are able to give below, should be of considerable interest to engineers.

Photographs of the machine, taken just before, and immediately after, the launch, are reproduced in Figs. 1 and 2, on pages 6 and 7, and from these a good idea of its appearance can be obtained. Figs. 3, 4 and 5, on pages 8 and 9, however, illustrate its general arrangement more clearly. Before commencing a detailed description of the machine we should, perhaps, first explain that the designer's aim has been to produce an aircraft in which comfortable travelling conditions for the passengers are combined with the maximum degree of safety. As already stated, the machine is fitted with three engines, and as it is capable of flying easily with only two of these in operation, the possibility of a forced landing, with its attendant risks, is comparatively remote. The adoption of metal construction, giving, as it does, a more reliable and accurate structure, also tends to greater safety over a long period of service, as well as to increase the commercial efficiency by enabling a greater paying load to be carried for a given total weight. The flights so far carried out have shown the machine to be inherently stable in all directions, and have also demonstrated that it is easy and comfortable to fly, all the control surfaces being balanced, and the ailerons being of the non-yawing type. We shall deal with the control arrangements later, but may now mention that the single rudder used is operated by a small trailing servo-rudder, visible in Figs. 2 and 4, which greatly reduces the effort required to operate that member, and tail-adjusting gear is provided, which enables the pilot to fly the machine with his hands off the control stick at all speeds within its flying range.

The main dimensions of the machine are as follow :—Span of upper main plane, 93 ft.; span of lower main plane, 76 ft. 6 in.; chord of both planes, 11 ft. 6 in.; overall length of machine, measured over servo-rudder, 64 ft. 9 in.; and height overall 22 ft. 3 in. The weight of the machine empty is 12,404 lb., and the corresponding figure for the fully-loaded condition is 20,000 lb., so that the weight of the load carried is 7,596 lb. This includes 15 passengers and a crew of three, with the necessary allowance for food, water and baggage, wireless and electrical equipment, instruments, cooking equipment, &c., together with 320 gallons of petrol and 30 gallons of oil. The quantity of petrol and oil mentioned is sufficient for a flight of 6·4 hours' duration, or a distance of 500 miles, but the tanks provided are capable of holding 480 gallons of petrol and 45 gallons of oil, which would enable the machine to fly for 10 hours and cover a distance of 760 miles. Its maximum speed at sea level is 125 m.p.h., and the cruising speed, also at sea level, is 100 m.p.h., while the landing speed is 57·5 m.p.h. The rate of climb at sea level is 730 ft. per minute, and the service ceiling is 12,650 ft.

Including the ailerons, which have a total area of 150 sq. ft., the area of the main planes is 1,825 sq. ft., so that the wing loading, in the fully-loaded condition, is 10·95 lb. per square foot. The horse-power loading, when each engine is developing 525 h.p., is 12·7 lb,

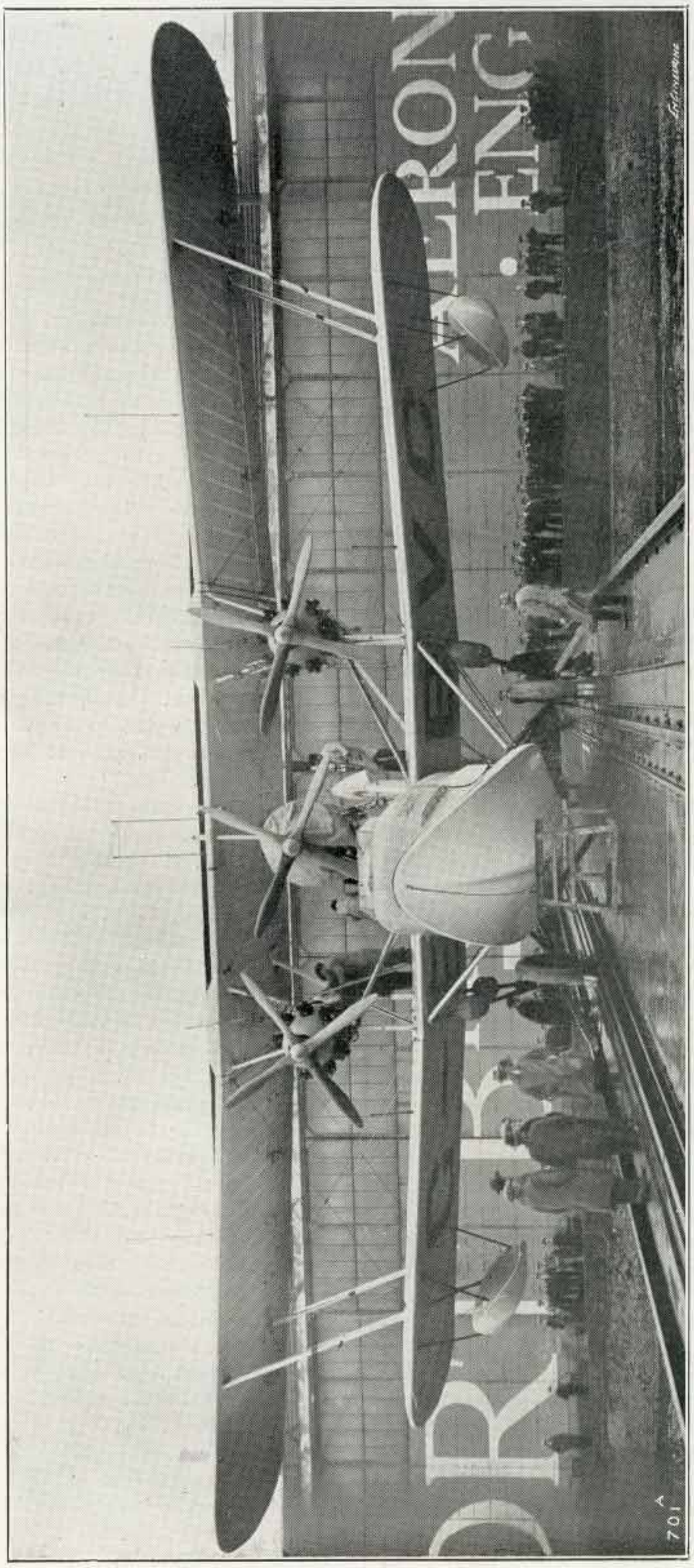
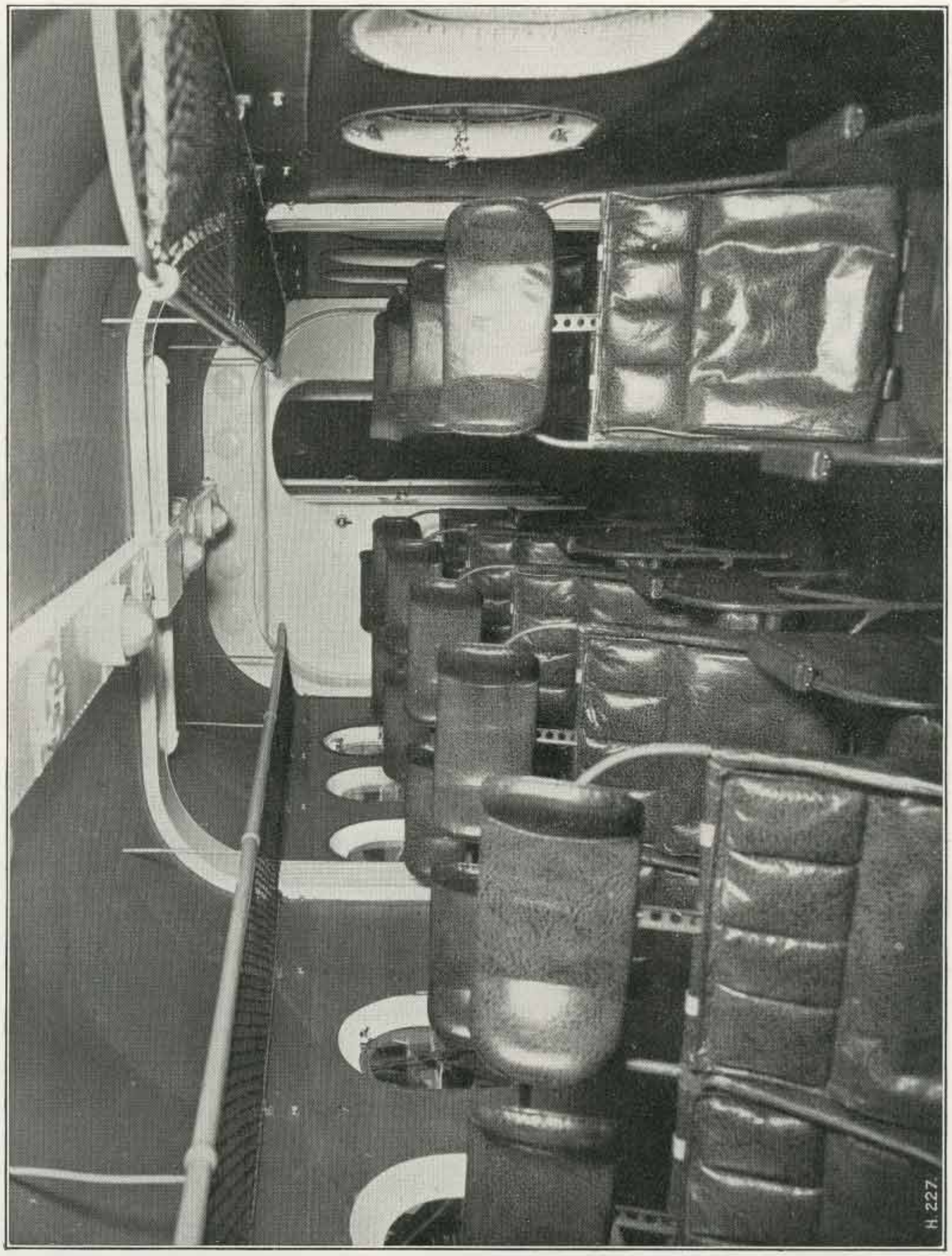


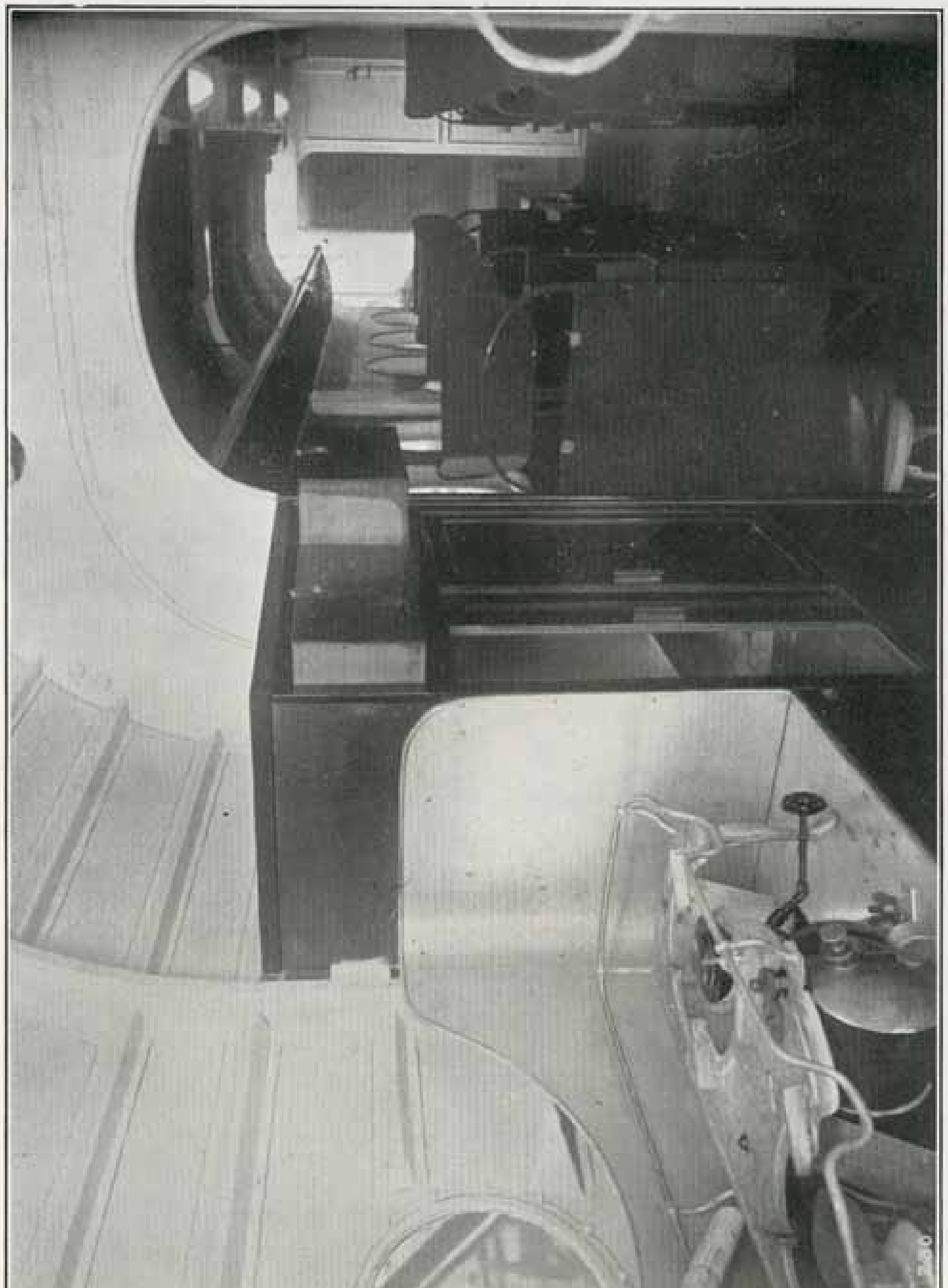
FIG. 1. AIRCRAFT ON LAUNCHING SLIPWAY.

"CALCUTTA" COMMERCIAL FLYING BOAT.



INTERIOR OF CABIN LOOKING AFT.

"CALCUTTA" COMMERCIAL FLYING BOAT.



Buffet and Stewards Compartment with View of Cabin, Looking Forward.

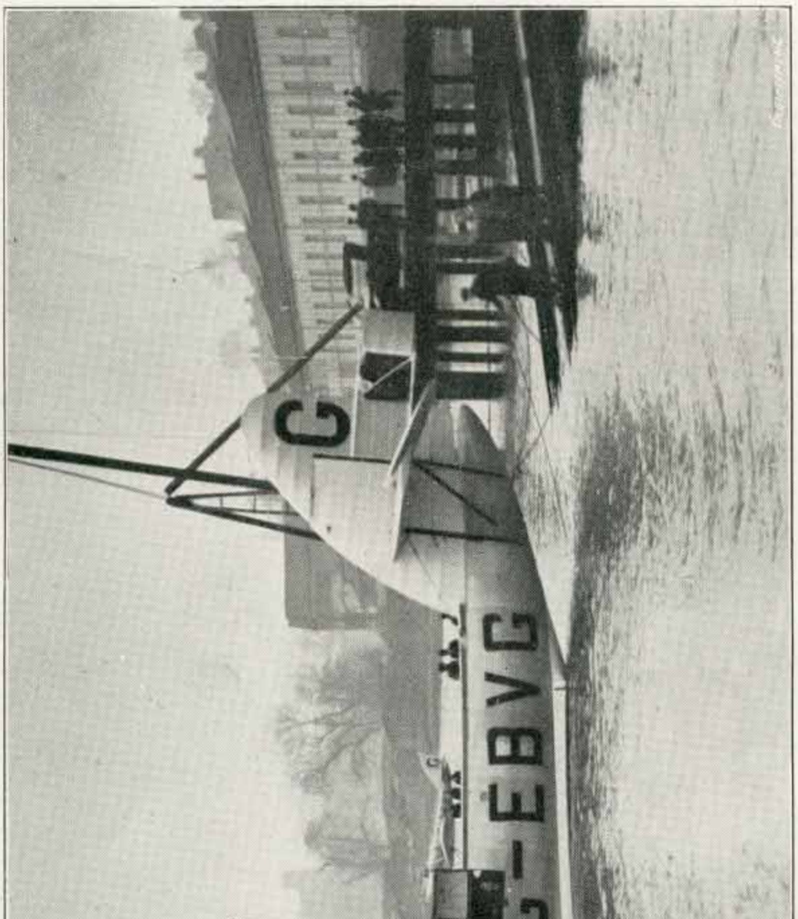
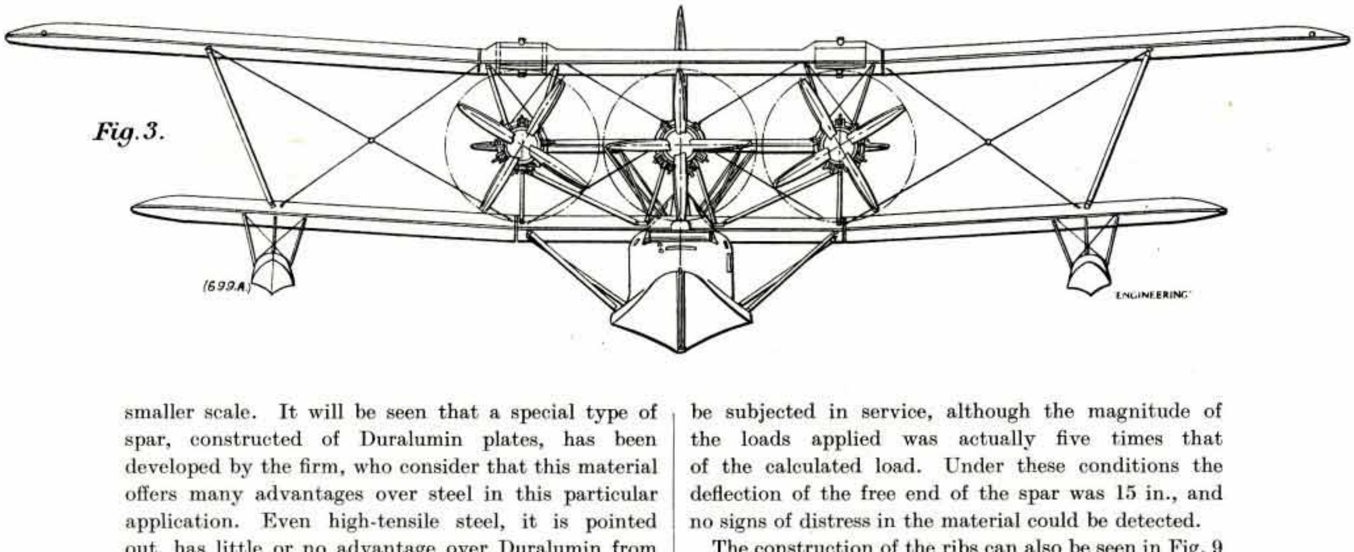


FIG. 2. AIRCRAFT AFLOAT AFTER LAUNCHING.

per horse-power, under the same condition of loading. A particularly interesting feature of the design of the machine is the construction of the wings, for which Duralumin is mainly employed, although the spar fittings are of stainless steel and the usual doped fabric covering is largely employed for the surfaces. In the case of the lower wing, however, the greater part of the centre section is covered with Duralumin sheet to provide a platform on which the crew can stand while attending to the engines, &c., and a walking way is also provided along the outer sections of this wing to enable the wing-tip floats to be reached. The wing, it may be added, is specially stiffened at these points to permit several men to stand upon its surface. Fig. 9 on page 11, shows one of the outer sections of the upper plane completed except for the fabric covering, and Fig. 10, on page 12, shows the construction of both wings to a smaller scale. It will be seen that a special type of spar, constructed of Duralumin plates, has been developed by the firm, who consider that this material offers many advantages over steel in this particular application. Even high-tensile steel, it is pointed out, has little or no advantage over Duralumin from the point of view of weight, while the latter material is easier to work, and is also less liable to local injury on account of the greater thickness necessarily employed.

Sections of the spar are given in Figs. 11, 12 and 13 on page 13. They are built up of corrugated web plates with flanges of approximately semi-circular section, the flanges and webs being connected by riveting as shown. These plates are pressed to the required form, using metal-faced hardwood formers in a hand-operated screw press, and afterwards finished by rolling between form rollers. The number of plates used in the webs and flanges depends upon the bending moment to be resisted at any point in the length of the spar, but the plates used are all of No. 18 gauge thickness. Figs. 11, 12 and 13 show how the strength of the spar is varied according to requirements, Fig. 11 showing the section at the junction end of the wing, Fig. 12 that near the inter-plane strut, and Fig. 13 that near the outer end. The method of tapering off the outer end of the spar is illustrated in Figs. 14 to 16 on page 13. This type of spar, it should be mentioned, is sufficiently stable to require no internal diaphragms, and is also particularly strong in torsion. A photograph of a bending test on a spar is reproduced in Fig. 8 on page 10, which, it should be explained, is a "phantom" photograph showing the spar both before and after the application of the load. In this test, the end of the spar at the left of the illustration was fixed, and the other end free, while loads were applied at each of the points at which the ribs are connected in the built-up wing. The loads from the interplane strut and the bracing wire were applied by means of a channel bar and a pair of steel strips, which can be seen near the top left-hand corner of the figure, so that the arrangement of the loading was exactly similar to that to which the spar would be subjected in service, although the magnitude of the loads applied was actually five times that of the calculated load. Under these conditions the deflection of the free end of the spar was 15 in., and no signs of distress in the material could be detected.

Fig. 3.



The construction of the ribs can also be seen in Fig. 9 on page 11, but reference must be made to Figs. 17 to 27 on page 14, in order to follow the details. The standard ribs are composed, as shown, of top and bottom booms of Duralumin tubing, with lattice bracing of the same material. Between the lattice bracing, it will be seen from Fig. 17, channel sections are fitted, but these are used only at certain parts of the lower wings, where walking ways are provided, in order to prevent the booms from being distorted by the application of concentrated loads between the bracing points. The booms and bracing tubes are connected by clips and hollow rivets, as is perhaps most clearly shown in Figs. 24 and 25, but Figs. 20 to 23 show the methods of connecting the channel sections above referred to, while Figs. 18 and 19 illustrate the connection of the rib to the front and rear spars, respectively. Details of the trailing edges of the standard and short ribs, respectively, are illustrated in Figs. 26 and 27. One of the drag struts is clearly shown in Fig. 9 on page 11, and drawings of one of these members are given in Figs. 28 to 30, from which their construction will be clear. They are composed of two Duralumin plates bent and also formed of Duralumin tubing with fairings of the same material, but their construction does not call for any particular comment.

Fig. 4.

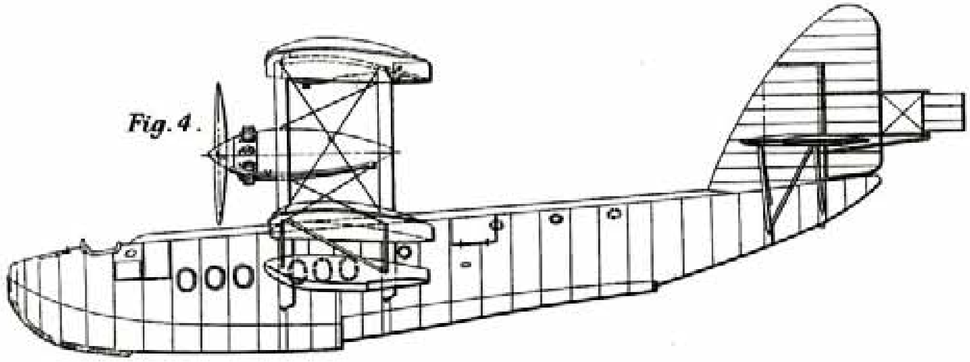
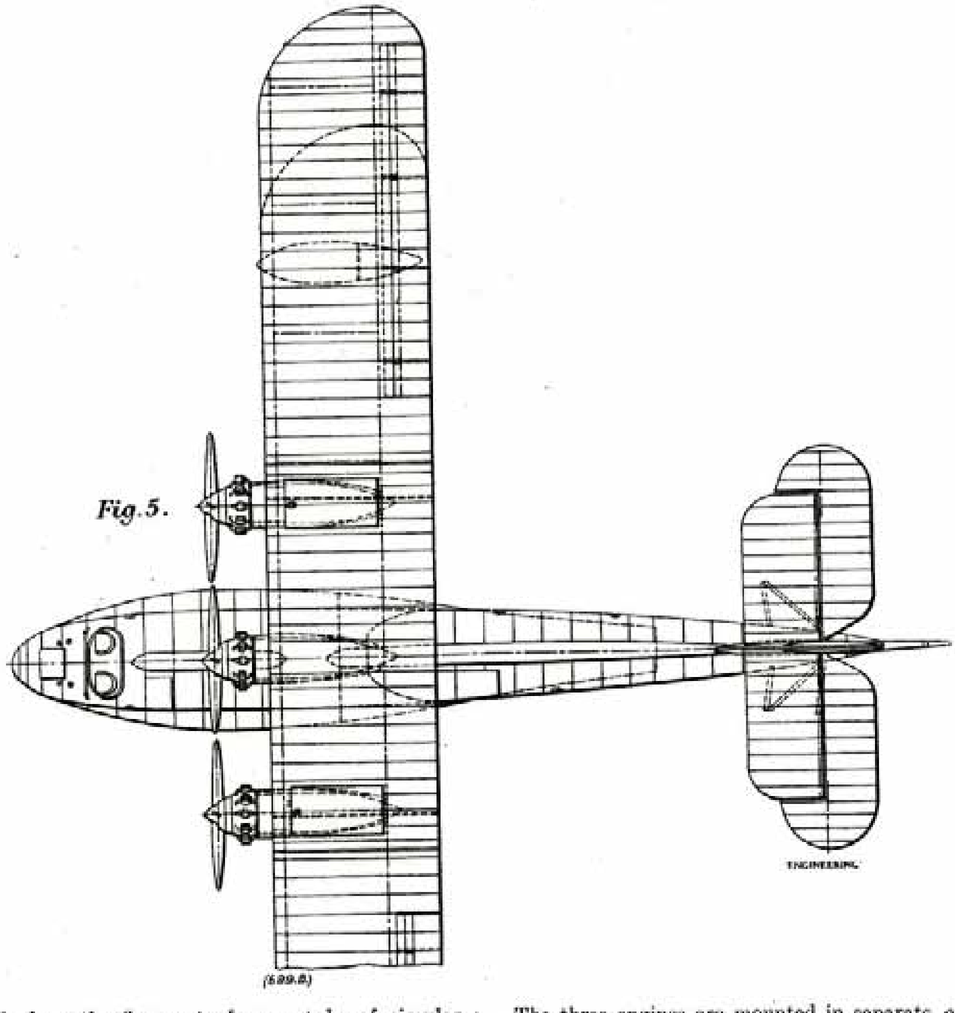


Fig. 5.



riveted along the flanges to form a tube of circular section, as shown in Fig. 30, tapered plates, of the same material, being riveted in at the ends to make the connections with the spars. The interplate struts are

The three engines are mounted in separate nacelles attached to the wing spar by three radial struts at each end, tangential struts being also inserted, as shown in Fig. 1, to take the torque. The nacelles can be seen in position on the structure, before the engines had been mounted, in Fig. 10 on page 12, and they are also shown separately in Fig. 56 on page 20. In the latter illustration, the engine-mounting plates, which form the forward ends of the nacelles, can be seen in position, in the case of the nacelle in the foreground, and resting on the floor in front of the other two nacelles. Drawings of one of the nacelles are given in Figs. 31 and 32 on page 16. The torpedo-shaped bodies are formed of Duralumin sheets with angle-shaped circumferential frames and longitudinal stiffeners of triangular-trough section. One of the frames is shown in section in Fig. 33, and this figure, together with Fig. 34, illustrates the method of riveting the stiffeners to the sheeting. Openings in the nacelle bodies are provided, as shown, so that all parts of the engine are readily accessible, and minor adjustments can be made on flight. The construction of the engine plates can be followed from Figs. 35 to 39, on page 17, with but little explanation. They are built up, as shown

Fig. 6.

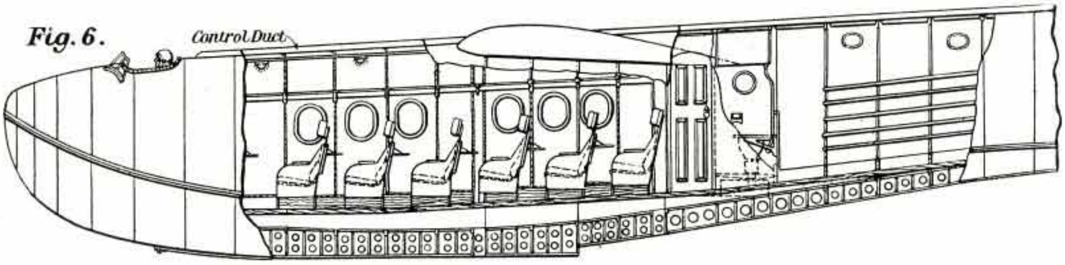
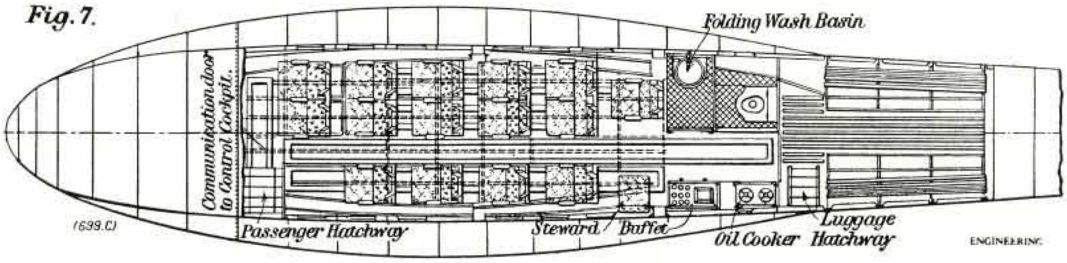


Fig. 7.



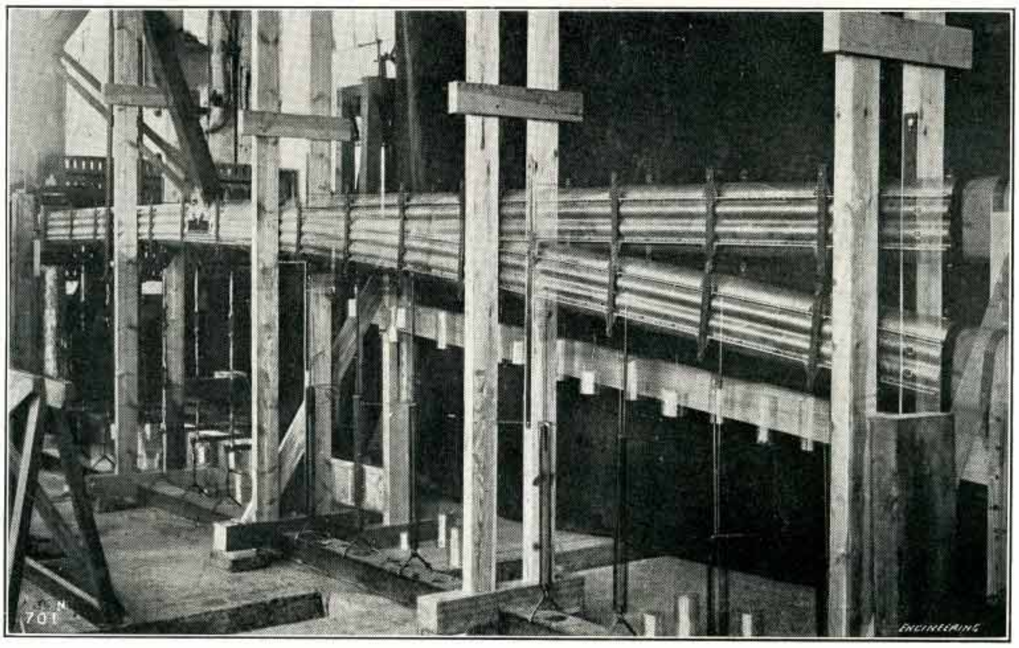


FIG. 8. "PHANTOM" VIEW OF SPAR TEST.

Fig. 9. Wing Section Completed Except for Fabric Covering.

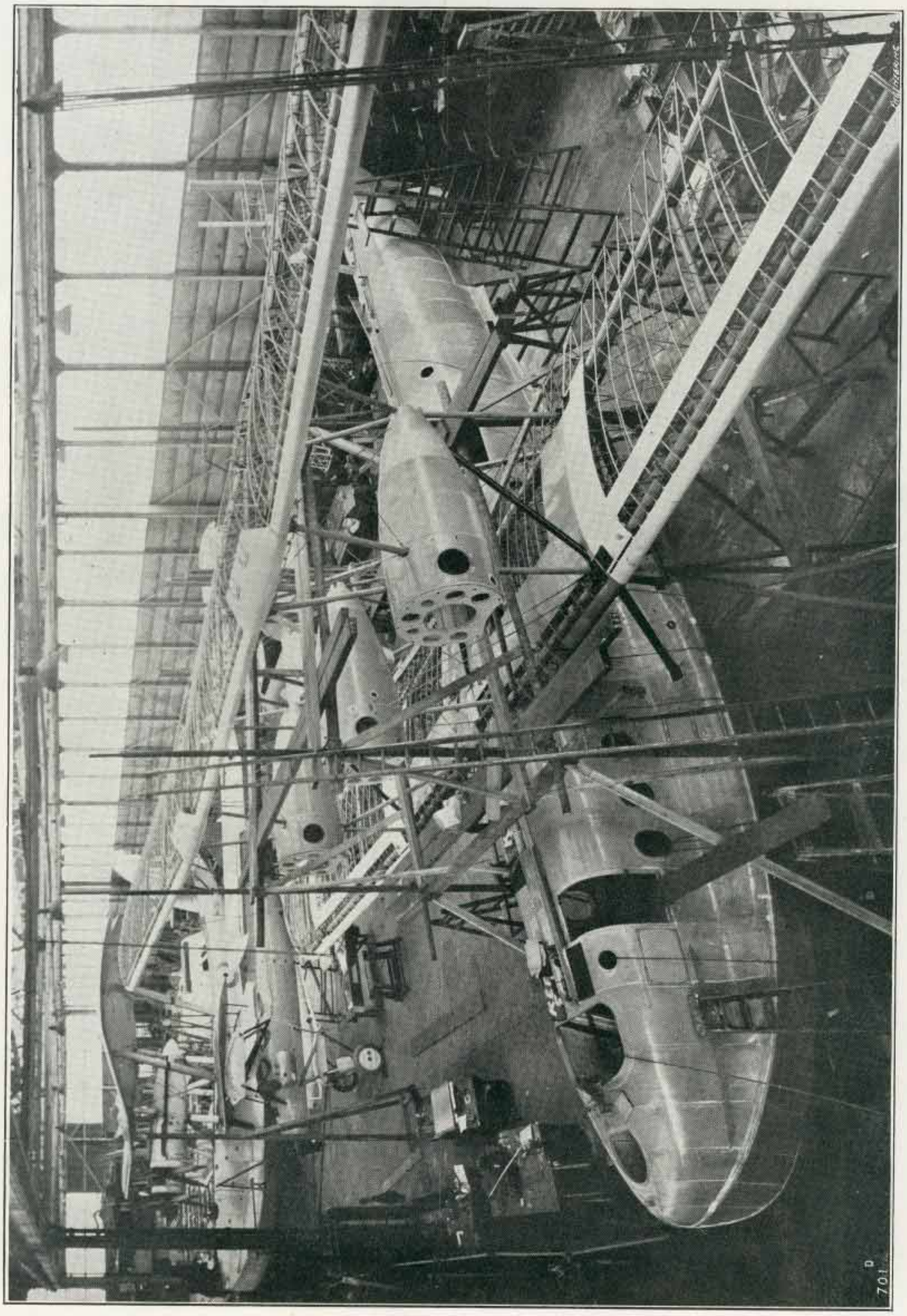
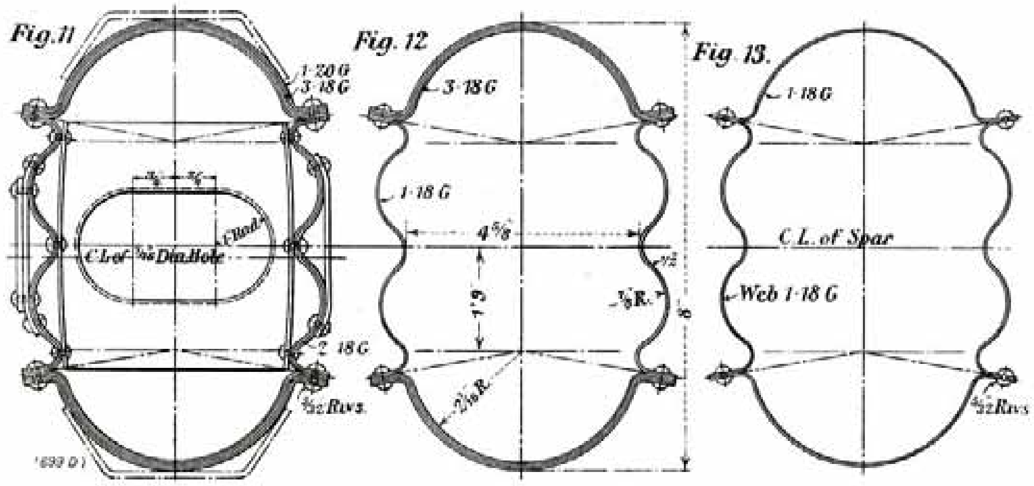
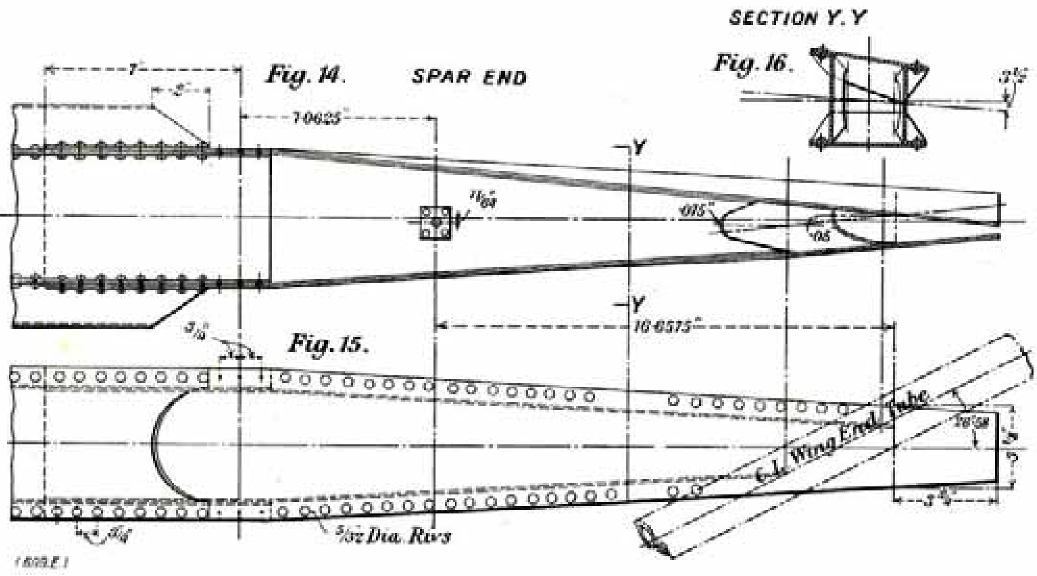


FIG. 10. COMPLETE AIRCRAFT IN COURSE OF CONSTRUCTION.

of two 10 S.W.G. Duralumin plates, spaced at a distance of 1 in. apart and held together by channel sections round the outer edges, round the central opening, and also round the access holes. Sections through the inner and outer channels are given in Figs. 36 and 37, respectively, and Fig. 38 is a detail





drawing showing the method of fixing the distance pieces which are located as shown in Fig. 35. Bosses are provided for the bolts by which the engine is fixed to the mounting plate, and details of one of these are given in Fig. 39, on page 17.

In connection with the engine installation it should be mentioned that a Bristol gas starter is fitted in the centre nacelle and connected to all three engines. The starting engine has been arranged to drive a bilge pump and an electric generator, which can be used for lighting and wireless services when the main engines are not running; in flight, the generator is driven by a small airscrew located in the slipstream. The oil tanks, which have an aggregate capacity of 45 gallons, are also fitted in the nacelles and connected up to external oil coolers. The petrol is carried in two tanks, each having a capacity of 240 gallons, fitted in the upper wing above the outer nacelles as indicated in Fig. 3, on page 8. This arrangement enables the engines to be fed by gravity and obviates the necessity for employing petrol pumps. All three engines can be supplied from either of the tanks, and the petrol cocks on the engines, in both the "on" and "off" positions, are controlled by the pilot. Emergency cocks are also fitted on the tanks and arranged so that they can be turned off by the pilot in the event of the breakage of a pipe. Four-bladed

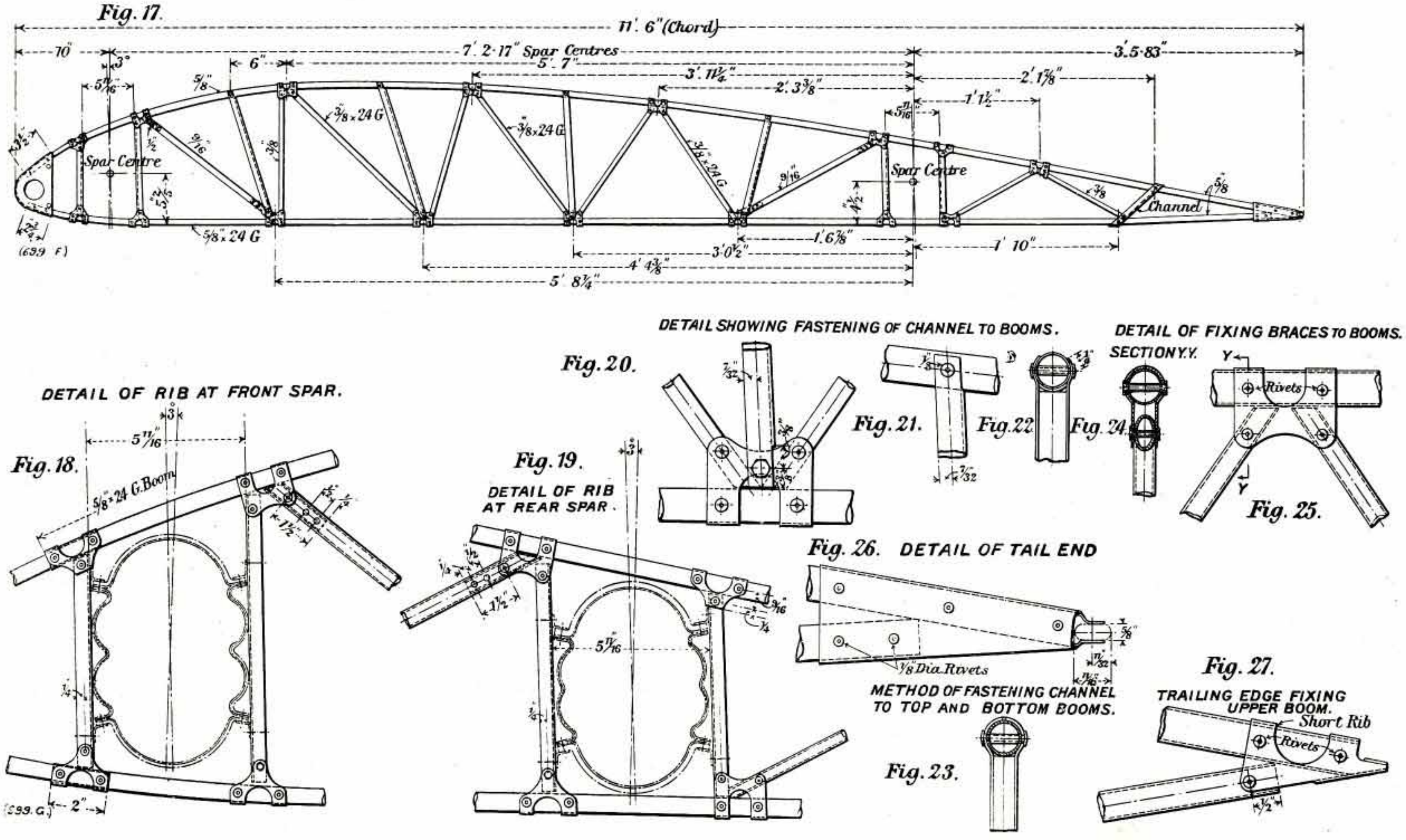
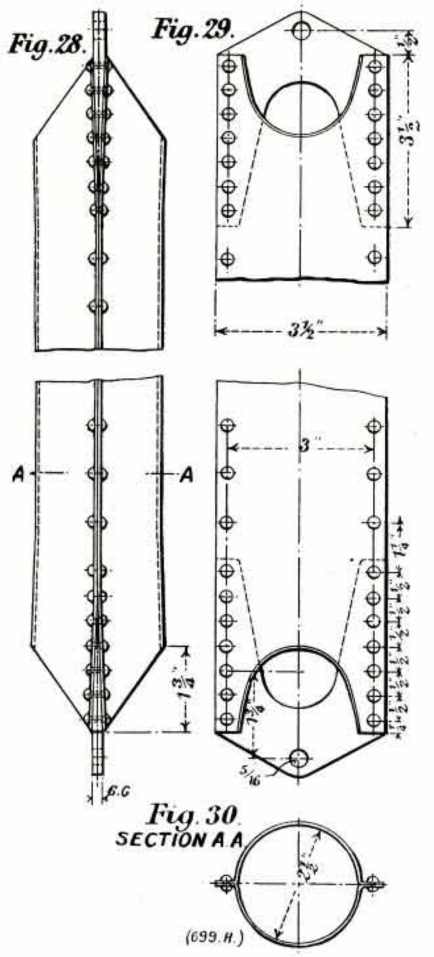


Fig. 17.
11' 6" (Chord)
7' 2·17" Spar Centres
5' 7"
3' 5·83"
Spar Centre
Channel
5/8 x 24 G
3/8 x 24 G
DETAIL OF RIB AT FRONT SPAR.
Fig. 18.
5/8" 24 G. Boom
Fig. 19.
DETAIL OF RIB AT REAR SPAR.
Fig. 20.
DETAIL SHOWING FASTENING OF CHANNEL TO BOOMS.
Fig. 21.
Fig. 22
Fig. 24.
DETAIL OF FIXING BRACES TO BOOMS.
SECTION Y.Y.
Rivets
Fig. 25.
Fig. 26. DETAIL OF TAIL END
1/8 Dia. Rivets
METHOD OF FASTENING CHANNEL TO TOP AND BOTTOM BOOMS.
Fig. 23.
Fig. 27.
TRAILING EDGE FIXING UPPER BOOM.
Short Rib

propellers, each consisting of a pair of twin two-bladed propellers, are fitted, this arrangement having been adopted in order to facilitate the carrying of spares; the blades are sheathed with metal at the tips to protect them against damage by spray.

Towards the outer ends of the lower wings, wing-tip floats are fitted, as usual, to prevent the machine from heeling over in a wind when at rest or travelling on the water. The floats can be seen in Figs. 1, 3 and 4, on



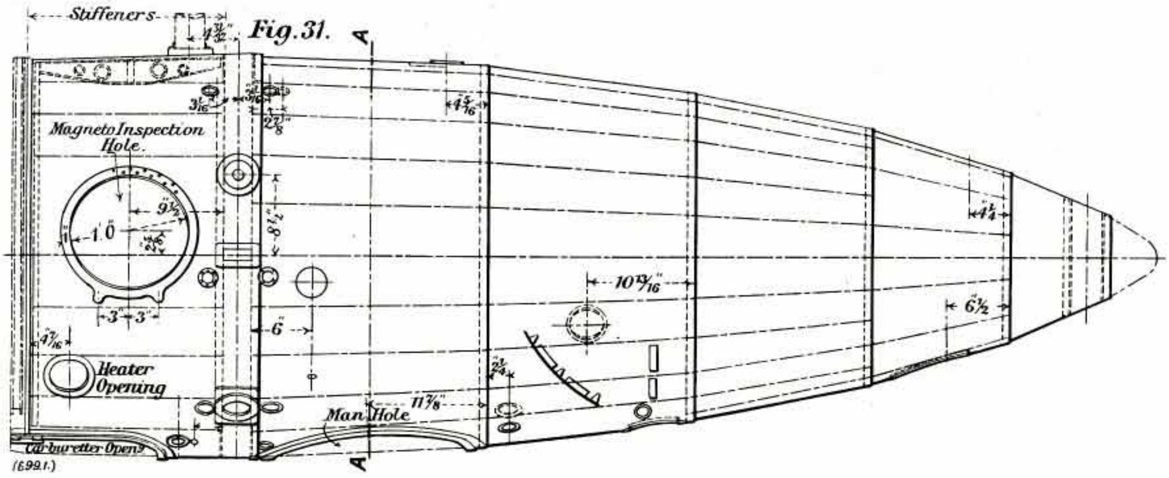
pages 6, 8 and 9, but their form is most clearly shown in the elevation and plan given in Figs. 41 and 42 on page 17. They are of Duralumin construction throughout and are of the single-step type. Their main dimensions are: Length 11 ft. 6 in., width 3 ft., and depth 2 ft. 8 in. A section on the centre line of the float, showing the keelson, is given in Fig. 40, and this, with the aid of the transverse section, Fig. 50, will enable its construction to be followed; single channel frames are employed with longitudinal stiffeners of Z section. Figs. 47, 48 and 49, illustrate the method of riveting the keels on to the bottom sheeting and to the keel plate, and details of the construction of the step are given in Figs. 43 to 46. Openings with covers are provided in the upper sheeting of the floats, as shown in Fig. 42, to enable the interior to be examined, and drain plugs are fitted in the bottom to permit any water that may enter to escape. A watertight bulkhead is provided at the mid-section.

Deferring for the moment our description of the hull structure and turning to the tail unit, we may first explain that the various members are of metal construction, generally similar to that of the wings described above, and they are also covered with doped fabric. The general arrangements can be followed by referring to Figs. 2, 4 and 5, on pages 7 and 9. It will be seen from these that the tail plane and elevators, which are 112 sq. ft. and 105 sq. ft., in area, respectively, are of the monoplane form, and the tail plane is braced to the hull by struts on each side. As the tail plane and elevators are located above the bottom of the fin, the latter has been made in two parts, to facilitate the removal of the tail plane. The angle of incidence of the latter, as already mentioned, can be adjusted in flight to suit the speed and loading, and the mechanism for effecting this adjustment is illustrated in Figs. 51 to 53 on page 18. The range of movement provided is 5 deg., and this is obtained by connecting the tail-struts to the tubular framework shown in Fig. 52, this framework sliding in vertical guides in the hull. Attached to the upper part of the frame is a screw on which works a nut, the outer part of which is formed as a sprocket wheel, as shown in Fig. 53. A chain from this passes round another sprocket, mounted on the upper end of a short shaft shown on the left of Fig. 51, and the lower end of this shaft carries a third sprocket operated by chain and cable from a handwheel in the cockpit. It will be clear that, with the mechanism described, the pilot can adjust the incidence of the tailplane as required by turning the handwheel.

The fin is mounted on the hull as a cantilever, the rear fin post being almost identical in construction to the spars of the upper main plane. The area of the fin is 56 sq. ft., and that of the main rudder 49 sq. ft. As already mentioned, the latter is operated by a servo-rudder, the area of which is 7·6 sq. ft., mounted on spars to the rear of the main rudder. The servo-rudder has, of course, to be turned in the opposite direction to that in which it is required to move the main rudder, and, for this reason, the flexible cables operating the former must be crossed. The arrangement, we understand, has proved very satisfactory in service, very little effort being required to operate the rudder, and the pilot being consequently relieved of much of the strain involved in a flight of long duration. The connections for operating the whole of the control surfaces are collected together in the cockpit, whence they are led through troughs fitted with inspection covers to the top of the hull, where a duct is provided for their accommodation. The top cover of this duct is removable, to give easy access to the connections, for which rods are used in place of flexible cables wherever possible.

The question of the seaworthiness of a flying boat is at least of equal importance to that of airworthiness, since an aircraft of this class spends a considerably greater part of its life in the water than in the air. It is necessary also to design the hull for the minimum water resistance, so that the aircraft may rapidly attain sufficient speed to rise, while at the same time the troublesome pitching phenomenon, known as "porpoising," must be avoided, as also must be the production of too much spray. Fully realising all these requirements, Messrs. Short Brothers have given particular attention to the water performance of the hull, which is of the two-step type. Extensive research work on models was carried out in the firm's own experimental tank, to determine the form which would be most efficient in all respects, and the results obtained in practice have amply demonstrated the value of this work. Similar experimental work, it may be added, was also carried out to assist in the design of the wing-tip floats already described. The hull, as already indicated, is constructed almost entirely of Duralumin, this material having been selected in preference to wood for several important reasons. Of these, we may mention that Duralumin has the advantage that its strength is known with much greater certainty than is that of wood, and the weight of a Duralumin hull can be made considerably less than that of a wooden hull of equal strength. Water soakage, which is a serious matter with wooden hulls, and may account for some 500 lb. to 800 lb. of added weight in service, is entirely eliminated in the metal hull, which can be made so perfectly watertight that the bilge pump need only be used in an emergency. Metal hulls, moreover, have a longer life than wooden hulls for a given amount of upkeep, and the former have the additional advantage that they are able to withstand a considerable amount of local damage without serious effects. Even if holed, they can be readily repaired by riveting on reinforcing plates, an operation which can be carried out anywhere by comparatively unskilled labour. The whole of the Duralumin used for the hull, and for all other parts of the aircraft, has been rendered

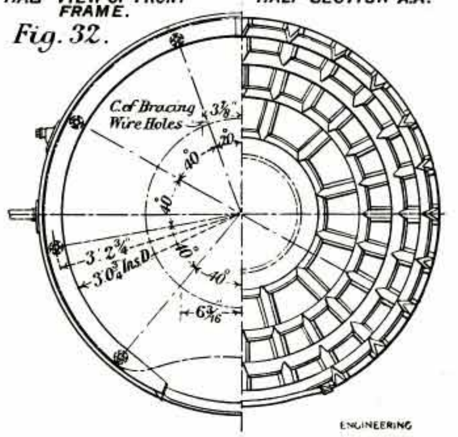
Fig. 31.



HALF VIEW OF FRONT FRAME.

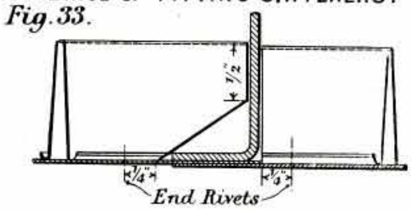
HALF SECTION A.A.

Fig. 32.



METHOD OF FITTING STIFFENERS.

Fig. 33.



RIVETTING OF STIFFENERS.

Fig. 34.

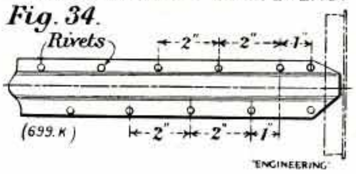


Fig. 35.

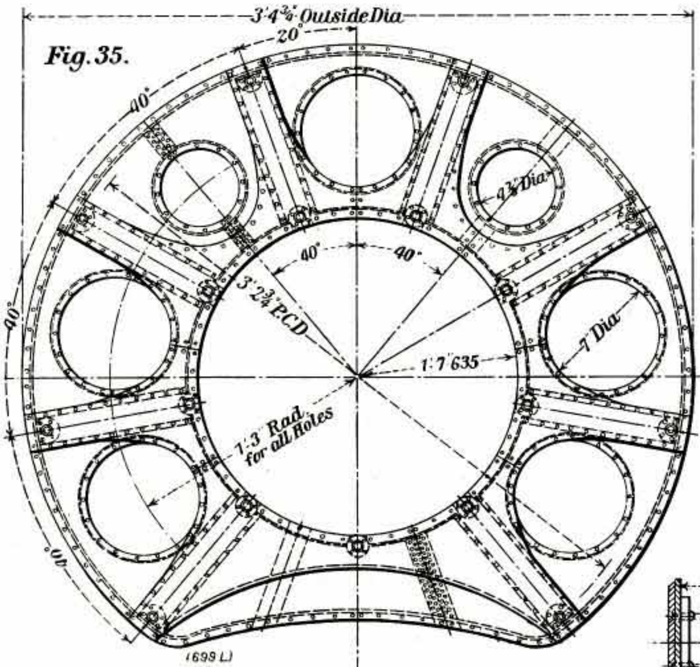
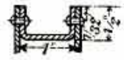


Fig. 36. SECTION THROUGH OUTER CHANNEL



SECTION THROUGH INNER CHANNEL

Fig. 37.

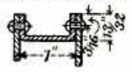


Fig. 38. DETAIL SHOWING FIXING OF DISTANCE PIECES

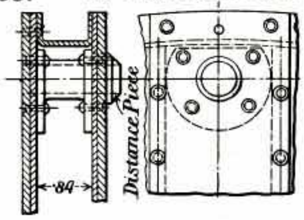
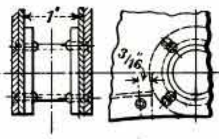


Fig. 39. FIXING OF BOLT BOSS



SECTION ON C.L. SHOWING CENTRE KEELSON

Fig. 40.

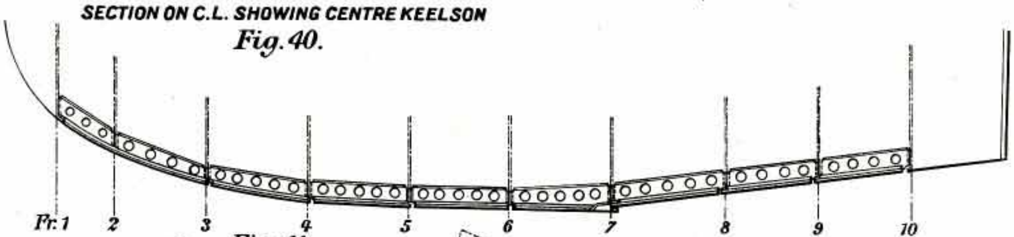


Fig. 41.

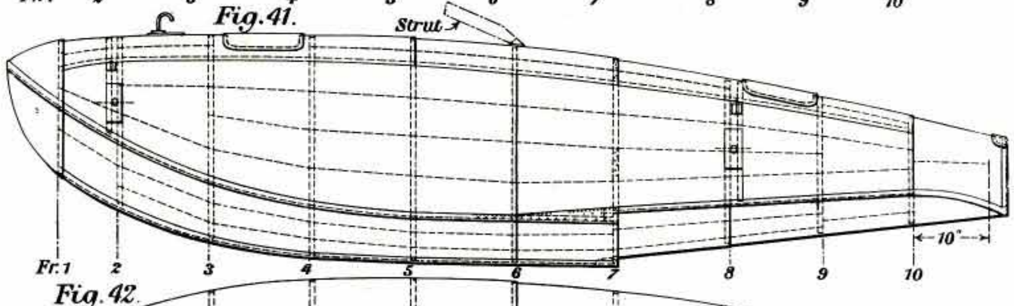
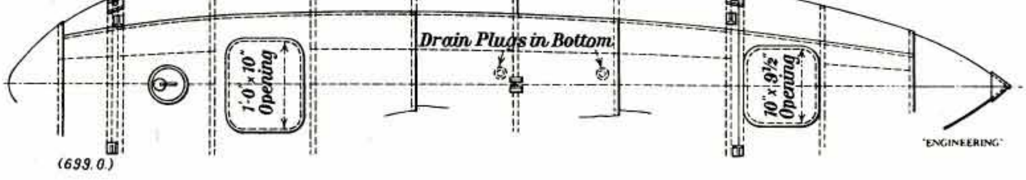


Fig. 42.



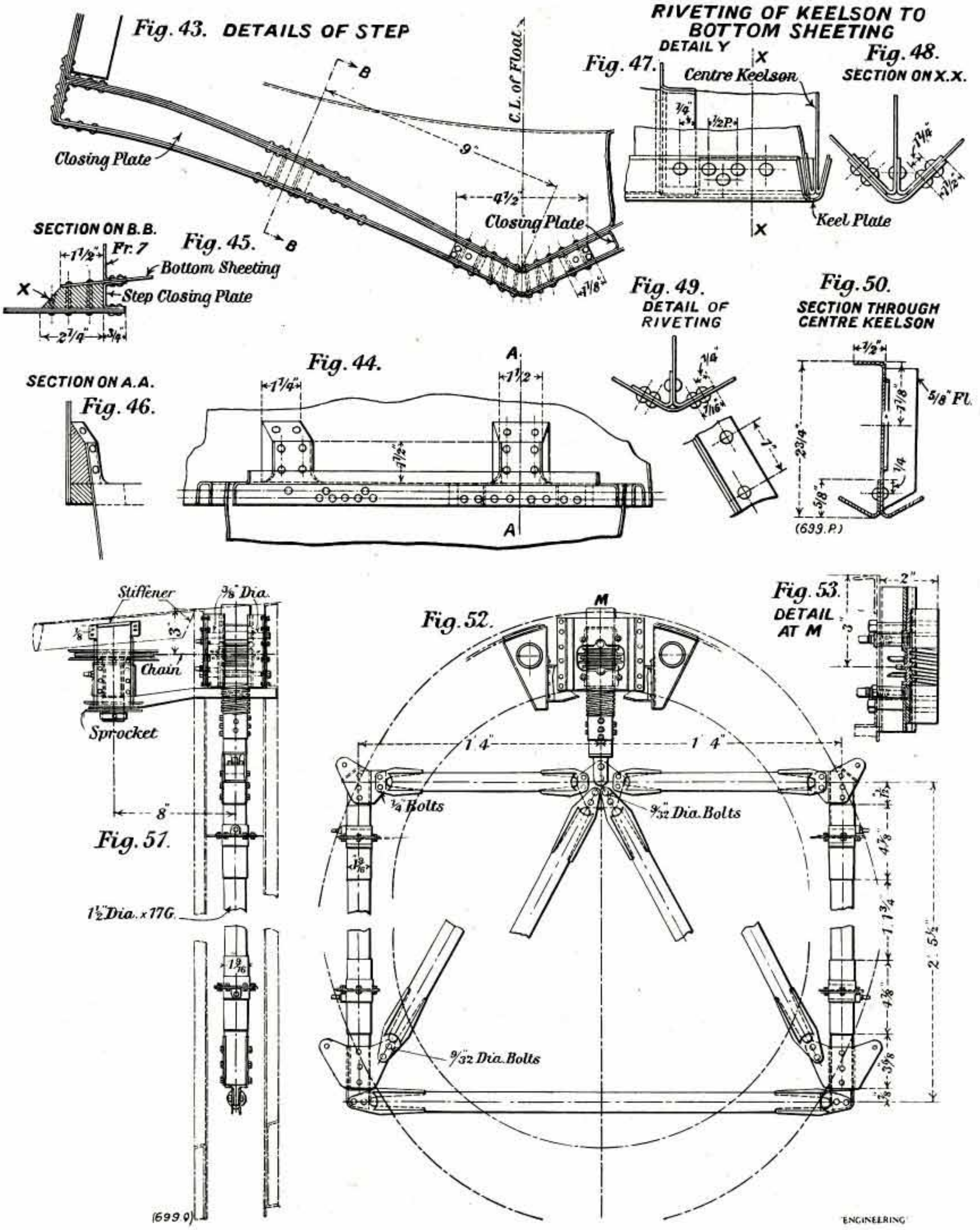


Fig. 43. DETAILS OF STEP
C.L. of Float
Closing Plate
9"
4½"
Closing Plate
B
B
SECTION ON B.B.
Fig. 45.
1½"
Fr. 7
Bottom Sheeting
Step Closing Plate
X
2¼"
¼"
RIVETING OF KEELSON TO BOTTOM SHEETING
DETAIL Y
Fig. 47.
X
Centre Keelson
¾"
1½P.
X
Keel Plate
Fig. 48.
SECTION ON X.X.
Fig. 49.
DETAIL OF RIVETING
Fig. 50.
SECTION THROUGH CENTRE KEELSON
5/8" Fl.
23/4"
(699.P.)
SECTION ON A.A.
Fig. 46.
Fig. 44.
A
A
1¼"
1½"
Stiffener
⅜" Dia.
Chain
Sprocket
8"
Fig. 57.
1½" Dia. × 17G.
Fig. 52.
M
1' 4"
1' 4"
¼" Bolts
9/32" Dia. Bolts
9/32" Dia. Bolts
2' 5½"
Fig. 53.
DETAIL AT M
2"
3"
(699.Q.)
ENGINEERING

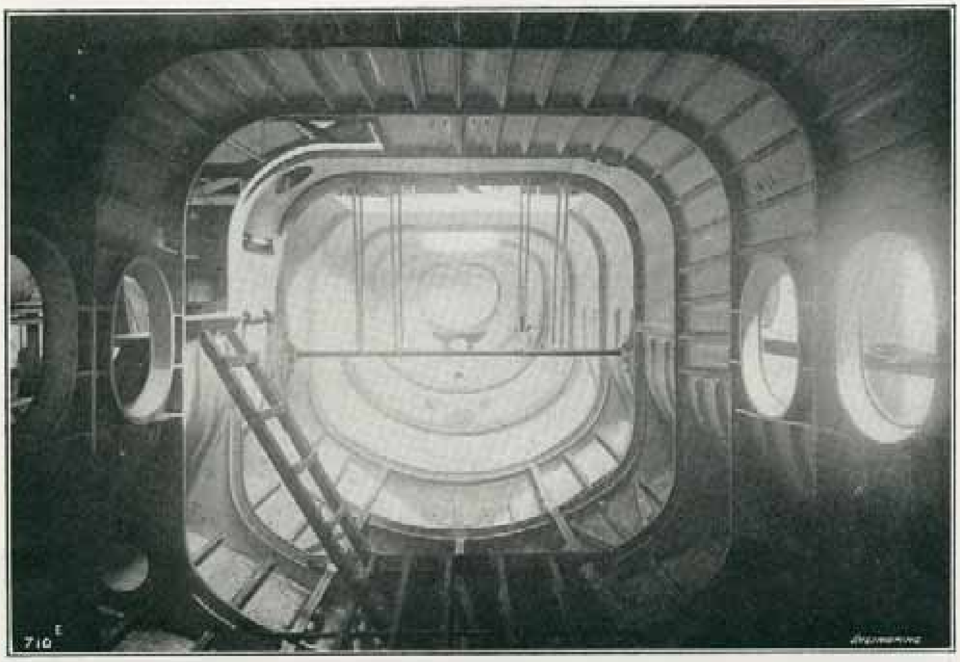


Fig. 54. Interior of Hull Looking Forward.

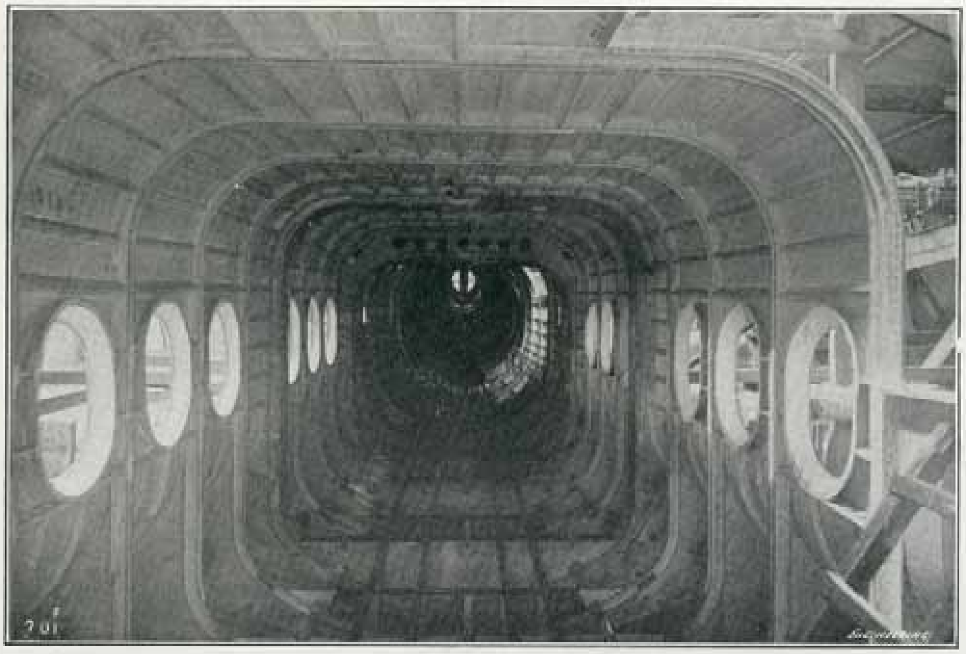


Fig. 55. Interior of Hull Looking Aft,

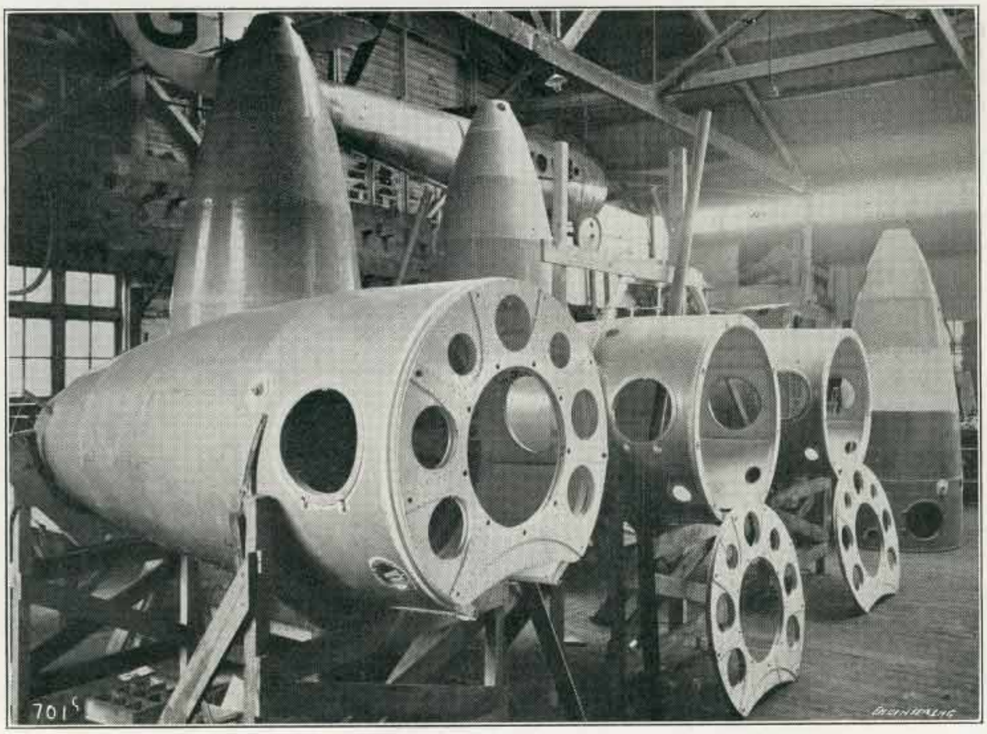


FIG. 56. ENGINE NACELLES AND MOUNTING PLATES.

FIG. 57. DETACHABLE LAUNCHING TROLLEY ON PORT SIDE.

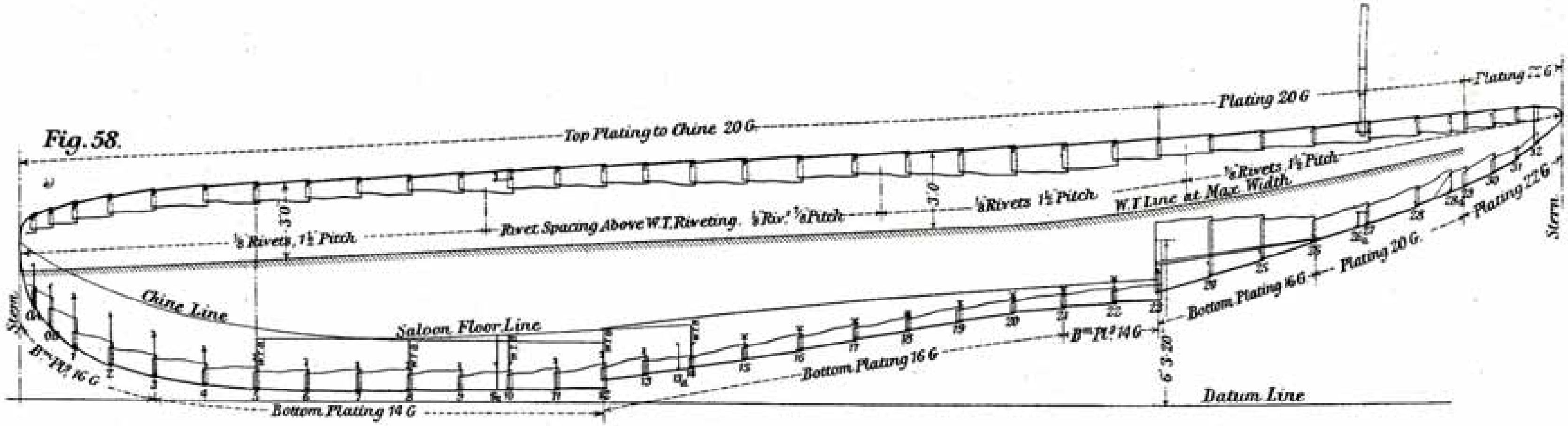


Fig. 58.

FRAME SECTION 0A & 0B

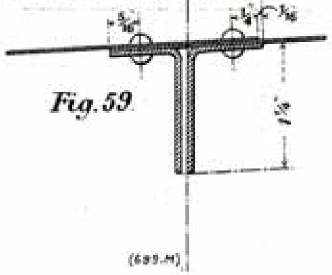


Fig. 59.

FRAME SECTION 1-22

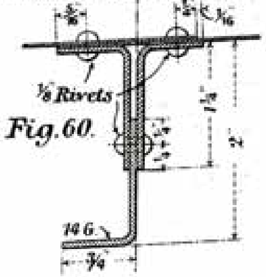


Fig. 60.

FRAME SECTION 23

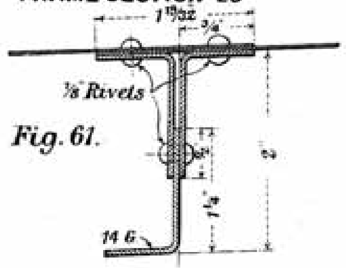


Fig. 61.

FRAME SECTION 24-30

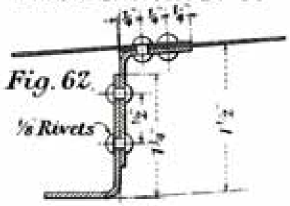


Fig. 62.

FRAME SECTION 31 & 32

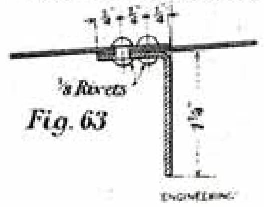
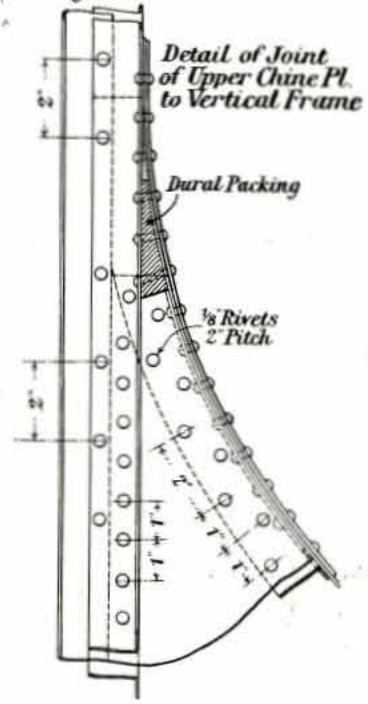


Fig. 63

corrosion-resisting by the anodic-oxidation process which was fully described in ENGINEERING, vol. cxxii, page 724.

The external form of the hull can be seen in the photographic illustrations, Figs. 1 and 2, on pages 6 and 7, Fig. 10, on page 12, and Fig. 57, on page 20, as well as in the line drawings, Figs. 3, 4 and 5, on pages 8 and 9, while Figs. 54 and 55, on page 19, are views of the interior, taken after the construction was completed, but before the internal fittings had been placed in position. The arrangement of the passenger accommodation and luggage compartment are shown in Figs. 6 and 7, on page 10. The main dimensions of the hull are:—Length 60 ft. 6 in., breadth 10 ft., and depth 8 ft. 9 in., and it consists of a number of frames of the required shape to which the outer skin is riveted, the skin being strengthened between the frames by longitudinal stiffeners of triangular-trough section riveted on; the latter can be seen in Figs. 54 and 55, on page 19. It should, perhaps, be mentioned that the local stiffening is considerably increased on the planing in all directions, so that the engine instruments, which are fitted on to the struts supporting the nacelles, in order to avoid the use of long connecting leads, are easily visible. Complete dual control is provided, so that the second pilot, who acts as navigator and wireless operator, can relieve the first pilot when necessary.

Fig. 71.

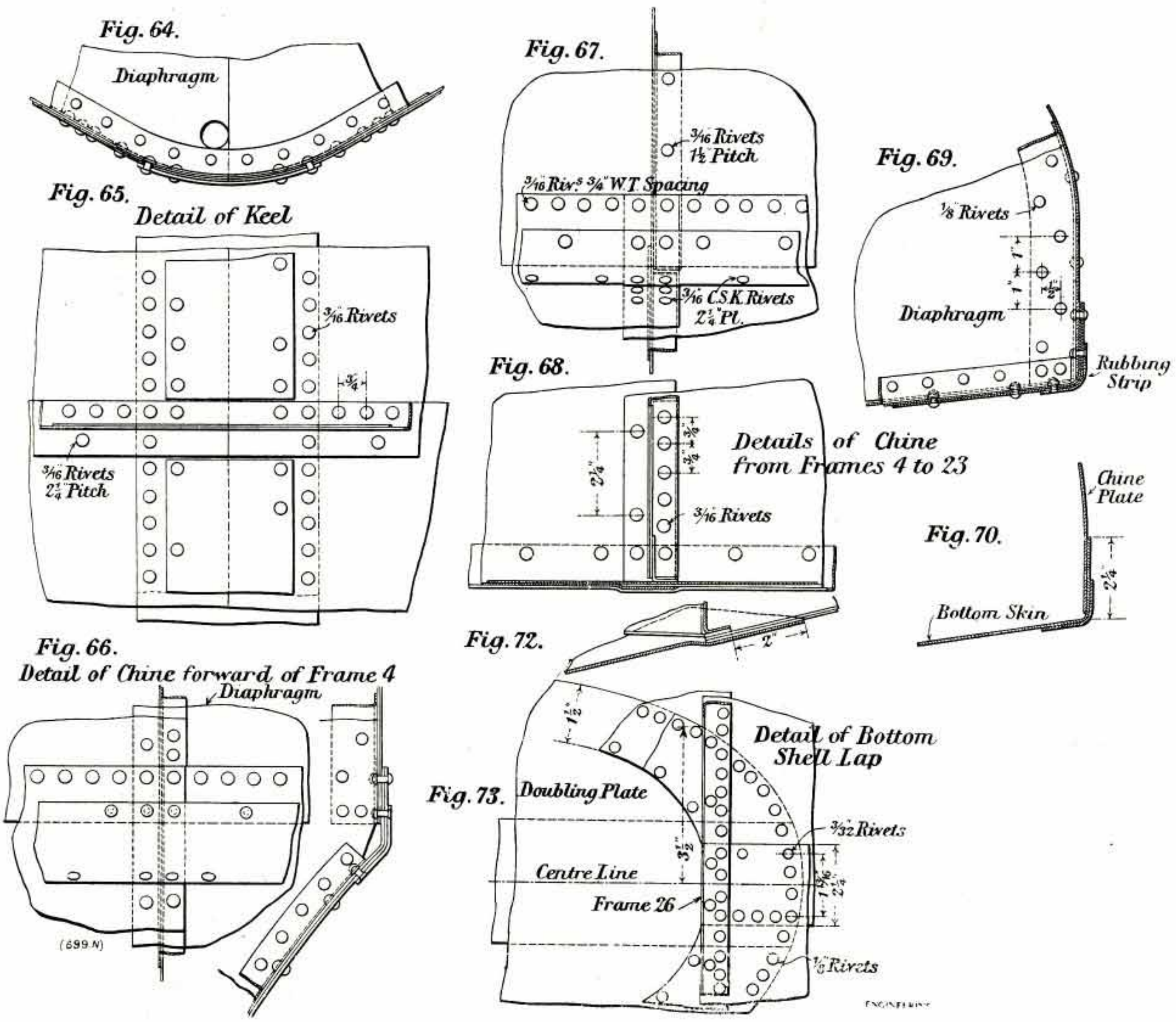


A small compartment immediately aft of the cockpit, and shut off from it by a roller blind, is provided for the navigating and wireless work, and still farther aft is the passengers' cabin. This is 17 ft. in length, 6 ft. 6 in. wide, and 6 ft. 3 in. high, and has seating accommodation for 15 persons, as well as a steward, arranged as shown in Figs. 6 and 7 on page 10.

The chairs are made of Duralumin tubes, with clip fittings, similar to those employed for the construction of the wing ribs, and can be readily removed if it is required to employ the aircraft for the transport of mails or goods. Aft of the passenger cabin, space is provided for a buffet, cooking stove, lavatory and w.c. Finally, there is a luggage compartment, of 200 cub. ft. capacity, provided with the necessary fastenings for preventing the movement of the packages. Access to the passenger cabin is provided by a specially-designed hatch at the forward end of the cabin, and arranged so that passengers can step directly from it to the quay to which the boat is moored. This hatch can be seen on the left of Fig. 10, on page 12, in which illustration a plank is resting on the sill. A separate hatch is provided aft for the luggage, this hatch being shown open in Fig. 2, on page 7, while the forward hatch is closed; the luggage hatch is sufficiently large to enable a spare engine to be carried. Another hatch, also visible in Fig. 10, is provided in the extreme bow of the boat, to accommodate the ground anchor and rope, for use when the aircraft cannot be moored to a buoy. The necessary towing and mooring eyes are fitted on the bow, wing tips and stern of the hull.

A complete equipment of instruments is provided, and the wireless equipment includes a 500-watt transmitter and a five-valve receiver, the former having a range of from 300 to 400 miles for either telegraphy or telephony. In conclusion, we may briefly mention the detachable launching trolley employed by Messrs. Short Brothers for the first time in launching the Calcutta. It is shown in position in Fig. 1, on page 6, but is more clearly illustrated in Fig. 57, on page 20. The usual wheeled trolleys, just visible in Fig. 57, are used at the after end of the hull, but the greater part of the weight is taken on a pair of pneumatic-tyred wheels, one of which is attached by struts to the hull and lower main plane on each side of the hull. The struts are connected to the end fittings of the raking struts which transmit the load of the outer engine nacelles to the hull, as is perhaps most clearly shown in Fig. 1, the connections being made by pins which can be withdrawn when the boat is floating in the water. The wheels and struts detached in this way are kept afloat by inflated rubber bags, so that they can be recovered after use. The same gear can be employed when it is required to draw the boat up a slipway, the detachable trolleys being taken out to the boat in any suitable floating craft and fixed in position by inserting the pins.

bottom, to resist the impact loads imposed by heavy landings. Thicker plating is also used for this part of the skin, as well as in way of the two steps. A longitudinal section of the hull showing the thickness of the skin plating in different positions is given in Fig. 58, on page 21, while Figs. 59 to 63, on the same page, are sections of the various forms of frames employed. Details of the keel are illustrated in Figs. 64 and 65, and of the chine in Figs. 66 to 70. Of the latter, Fig. 66 shows the construction of the forward position, to the left of frame 4 in Fig. 58, and Figs. 67 to 70 that of the portion between frame 4 and the after step. Specially strong frames are employed where the spars of the bottom main plane pass through the hull and also at the point of attachment of the tail unit. The joint between one of the vertical frames and the upper part of the curved chine plate is illustrated in Fig. 71, from which it will be seen that the joint is made with the aid of a shaped packing piece of solid Duralumin. The other detail illustrated in Figs. 72 and 73 shows the lap of the bottom plating at frame 26. It is of importance to mention that no watertight packing material is used between the joints of the outer skin, water-tightness being secured with a metal-to-metal joint by close riveting below the water line.



As will be clear from Figs. 54 and 55, on page 19, the interior of the hull is entirely free from obstructions, except for the depth of the frames, and no complete water-tight bulkheads are fitted, although the floor of the cabin is designed to form a double-bottom. The two pilots are accommodated side by side in a cockpit in the nose, from which position a clear view is obtained