H C Wilson

DF-5

cy. 2

TECHNICAL MEMORANDUMS

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

No. 546

STRUCTURAL DETAILS OF THE GIANT DORNIER SEAPLANE "Do X"

By Corrado Gustosa

From Rivista Aeronautica, October, 1929

Washington
January, 1930

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.

TECHNICAL MEMORANDUM NO. 546

STRUCTURAL DETAILS OF THE GIANT DORNIER SEAPLANE "Do X."*

By Corrado Gustosa.

In July, 1929, the 6000 hp giant Dornier seaplane, already known by its abbreviated name of "Do X," was successfully launched on Lake Constance and made its trial flights. These flights were of perfect regularity and of increasing length on successive days and demonstrated that the new seaplane was free from defects and ready for use.

On the fourth day Balbo and General Crocco participated, as guests of the builders, in a half-hour's flight around the lake and reported a very favorable impression of the giant seaplane and of its controllability. On the sixth day it made numerous take-offs with a full load of 48,600 kg (107,144 lb.), equivalent to three loaded railway cars. This made a power loading of over 8 kg/hp (17.6 lb./hp), since the engine power was about 6000 hp. This event must be considered as a milestone in the history of aviation. It is the first airplane of large carrying capacity.

After these successful flights we have gladly granted the request of the "Rivista" for a brief description of the structural details of the new seaplane which we have followed in its development from the beginning, with the aid of the illustrative

*"Particolari Costruttivi dell'Aerovascello Do X," from Rivista Aeronautica, October, 1929, p.84-113.

material furnished by the Dornier Company.

General Description

The general design of the seaplane preserves the fundamental characteristics of the previous Dornier seaplanes, the "Wal" and the "Superwal." Nevertheless, each part presents special details of form and structure.

The central hull has a marked V-shaped bottom at the bow similar to a torpedo boat. Moreover, the lower part of the midship section is much broader than the upper part.

The central part of the main wing is surmounted by an auxiliary wing which connects the six engine nacelles. The two wing stubs projecting from the sides of the hull serve principally for stability on the water, but also as supports for the three large wing struts on each side of the hull.

The horizontal empennage is not of the monoplane type, there being two stubs below parallel to the fixed horizontal stabilizer. These stubs assist in supporting the large vertical balancers of the rudder and the struts which support the horizontal stabilizer.

The controls of the tail surfaces and ailerons are rigid steel tubes without welds, subjected only to tensile stresses. The perfect balancing of the rudder and elevator enables the pilot to operate the controls by hand without the application of much force. In view of the rigid transmission for 30 m (98.4 ft.), we are led to admire the success of such a simple and responsive mechanical device.

The twelve engines are installed in nacelles whose axes are situated 2 m (6.56 ft.) above the main wing. The propellers have four wooden blades. The wing span is 48 m (157.48 ft.); wing chord 9.5 m (31.17 ft.); wing area 434 m² (4672 sq.ft.). The span of the small upper wing is 22.8 m (74.8 ft.); chord 1.75 m (5.74 ft.); area 36 m² (387.5 sq.ft.).

The hull has a length of 40 m (131.2 ft.); height 6 m (19.7 ft.); maximum width including wing stubs 10 m (32.8 ft.). The maximum height of the seaplane from the bottom of the hull to the tips of the propeller blades is 10 m (32.8 ft.); maximum height of tips of propeller blades from the water line under full load 9 m (29.53 ft.). The ratio of the submerged portion of the hull to its height is least at the trailing edge of the wing stubs which barely touch the water. Any one seeing for the first time the Do X resting on the water or taking off, is struck with wonder that so large a mass does not sink deeper in the water.

The weights are taken from Dornier's lecture in London (See No. 3, March, 1929, of the Notizario Tecnico d'Aeronautica). The empty weight was slightly increased by a few structural modifications during the process of construction. The normal full load is 46,000 kg (101,412.5 lb.). This weight was taken as the basis for the static calculations.The factor 5 (or 5 x 46,000 kg) was taken by the company for the static calculations of the wing structure for a given flight condition, case A of the German standards, in which the aerodynamic resultant is applied to the lower side of the wing at one-third of the chord from the leading edge.

For the static calculations of the bottom of the hull, of the midship section of the keel and of the wing stubs, the company took a landing speed of 120 km (75 miles) per hour and the factor 8 for the case of striking the water horizontally or with the bow inclined 10 degrees.

We do not know the effective flight characteristics at the moment of writing. The calculations indicate a maximum horizontal speed of 210 km (130.5 miles) per hour under full load and a landing speed of 113 km (70 miles) per hour. Moreover, the calculations indicate an economical cruising speed of 170-180 km (105-112 miles) per hour and a ceiling of 3500 m (11,483 ft.)

M a t e r i a l s

All the principal structures are metal. The transverse frames of the hull and wing stubs are the usual open duralumin types. The keelson and the wing spars are constructed of open U-section metal, I-section metal, and L-section metal, or plates of special compressed duralumin of the ZB type. The two spars of the upper wing between the engine nacelles are steel and of the type previously used in other Dornier seaplanes. The two spars of the horizontal stabilizer are also steel. Parts made of high-resistance steel occur also in the fittings of the large struts between the wing stubs and the main wing, in the plates for attaching the struts to the wing spars and in the three principal transverse frames of the hull which strengthen the zone of the wing struts.

Moreover, ordinary steel is used for the tail and for the struts between the wing stubs and the hull, the terminal transverse frames of the nascelles and the engine supports on the wing, the brace wires of the struts between the wing stubs and wing, all the wires in the wing panels and lastly for all the tubular steering controls. The after part of the hull is covered with duralumin plates of 1 to 2 mm (0.04-0.08 in.) thickness. The bottom of the central part of the hull is covered with 3 mm (0.12 in.) plates, and the portion between the two longitudinal steps is covered with 4 mm (0.16 in.) plates.

The parts of the lattice girders and the covering plates are joined with duralumin rivets by the same method of distribution of the junction flanges and of the number of rivets as employed in the construction of metal bridges. The duralumin rivets vary in length and diameter, reaching diameters of 6 and 8 mm (0.24 and 0.32 in.) in the lattice girders. The riveting is generally done with hammers operated by compressed air.

The wing is covered with linen fabric, excepting the panels or bays between the engine nacelles where metal plates are used, so the engine mechanics can walk on them. The leading edge of the wing, the entire stabilizer, the fin, and the six small balancing surfaces are also covered with duralumin plates. Only the elevator, rudder and ailerons are covered with fabric.

The fuel tanks are made of duralumin. The fuel and oil pipes are partly copper and partly duralumin. The window frames, handles, cleats, etc., are castings of aluminum alloys.

Details of the Main Wing and Upper Wing

The main wing is of the medium thick type. It has three spars, each constituting a lattice girder of duralumin. The middle spar is higher - 1.2 m (3.94 ft.) - and stronger than the other two.* All three spars are constructively calculated as girders with four supports, the two central ones being rigidly attached to the hull (in correspondence with the three main transverse frames) and the two outer ones being elastic at 10.5 m (34.4 ft.) from the center of the wing and forming the points of attachment of the large struts.

The planes of the three spars are 2.8 m (9.19 ft.) apart and are held at this distance by 12 lattice ribs of compressed duralumin perpendicular to the spars at intervals of a little over 3 meters. The spars and ribs form a grid to which the covering is attached. Each quadrangular panel of this grid is covered with a trelliswork of light duralumin bars supported by five small trapezoidal girders, three parallel to the ribs and two parallel

*For further details, see No. 12 of the 1928 Rivista Aeronautica, "Prove statiche di longheroni alari metallici."

to the spars. The network of small ribs makes the mean distance between the seams of the cover about 25 cm (9.84 in.).

The small trapezoidal girders, each weighing about 1.65 kg (3.64 lb.) are arranged with their narrower base toward the inside of the wing. Hence there is a free space of about 40 cm (15.75 in.) in the thickness of the wing between the top and bottom panels. Two special transverse bonds, between the three junction plates of the spars and struts, are lattice girders which form steps in the center to make room for the small girders of the upper and lower covering panels. Every covering panel carries perforated projections for attaching the corners of the trelliswork, which can therefore be readily removed. This is the first time the wing covering has been made removable. The shape of the small girders naturally varies according to whether the panel is on top of the wing (convex) or underneath (flat). It differs for the zone between the first and second spars and for the zone between the second and third spars. From the third or rear spar to the trailing edge of the wing both the upper and lower coverings are supported by a system of triangular ribs held in shape by transverse reinforcements, similar to any airplane.

Nacelle supports.- Between the front and central spars at a distance of 56 cm (22.05 in.) from the main ribs there are parallel intermediate ribs which form the rectangles on which rest the steel supports of the engine nacelles. Each supporting frame consists of four vertical struts joined by two oblique struts (Fig. 18). Each pair of front, rear and diagonal struts is connected by lattice bars. The bars between the oblique struts are horizontal, forming a ladder for the engine mechanics. As seen from the right or starboard side, the three pairs of struts form the letter N. The whole is encased in a streamlined cowling of corrugated sheet duralumin (Figs. 5 and 19). The nacelles are spindle-shaped. Their transverse frames are circular and made of duralumin, excepting that the end frames are steel. The latter are bolted to the four struts which support the engines.

Ailerons.- The first, fourth, and sixth ribs of each half-wing are extended to the trailing edge or to the point of attachment of the ailerons. Each aileron has a length of 12 m (39.4 ft.) and a width of 1 m (3.28 ft.). Its leading edge is formed by a large duralumin tube. Due to its great length, each aileron consists of two pieces joined by a universal sleeve coupling. Each aileron is attached to the wing by means of ball bearings. The aileron balancers (Figs. 2 and 11) have each a length of 4.5 m (14.76 ft.), a width of 0.5 m (1.64 ft.), and are located 0.7 m (2.3 ft.) above the wing.

The leading edge of the wing, or all the wing forward of the front spar, consists of parabolic latticework formers placed at regular intervals and serving to support the plywood covering. For the whole span there are six sections of 8 m (26.25 ft.) each. The end sections decrease in thickness at their tips and carry the sockets for the position lights. The central sections have a sheet-metal floor and a passageway which enables the mechanics to crawl from the central cabin to the different engine nacelles even during flight. The passageway is sufficiently lighted by two celluloid windows in each of the four central sections. Where the leading edge joins the control cabin, or forward of the more central engine nacelles, the space in the leading edge is occupied by suitably shaped fuel tanks with a capacity of 300 liters (about 80 gallons) each.

The small upper wing connects the six engine nacelles at the height of their junction with the steel supports. The spars of this wing have steel flanges and duralumin latticework webs. The thin wing has a concave lower surface with a strong aerodynamic lift and a duralumin covering with corrugations parallel to the profile. The portions of the wing between the four central nacelles are rigidly bolted to the latter. The other two terminal portions are attached externally to the four central nacelles by means of swing bolts, and the wing covering is interrupted and replaced by a strip of fabric with bands. In this way the elastic deformations of the large wing during flight are absorbed by the cloth strips and cannot cause deformations in the metal covering of the upper wing.

The outer struts between the hull and the wing are duralumin, both in the internal resisting parts which form a quadrangular box and in the very strong outside fairing which increases the strength of the struts. Only the trailing edge of the fairing has a series of large perforations covered with cloth for lightening. The free length of each strut is about 6 m (20 ft.).

The ends of the struts are specially fashioned in steel. The end of each strut designed for attaching to a wing spar has the form of a long fork. Each branch of the fork is pierced by a steel rod which functions as an attaching bolt. Each of these rods, weighing about 4 kg (8.8 lb.), has a spherical enlargement in the center to match a corresponding spherical cavity in the spar fitting. It can therefore operate like a hinge. The other end of each strut, for attaching to one of the three steel projections of the wing stub, has three parallel branches which fit over the two sides of each attachment fitting. The five plates are perforated simultaneously with a special tool, after which the two steel bolts are introduced and secured by locknuts.

Details of the Hull and of the Wing Stubs

The strong framework of the hull consists of a lattice girder of large section duralumin a little over 2 meters (about 6.6 feet) high and 23.5 m (77.1 ft.) long, forming the keelson (Fig. 12). Parallel to the main keelson there are four side keelsons with a mean height of about 40 cm (16 in.). The two inner ones form the sides of the two longitudinal steps on the bottom of the hull (Fig. 9, section EF). At right angles to these longitudinal members, at intervals of 70 cm (about 28 in.) from the bow to the water rudder there are 37 transverse frames.

The principal step is located at frame 35. Back of the step the bottom rises but leaves an extension of the longitudinal steps forming a small stern where the water rudder is placed. Back of the water rudder the hull tapers rapidly to the tail. This portion of the hull has 21 transverse frames at variable intervals of from 50 to 70 cm (20 to 28 in.). Its structure is much simpler, however, than that of the hull proper.

Altogether the hull has 58 frames. The three most important frames are numbers 34, 38, and 42, counting from the stern. These are of mixed construction of steel and duralumin with plates at the top for attaching the three wing spars and at the bottom a double band of steel angles which extend into the wing stubs and form the supports for the outer struts (Fig. 17).

The sides of the hull have strong horizontal reinforcing members. All the side and bottom plates, in addition to being riveted to the frames, are reinforced by numerous diagonal members between the frames.

As in the "Superwal" also here behind the step the bottom is traversed by two tubes to release the air which is compressed in landing. Instead of being vertical, these tubes are curved and open on the sides of the hull above the wing stubs opposite the after wing struts.

Many of the frames are covered with metal plates at the bottom to form water-tight bulkheads. The location of the bulkheads is so calculated that the hull has sufficient buoyancy even when two compartments are flooded. Frames 21, 42 and 55 are made into water-tight bulkheads throughout their whole extent. On the contrary, the frames 28, 34, 47 and 50 are made water-tight only in their lower part, up to the top of the keelson. In the wing stubs, however, the frames 34, 36, 38 and 41 form water-tight bulkheads.

Division of the space.- Above the keelson there is a floor made of removable panels of duralumin. These plates rest on the keelson in the middle of the hull and, toward the sides of the hull, on suitable lattice girders which connect the frames. Below this floor there is the hold containing spaces on both sides of the keelson for the large fuel and oil tanks, merchandise, spare parts, etc.

Above the floor, from frame 21 to frame 55, the space is occupied by the passenger cabin, 24 m (78.7 ft.) long and divided into 11 rooms, in which it is possible to arrange all the accommodations for the day and night transportation of passengers. The cabin has a height of 1.9 m (6.23 ft.). The rooms have a length of 2.1 - 2.8 m (6.9 - 9.2 ft.) according to whether they cover the spaces between three or four transverse frames. The width of the rooms from one side of the hull to the other averages about 3.5 m (11.5 ft.). The whole length of the cabin is traversed by a corridor 60 cm (nearly 2 ft.) wide.

Access to the cabin and indeed to the whole seaplane is had through the entrance room between frames 42 and 44 by way of two doors in the sides of the hull above the wing stubs. The entrance room is also the place of passage from one floor to the other by means of a fixed metal stairway against frame 42 on the starboard side. It rises from the floor of the passenger cabin to that of the control cabin. Below a trapdoor in the floor of the entrance room another stairway descends into the hold. Two other stairways against the frames 21 and 55 at the ends of the cabin floor afford safety exits through hatchways to the top of the hull.

The space on the cabin level in front of frame 55, or the zone of collision, contains the anchors and hawse holes, the windlass for the anchor cables, and other accessories. Both here and in the cabins the daylight enters through numerous circular glass windows of 35 cm (13.8 in.) diameter. In secondary locations the windows have a diameter of 23 cm (9 in.). The windows are 1.1 m (3.6 ft.) above the cabin floor for the convenience of passengers while seated.

On the starboard side of the hull there are three large removable plates, each 1.5 x 1.3 m (4.9 x 4.3 ft.) to enable the introduction of large tanks to the cabin floor from which they can be lowered into the hold by removing panels in the floor.

Aft of frame 21 the space in the hull is not utilized and could be used when at anchor for the sleeping hammocks of a small crew. Manholes are left near the bottom in the transverse frames of the tail end of the hull, which give access to the extreme end of the tail abaft the tail surfaces, where there is a post for signalling during the operation of mooring.

The control cabin is in the third story of the seaplane. It projects forward from the main wing in the form of an elliptical turret resting on the hull. The fore part of this turret contains a commodious pilot room. The latter is followed by a large room for the commander of the seaplane and the navigator. The rest of the third story is contained in the wing. It consists of rooms for the engine controls, the engineer, the head mechanic, the radio outfit, the auxiliary motors, the electric generator and the storage batteries. The third deck also contains the passageways to the engine nacelles. The latter, together with the sections of the upper connecting wing, would constitute a fourth deck on which the mechanics move about.

The wing stubs have very strong frameworks. Outside of the 12 principal frames, which are extensions of transverse frames of the hull, there are 11 intermediate frames for reinforcing its lower side. The surface of the bottom of the stubs is joined to the sides of the hull.

Three streamlined steel struts about 2 m (6.56 ft.) long connect the top of each stub to the hull in correspondence with the three wing struts. They serve for a more regular division of the stresses between the stubs, hull and wing in alighting with a full load. The maximum width of each stub (at right angles to the hull) is 2.5 m (8.2 ft.) on the top and 3 m (9.8 ft.)

on the bottom. The different water-tight compartments of the stubs are accessible through manholes in the top. Each stub is traversed moreover by a strong vertical tube, hermetically separated from the interior of the stub. Into this tube there can be introduced a steel rod with an extensible screw head. These serve as points of attachment while towing on trucks or on floating docks, in addition to the central one on the bottom of the hull near the step, in order to avoid possible heeling.

Tail Surfaces and Control lines

The fin, extending about 5 m (16.4 ft.) above the tail end of the fuselage (Fig. 4), has two vertical lattice girders thin at the ends and thicker toward the middle. These girders go to the bottom of the fuselage, being held by two suitable transverse frames. At half its height the fin supports the main horizontal stabilizer, which has two steel spars, the front one being fastened to the front girder of the fin. It can be adjusted, when the seaplane is not flying, along a toothed arc, so as to give the stabilizer a maximum angle of attack of 2.5°. The after spar of the stabilizer has a sleeve attachment to the after girder of the fin, in order to enable the said variations in the angle of attack of the stabilizer.

The distance of the stabilizer from the wing is about 15 m (49.2 ft.) and the length of the stabilizer and elevator together is 3.5 m (11.5 ft.). There is also a relatively short auxiliary stabilizer at the base of the fin. The elevator has a triangular notch in the middle of the trailing edge, which allows the rudder a total rotation of 60° (i.e., 30° to either side). The rudder and elevator, like the ailerons, have tubular frontal spars of duralumin on which are threaded and fastened light lattice ribs of triangular form. The elevator is connected with the stabilizer by five ball-bearing hinges. The rudder is attached to the fin by three ball-bearing hinges.

The main rudder is supplemented by two auxiliary rudders between the main and auxiliary stabilizers. The auxiliary rudders rotate about struts, located 2/5 of the distance from the leading edge, and are joined together by horizontal rods. These function as variable-incident balancers of the rudder and can be set at will by the pilot at a given angle with respect to the main rudder, either to offset the effect of an eccentric nacelle or unsymmetrical load distribution. The maximum value of this variable angle of incidence or attack is ±8°. The elevator also has two balancers with a variable angle of attack of ±8° at the will of the pilot.

The control lines from the pilot room to the tail surfaces are operated without any deviation, along a horizontal plane for a maximum distance of 30 m (98.4 ft.). They consist of rigid steel tubes suspended on small oscillating levers located at regular intervals of about 3 m (9.8 ft.).

The aileron control also follows the same plane of transmission as far as the after wing spar (hull frame 34), whence, by means of a bent lever on ball bearings, it sets in motion a large double balancer acting in the plane of the wing spar. This balancer actuates a pair of rigid tubes which run parallel to the wing spar until they reach the ailerons.

The Do X has dual controls with two pilot seats. In front of each pilot there is a control column ending in a vertical wheel (Fig. 21). As on other airplanes, the shifting of the column fore and aft operates the elevator, while its rotation actuates, by means of chains of the bicycle type, the rigid tubes which control the ailerons. Pedals with a fore-and-aft motion operate the rudder. The position of each pilot seat can be adapted vertically and longitudinally to the pilot, so as to facilitate the operation of the pedals. The pilot on the left can operate with his right hand three wheels near his seat (Fig. 21). The largest one controls the water rudder. The other two wheels are located farther aft and are coaxial, controlling respectively the angle of attack of the auxiliary rudders and of the elevator balancers.

The instruments indicating the altitude, speed, direction, etc., are located either in the pilot room or in the control cabin just behind it. The controls of the variable angles of attack are operated by means of smooth steel cables which rotate, in the zone of the tail surfaces, systems of two toothed wheels and an endless chain like a bicycle chain.

To the left of the left pilot and to the right of the right pilot two large parallel levers enable each pilot to operate directly the throttles of the six left engines with one lever and the six right engines with the other lever. A new type of electric indicator shows between the two posts the mean r.p.m. of all the engines. The complex and cumbersome instrument board for the twelve engines is installed in a suitable room aft of the control cabin.

Power Plant

The twelve 500 hp Jupiter engines, made by Siemens of Berlin, are installed tandem in six nacelles 3.6 m (11.8 ft.) between centers. The end frames of the nacelles and the flanges of the engine supports are of two types, differing 20 cm (7.87 in.) in depth. On adjacent nacelles the supports are installed so that the propeller planes are alternately staggered 20 cm. The vortical zone of air at the periphery of the propeller is thus prevented from affecting the rotation of the adjacent propeller.

The engines have reduction gears, their maximum r.p.m. of 2100 corresponding to 1050 r.p.m. for the propellers. These are wood with four blades. They have a diameter of 3.55 m (11.6 ft.) and a pitch of 3.65 m (12 ft.). Their leading edges are completely covered with sheet copper. The forward propellers consist of two 2-bladed propellers superposed at an angle of 90° (Fig. 5).

The after propellers, on the contrary, have a one-piece hub and are covered with oil varnish. The metal hubs are of the Rupp type with a central bolt and without the 12 bolts between the metal flanges, as in ordinary propeller hubs.

The engines are controlled from a suitable room in the center of the wing, as already mentioned, on two large instrument boards, one for each group of three nacelles. These boards carry the gas throttles, revolution counters, oil thermometers, pressure indicators, etc.

Two steel cables transmit the rotation of the axis of the gas throttle to the different engines. One wheel can operate simultaneously the throttles of each set of six engines controlled from the same board. The individual throttle levers are located on the same axis of rotation at the side of the pilot. In each nacelle there are other throttle levers and other indicators in duplicate.

The gasoline is carried in the hold. There are four main tanks of 3000 liters (792.51 gallons) between the principal frames of the hull, and two other tanks of 1700 liters (449.1 gal.) toward the prow. The addition of two small tanks of 300 liters (79.25 gal.) makes a total normal fuel load of 16,000 liters (4227 gal.). If it is desired to increase the flight range of the Do X for some special purpose at the expense of the pay load, six other tanks (2 in the bow and 4 in the stern) of 1300 liters (343.42 gal.) can be carried, thereby increasing the fuel load to nearly 24,000 liters (6340 gal.).

The fuel tanks are duralumin reinforced internally by numerous circular frames. Moreover, the cylinder walls are thicker underneath than on top. All the tanks have tubular connections at the bottom, which connect them with a central pipe beside the stairway descending into the hold at frame 42, where there is a central instrument board for opening and closing the cocks of the different tanks and where the fuel gauges are located. The whole system of fuel and oil pipes is installed on the vertical plane of frame 42, which is the plane of the forward wing spar.

The fuel is pumped by electricity from the tanks in the hold through the central pipe into the tanks in the leading edge of the wing, passing through suitable filters. From the wing tanks it flows through smaller pipes to the different nacelles. The pipes run along the forward wing spar in close contact with one another. Together with the oil pipes, the fuel pipes to the engines and the compressed-air pipes for starting the engines, they occupy almost the entire height of the spar in the central part of the wing.

For refueling from the outside there are suitable connections in the plane of frame 42 which terminate, near the control cabin on the right and left sides of the hull, in two large covered orifices adapted to any flexible refueling pipe.

The oil is contained in a 1000-liter (264-gallon) tank in the hold, from which a system of pipes conducts it to the six nacelles. In each nacelle there is a small oil tank equal to 0.1 of the normal volume of gasoline.

We will not here go into further details which are not necessary for a general description of the Do X. We will refrain from describing all the accessory systems (furnishings, radio, drainage, fire prevention, illumination, etc.). We refer the reader to what we have previously written regarding the "Superwal" ("L'idro Dornier Superwal," Rivista Aeronautica, 1928, No. 9).

Launching Car and Floating Dock

The Dornier Company, in building its principal workshops at Altenrhein on the Swiss shore of Lake Constance, where the Do X was constructed, provided a complete launching plant with rails and a large launching car, railways between the principal hangars and an 85,000 kg (187,393 lb.) balance in the large assembling hangar in order to weigh the Do X on the car. The launching car weighs a little over 37,000 kg (81,570 lb.) and admirably serves its purpose. It has two electric motors enclosed in two water-tight boxes, which are kept during immersion at an internal pressure higher than the external by means of a cylinder of compressed air, in order to prevent the infiltration of water. The motors have horsepowers of 35 and 15 and are supplied by a large flexible cable attached to the car, the other end of the cable being attached to a post of control on the ground.

According to the motion of the car, the cable is wound on or unwound from a large drum. The motors can also be operated on the ground directly from the car. The car can enter the workshops and descend into the lake on the track. The more powerful motor moves the car on the track while the other rotates the platform supporting the Do X. Without some such device, the Do X could not be moved from the land into the water and vice versa. On the other hand, the Do X cannot be allowed to remain permanently in the water. The bottom plates of the hull, though strong and quite thick, are duralumin, which is corroded by sea water. The varnishes used do not afford perfect protection unless applied quite frequently.

Two processes of protecting duralumin have been developed. One is to cover the duralumin with a protective layer of oxide; the other is to plate the duralumin with a layer of pure aluminum. These new and expensive processes have not yet come into general use. They were hardly known when the construction of the Do X was begun. At present the protection of the Do X will be entrusted to special varnishes. Hence it must be brought ashore occasionally for revarnishing. The raising of it by powerful naval cranes is out of the question, because, even if the cranes had a lifting capacity of 26,000 to 28,000 kg (57,320 to 61,730 lb.) (the empty weight of the Do X according to its equipment), there would be no adequate points of attachment for lifting it. It would be necessary to take the seaplane apart, by first removing the nacelles with the engines and then the various parts of the wing. This would upset the whole system of engine controls and pipes, involving an amount of work entirely disproportionate to the simple operation of varnishing the hull. Consequently, any company wishing to use the Do X, must equip one of its stations with a car and track system similar to the one at Altenrhein.

The case of the "Luft Hansa" is of interest in this connection. It has purchased the Do X and will transport it to the Baltic Sea, where the company already has a floating dock with a capacity of 100,000 kg (220,462 lb.) for raising large seaplanes, which is very useful for repairing slight injuries. Since the Baltic Sea was frozen over for several months during the past winter, the "Luft Hansa" is now constructing a track and car in a Baltic port before transporting the Do X there. In the meantime the Do X will remain in the fresh water of Lake Constance or on land on suitable supports which can be elevated by powerful jackscrews.

The above statements were made because there is a common tendency to regard large seaplanes as capable of remaining in the water a long time, like boats.

Doubtless, in the service of the air lines, seaplanes of the Do X type will remain on the water weeks at a time. Once in every three to six months, however (according to the kind of varnish used), they should be removed from the water for cleaning and varnishing. It is therefore necessary to provide adequate means for doing this at the most important stations.

The Do X, in taking off with 48,000 kg (105,822 lb.), has demonstrated a carrying capacity of at least 20,000 kg (44,092 lb.) including equipment, fuel, crew, and pay load. It is not improbable that, by lowering the safety factor of the wing to 4, the take-off load could be increased beyond the 48,000 kg, if the engines were powerful enough.

It is probable therefore that the first Do X seaplanes can make nonstop flights of 2500 km (1553 mi.) with a small pay load at the economical cruising speed and could cross the South Atlantic by the Cape Verde-Port Natal route. It is reported that the United States of America is about to place floating airdromes in the Atlantic. In such an event the Do X seaplanes could also follow the route Europe-Azores-floating airdromes-Bermuda-Florida or the route Ireland-floating airdrome-Newfoundland. The results obtained with the first Do X seaplanes indicate that, with suitable structural improvements and modifications, future seaplanes of this type will be able to provide regular transatlantic service.

Desiring to be conservative, Mr. Dornier recently stated that the Do X can guarantee normal and regular flight on stages of 1000-1500 km (622-932 mi.) with a large number of passengers and thus increase the efficiency of air lines.

In fact, taking into account a medium consumption of fuel and oil of 6 kg/km (21.3 lb./mi.) at an economical speed and calculating a fuel reserve of 30% per 1000 km (621 miles) of the course (which no existing type of seaplane can guarantee), it will be possible to carry comfortably 10,000 kg (22,046 lb.) of passengers and merchandise, with a maximum of 100 passengers. If it is desired to travel still more comfortably, the number can be reduced to 60 or to 40. The giant Dornier seaplane Do X can therefore offer increased comfort and safety on flights of five or six hours between maritime places.

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

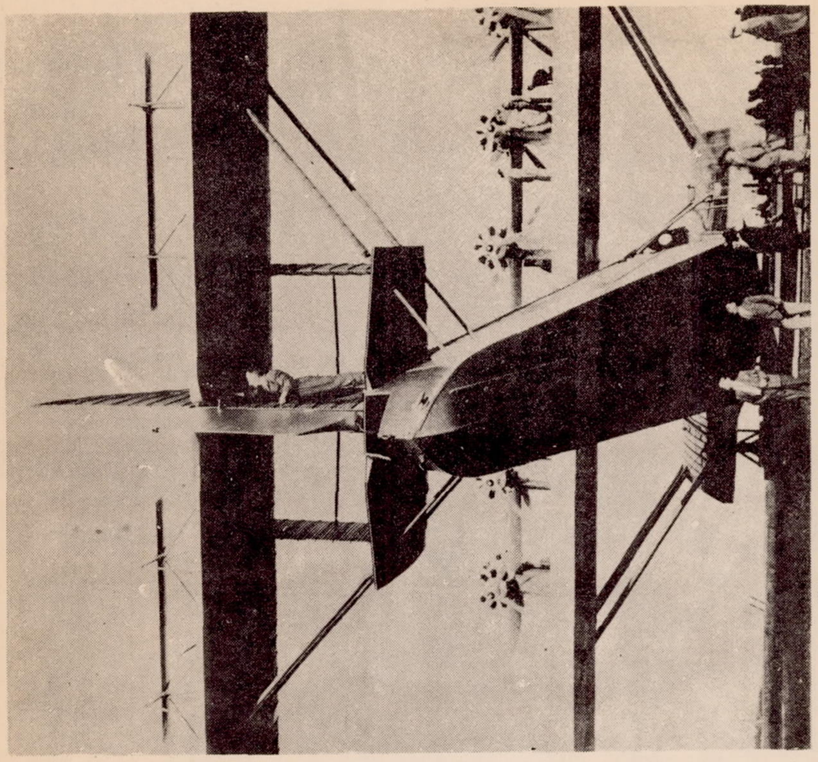


Fig.4 Rear view of the "DoX"

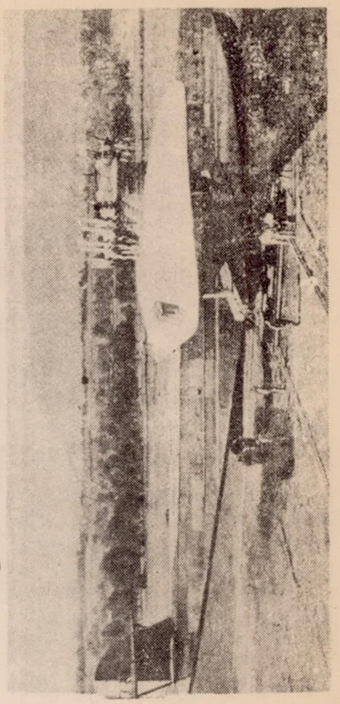


Fig.1 The "DoX" on towing truck outside the work-shop.

Fig.5 Control cabin.

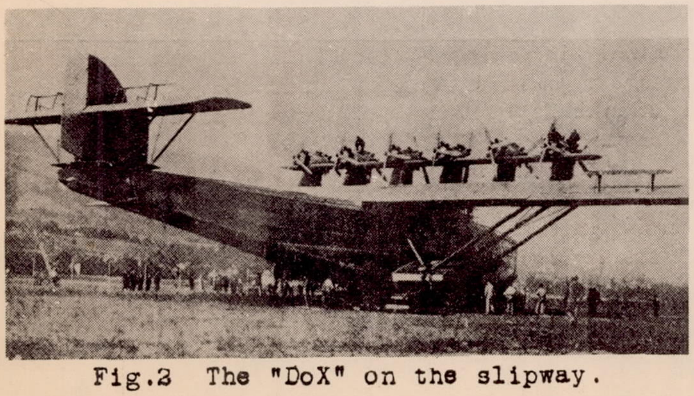


Fig.2 The "DoX" on the slipway.

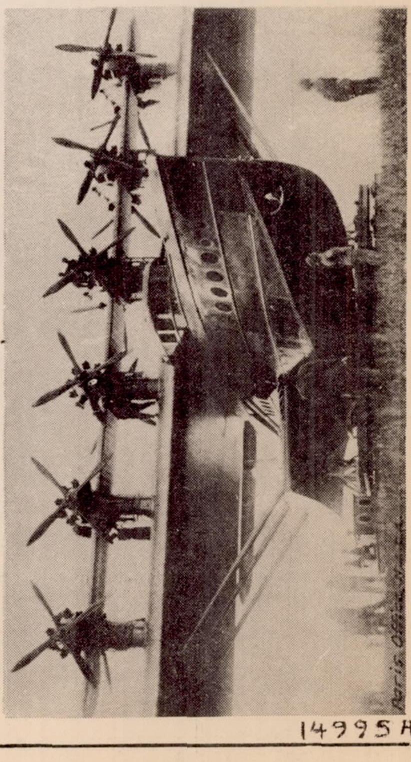


Fig.3 Front view of the "DoX" on truck.

14995 A.S

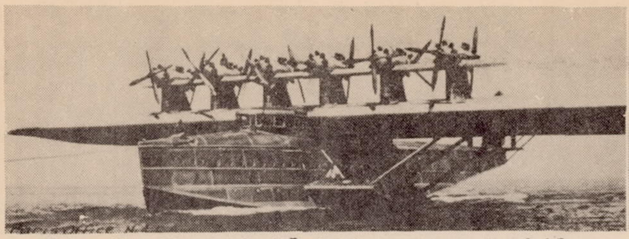


Fig.6 The "DoX" being towed while starting the engines.

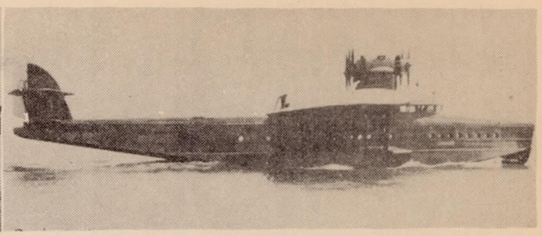


Fig.7 The "DoX" afloat.

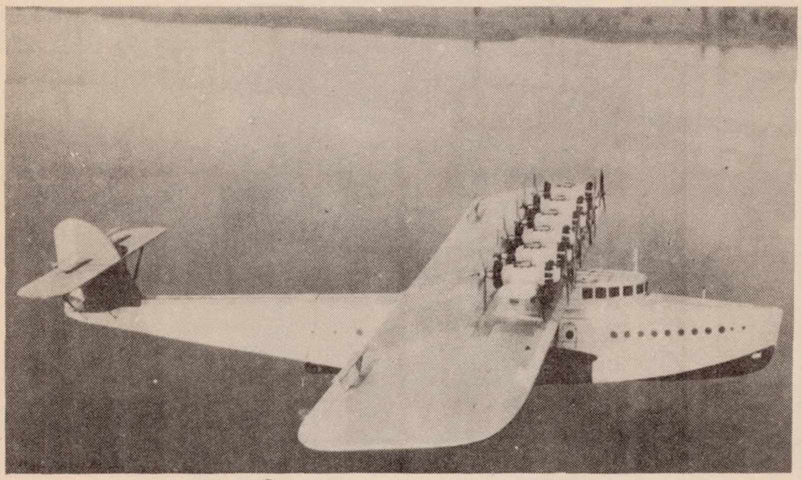


Fig.8 The "DoX" in flight.

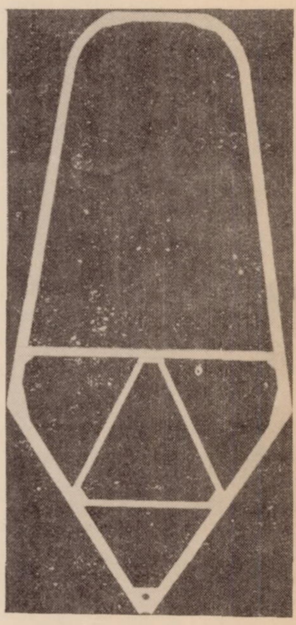


Fig.14 A frame of the hull near the prow.

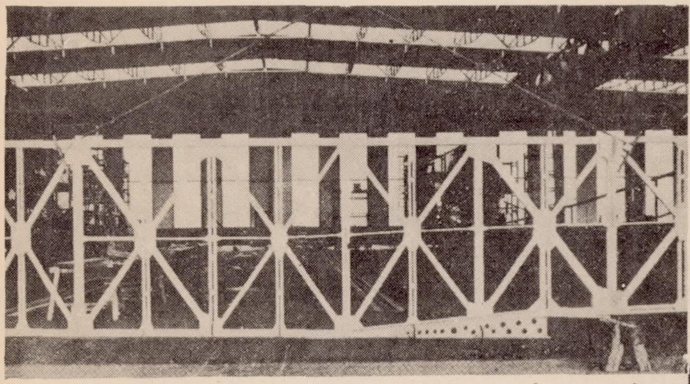


Fig.12 Keelson of the "DoX" in the region of the step.

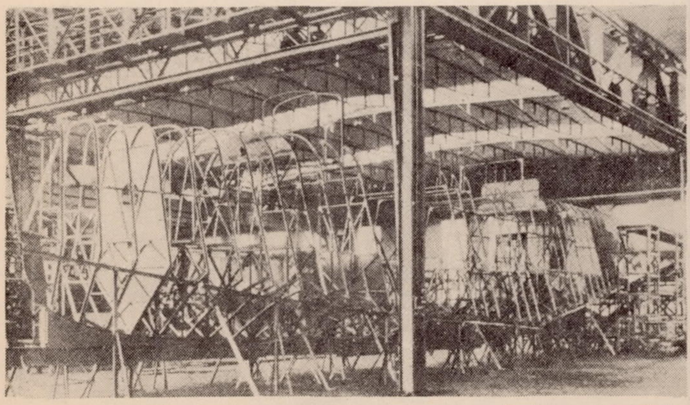


Fig.15 Skeleton of the hull of the "DoX" with all the frames attached to the keelson.

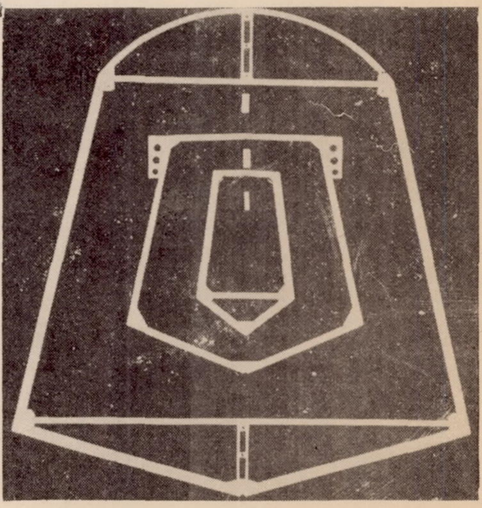
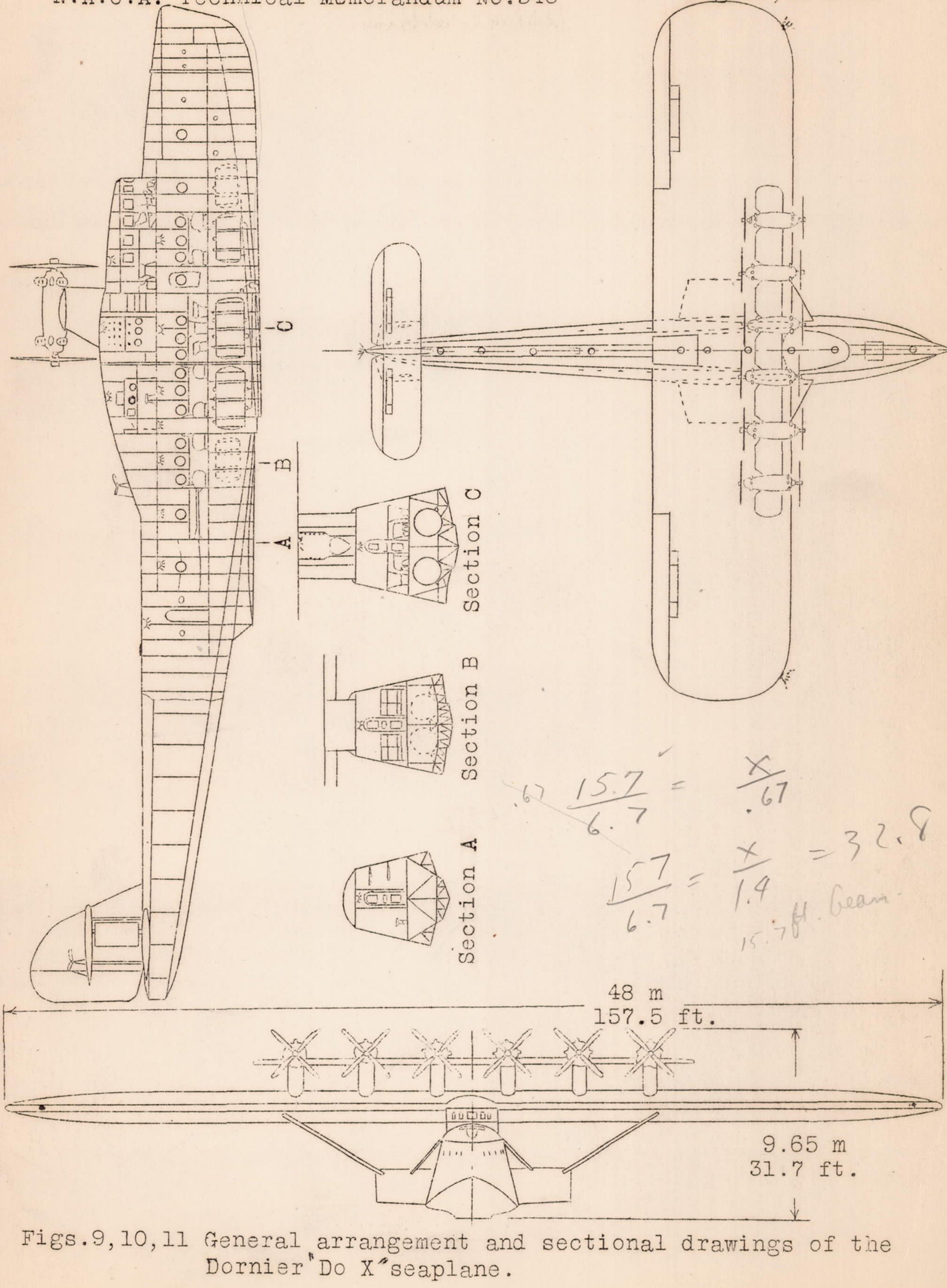


Fig.13 Three frames of the hull near the tail.

14996 A.S.



Figs.9,10,11 General arrangement and sectional drawings of the Dornier "Do X" seaplane.

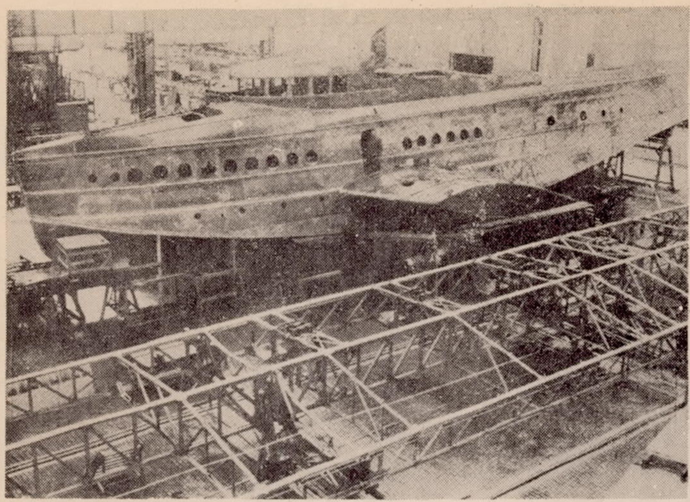


Fig.16 Assembly of the three wing spars with the ribs. In the background a "DoX" hull with wing stub under construction.

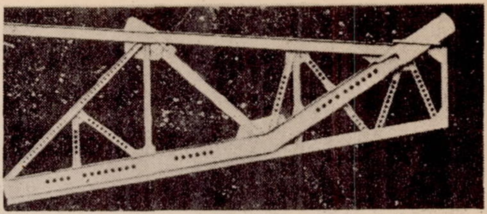


Fig.17 One of the main frames of a wing stub with attachment for wing strut.

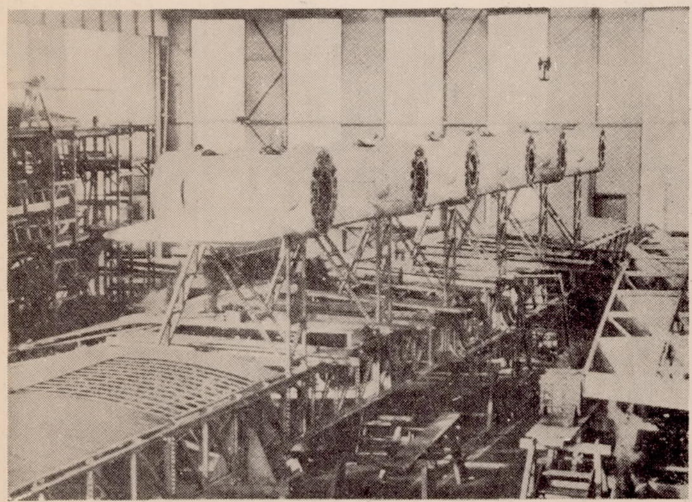


Fig.18 Assembly of six engine nacelles with connecting wing and supports. Partially covered wing at the left.

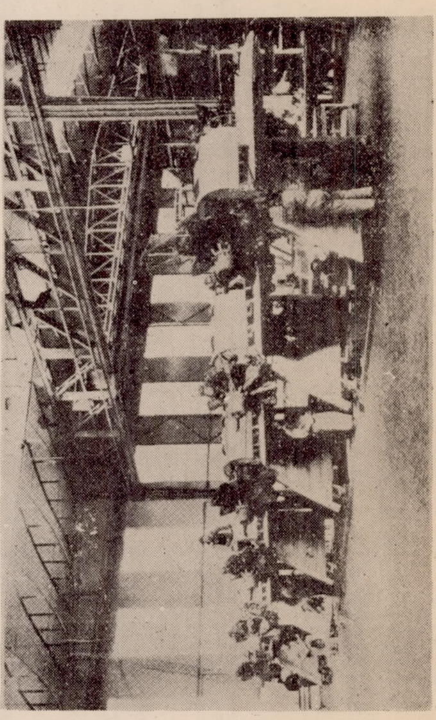


Fig.19 Assembly of six nacelles equipped with Jupiter engines.

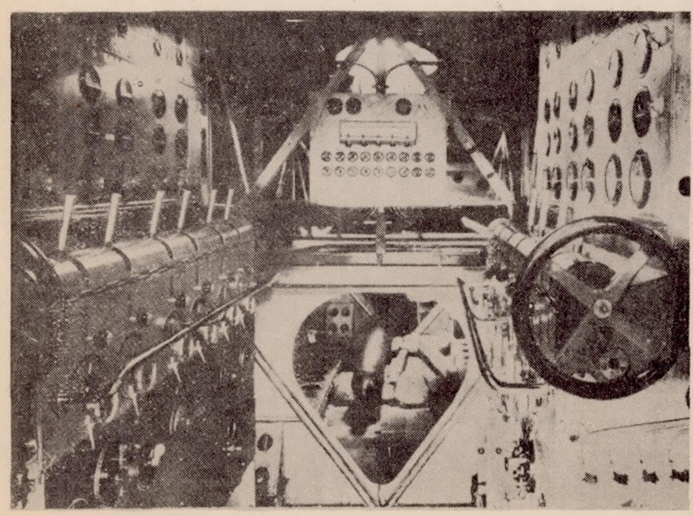


Fig.21 Cabin of chief mechanic.

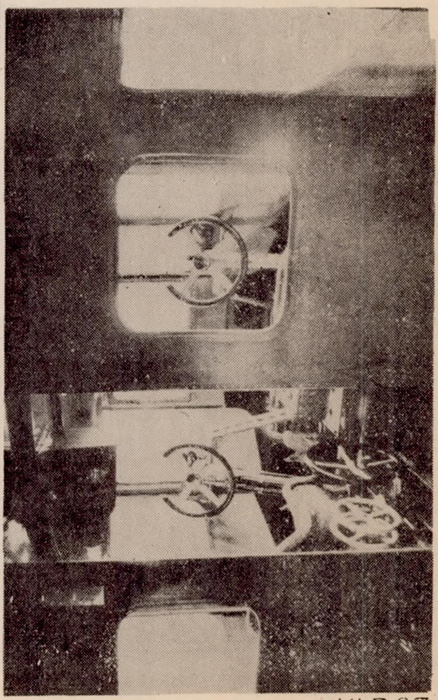


Fig.20 Pilot room as seen from control cabin.