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GERMAN AIRCRAFT INDUSTRY

BRITISH INTELLIGENCE OBJECTIVES

SUB-COMMITTEE

GERMAN AIRCRAFT INDUSTRY

Report of visit by representatives of

SHORT BROS. (Rochester & Bedford) LTD.

on September 24th - 29th 1945.

Reported by:

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BIOS. Party No.1264

BIOS Target Numbers
4/50, 4/48(a), 25/186, 25/3, C25/385,
26/43, C9/566, C9/269

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1. SEAPLANE TESTING ESTABLISHMENT - TRAVEMUNDE

The establishment is now used principally as a store and junk heap. The interesting items available were as follows:

1. Damaged B.V.222. 45 ton. 6 engined Flying Boat. For details see Part 2.

2. D.B.606 (?) engines geared together in pairs in single power units (presumably for Heinkel 177).

   The two inverted V engines are side by side with their crankcases brought close together. All engine accessories appear to be duplicated. The radiator is of the ring type as developed for the Sabre in this country.

   The installation looked neat but difficult to service.

3. Rocket assisted take off Units. Walther liquid fuel rocket system. The units, complete with tankage, are approximately 2'3" in diameter and 3' long.

4. Wing of fighter aircraft (Unidentified). The spar constructions were of interest, being built up of two flat extrusions with a sheet web. The web was flanged over and rivetted to the extrusions.

5. A number of miscellaneous flight test instruments were also seen but there was no time to examine them.

WALTHER WERKE - KIEL

2.1 General

This establishment was solely concerned with research and development on Rocket engines. The progress made in this field is most impressive. The work was reported to be subsidised by the government to the tune of a million pounds per annum.

Mr Baxter and Mr Kell of R.A.E. conducted the party who saw the following :-

1. Rocket engines under test both active and inactive.
2. Demonstration of chemical reactions in the laboratory given by Von Duren, one of the chief chemists.
3. Application to torpedoes, etc., in the workshops.
4. Film demonstrating the various applications of the rocket engines.

2.2 Description of Engine

"T Stoff" (concentrated hydrogen peroxide) and "C Stoff" (fuel) are supplied by separate centrifugal pumps to a number of nozzles in the combustion chamber.

The mixture of the two fuels in the combustion chamber results in decomposition of the hydrogen peroxide into oxygen and steam with spontaneous combustion. The combustion reaches a temperature of 1,800°C with a jet velocity of 5,000 f.p.s. This is known as the "hot" process.

It is interesting to observe the shock waves in the jet.

The particular unit seen under test was for the Me.163 and gave a thrust of 3,700 lb. for an engine weight of 380 lb. and a fuel consumption of 20 lb/Sec. total.

The centrifugal pumps are driven from a single turbine operating on the "cold" process. Here "T Stoff" by-passed from the main flow to the nozzles, is decomposed by the action of a solid catalyst. The resulting steam and oxygen, at a temperature of about 500°C, drive the single stage turbine.

The "cold" process is less efficient than the "hot" process. The fuel consumption comparison is roughly -

"hot" process 19.5 lbs. of fuel/hr. per lb. thrust.
"cold" process 32.4 lbs. of fuel/hr. per lb. thrust.

c.f. Turbine Jet engines with a consumption of approximately 1 lb. of fuel/hr. per lb. thrust.

2.3. Chemistry

"T Stoff"

The essential ingredient of both the hot and cold process is "T Stoff" which is concentrated hydrogen peroxide - 80 - 85% H2O2. An inhibiting catalyst is added to this to make the liquid more stable and to control the combustion.

"T Stoff" is decomposed by nearly all organic matter with evolution of oxygen and usually results in spontaneous combustion, e.g. when sprinkled on rag or paper there was an immediate fire.

To protect the workers, overalls of woven polyvinylchloride are supplied.

The best form of neutralisation is by dilution with large quantities of water. A plentiful water supply is, therefore the only other protection needed by the workers.

"T stoff" can be stored in anodised aluminium tanks coated with paraffin wax (note, bees wax causes decomposition). Aircraft and submarine tanks are made as flexible, rubber like bags of polyvinylchloride.

"C Stoff"

"C stoff" is the fuel used in the hot process and comprises a mixture of methyl alcohol and hydrazine hydrate ("B stoff").

Methyl alcohol	CH_3OH	57%
Hydrazine Hydrate	$N_2H_4.H_2O$	30%
Water	H_2O	13%
		100%

No catalyst is needed with this fuel.

Catalysts.

The catalysts used in the cold process may be either liquid or solid. A solid catalyst, made by impregnating porous porcelain marbles with calcium permangenate and potassium chlorate or managanese dioxide, is favoured. It appears that the catalysts are all powerful oxidising agents.

Von Duren gave a very convincing demonstration of these reactions in the laboratory.

2.4 Applications of the Walther Engine

A film demonstrating the applications of the engine was displayed. These include:-

Aircraft e.g. Me.163.
Projectiles
Launching ramps for V.1
Assisted take-off - see Chapter 1.

Experiments have also been made on Hydrofoil floats with speeds of approximately 50 knots.

Landing barges capable of running up the beach and, in the example shown in the film, of clearing the sand dunes and coming to rest in a field of cows.

The V.2 rocket engine is similar in conception but uses liquid oxygen in place of hydrogen peroxide.

It would be interesting to get details of the hydrofoil floats which, judging by the film, seem to be very stable at speed. They appear to be fitted with three hydrofoils - two forward and one aft.

2.5 Conclusion

The progress made at Walther works is most impressive and it is indeed fortunate for the allies that the applications had advanced no further before the cessation of hostilities.

It is essential that the research work should be continued, as we understand it will be for the benefit of this country.

3. ELECTROACUSTIC - KIEL

The party were shown round by Dr. Nicholson, Chief Designer to Electroacustic. The works had been engaged upon the manufacture of sound location and radar equipment for ground and marine installation.

There is no aircraft interest here.

4. BLOHM & VOSS - FINKENWARDER - HAMBURG

4.1 General

This was a large and well equipped factory used for development work but most of the equipment had been removed before our visit. The large BV.222 and 238 flying boats and the BV.155 high altitude fighter were built here.

Design and technical offices were situated alongside the factory.

The principal items of interest were :-

Drawing Offices.
Experimental shop.
Wind Tunnels.
Full Scale Lofting Equipment.
Parts of BV.238. Tubular Steel jigs.
Parts of BV.222
Parts of BV.155.
Small scale models of current types.

4.2 Drawing Offices

Most of the equipment had been removed but from what remained it appeared that all draughtsmen were supplied with "draughting machines". That is to say that the boards are fitted with automatic "T" squares and are capable of being put to any angle or height desired. There was no evidence of any boards and benches as used at Short Bros.

The drawing library which is directly below the Drawing Office was also well equipped with steel cabinets to contain the drawings. These presumably offer some measure of protection against fire.

4.3 Experimental Shop

There was very little apparatus left in the experimental shop which was chiefly interesting from the point of view of the shop itself.

It is a lofty building with overhead crane. The floor is cross hatched with steel rails set flush in the concrete to allow equipment to be bolted down.

The building is approached from the drawing offices at one end and has large hangar doors at the other.

The whole block of buildings showed signs of careful planning.

4.4 Wind Tunnels

The wind tunnels are placed in an annexe to the main experimental shop. There are two tunnels in working order.

1. Open jet general purpose tunnel.

5 ft. jet (circular)
70 metres/sec. (230 f.p.s.) max. speed.
400 BHP.
Universal Balance.

It is considered that this tunnel is well suited for ad hoc testing in an organisation such as ours. Application is, therefore, being made to have this tunnel allocated to Short Bros.

2. Smoke Tunnel.

Working Section 4 ins. x 5 ft. approx.
50 metres/sec. (164 f.p.s.) max.speed.
50 BHP.
Oil smoke from small burner plant.
Very strong lighting on working section.

It was stated that both tunnels were in almost continuous use and the staff required to operate them was a total of 20 - 10 men and 10 girls.

An excellent technique had been developed for exploring the flow round nacelles, etc. A fine suspension of chalk in water was sprayed onto the test specimen during test by means of a hand held tube with a single small jet. We were shown photographs of models on which clearly defined chalk lines displayed the flow pattern very clearly.

Blohm and Voss were about to instal a third tunnel capable of testing to high Mach numbers.

4.5 Full Scale Lofting

Blohm and Voss had adopted photographic lofting. The apparatus used was most impressive and obviously very expensive. The contact printing frame was approximately 10 ft. x 20 ft. and fitted with over 100 bulbs of 500 watts (?) each. The developing and washing plant which like the printing apparatus was still complete, was on the same scale.

The camera (at the Elbschloss Brewery) was also on a very large scale. It was mounted with axis horizontal, i.e.

vertical plate.

Apart from the camera from which the lens has been removed, the whole of the lofting equipment appears to be complete.

There were samples of printing on a variety of mediums including paper, wood, metal sheet and plastics.

4.6 Parts of BV.238

The BV.238 is a 90 ton flying boat similar in conception to the BV.222. One had flown but unfortunately was destroyed by fighter attack only a few days before VE day.

The hull at Finkenwarder was in a tubular steel jig and was about 50% complete. This jig was of particular interest in that it was built up on standardised tubes and clamps and could be assembled to suit any size of aircraft. The same jig could be made up an unlimited number of times for different type of aircraft.

It would seem that such equipment would be most valuable for a development section building prototype aircraft because it would avoid the cost and time of building permanent jigs. The initial outlay would be heavy but would be spread over many prototypes.

The wing jig was similar to the hull jig and contained a small portion of wing leading edge.

Other parts including the welded tubular steel spar were seen in different parts of the factory. The centre section of the spar was in the yard for pressure testing (it also forms tankage for fuel and oil. For further details see Part II Chapter 3.1).

4.7 Parts of BV.222.

The BV.222 is a 45 ton. 6 engined flying boat of which about 13 have been built and flown.

A hull complete with wiring was seen in one of the hangars. It was not examined because a similar hull is available in England. A wing tip float was seen alongside the hull.

4.8 Parts of BV.155

The BV.155 is a single engined high altitude fighter with a conventional reciprocating engine fitted with turbo blower. One prototype had flown.

The fuselage was seen in the jig and beside it was a mock-up of the nacelles which carry the radiators (inter-cooler?). These nacelles extend the local chord by some 10% forward and 60% aft. They are flat topped and of similar aerofoil section and t/c ratio as the wing itself.

4.9 Small Scale Models of Current Types.

A number of models were seen in one of the offices. Most striking of these was a model of a civil version of the BV. 238 on which large panels were cut out and replaced with perspex to show the interior fittings and decorations.

5. BLOHM & VOSS - ELBSCHLOSS - BRAUEREI

A machine shop belonging to Blohm and Voss was situated in the cellars of the Elbschloss Brewery, Teufelsbrucke, Altona, Hamburg.

The chief items of interest were:-

(1) The camera for full scale reproduction from the loft. The lens of this camera was missing. See 1, 4, 5.

(2) A 150,000 kg. tension and compression electrical testing machine by Losenhausenwerk.

(3) A 500 kg. tension and compression manual testing machine by Amsler.

(4) A Brinell hardness testing machine by Briviskop.

6. BLOHM & VOSS - BARSBUTTEL

This was an underground machine shop located in the Autobahn tunnel at Barsbuttel, near Hamburg.

It was now used as a R.E.M.E. store and workshop and there was nothing of aeronautical interest.

7 J.D.MOLLER - WEDEL

This was a small firm engaged on the manufacture of spectacle and other lenses, prisms for periscopes, binoculars, etc. They did not manufacture optical glass but only processed it. We were told that only some 10% of the output was "war production", the remaining 90% being the same products as were made before the war.

The most interesting section of the works was a special under-ground shop making diffraction gratings and other precision optical parts. The lines on the finest gratings were spaced at intervals as small as 10^{-5} inches. The machine for making these lines on glass sheet had been designed and built in the works and it was stated that the errors in the spacing of the lines had been reduced to as little as 10 Angstrom units. The elderly technician in charge stated that with two or three years further research he could reduce this to 2 or 3 Angstrom units.

We had been told in Hamburg that the firm had been concerned with experiments on concentrated hydrogen peroxide for use in rocket engines of the Walther type. No evidence of this was found.

8 L.F.A. VOLKENRODE - BRUNSWICK

A short visit was paid to Volkenrode where the party were shown round by Dr. Duncan.

Among the test equipment seen was :-

25 ft. open jet tunnel..

Sonic and super-sonic (flexible wall) tunnels.

High speed tunnel (similar to R.A.E. but with air exchange instead of refrigeration).

Shooting tunnels for testing the flight of bullets in a strong cross wind such as obtains in air to air gunnery.

Turbine blade testing equipment with interferometer. This was impressive in that the apparatus was small and simple and the results very clear. Briefly the principle is to divide a light beam so that part passes through the test section of the tunnel and part passes outside the tunnel. The two beams are then brought together to a common focus. By adjustment to the relative lengths of the two paths a series of parallel interference bands are shown on the screen. The tunnel is then started up and the changes in air density round the model gives rise to distortion of the interference bands. Breakaways and shock waves can be clearly seen by this means.

Water Cooled Turbine Blades. There was no forced circulation through the blades. Circulation was obtained solely by convection which is enhanced by centrifugal force.

High Altitude engine test equipment. The equipment viewed simulated high altitude conditions at the carburrettor and exhaust only. Chambers for testing the complete engine at high altitudes were under construction. An interesting point was the method of obtaining low temperature by compressing the air, cooling it, and expanding through a turbine so as to regenerate as much power as possible.

It is not within the scope of this report to give an account of the tremendous research organisation at Volkenrode. However, the party was much impressed by the huge scale of the organisation and the fact that it had been built up mostly during the war. It was entirely undamaged due to the excellent camouflage.

PART II

DESIGN

1. Introduction

An interview was held in the Hamburg Museum on September 27th with the following members of the Blohm and Voss staff :-

Dr.R.Voght	Chief Designer
R.Sshubert	Chief of Aerodynamics and Hydrodynamics Department.
K.Scherer	Chief Flight Test Engineer.
Kroll	Assistant Director (Part time)
Gaats	Production Engineer.

The interview with Mr Gaats is reported by Mr Swallow in Part III of this report.

In this report, the design information gathered from the above interview is set out in conjunction with the observations made on the actual aircraft. All information on each subject is thus collected under a single heading.

Owing to lack of time, the discussion was limited to the large flying boats, viz:

B.V.222	6 engined boat of 45 tons approx. 13 boats had been completed and flown.
B.V.238	6 engined boat of 90 tons. One had been completed but unfortunatey it was destroyed by fighter attack just before VE day.

The main points of interest were :-

Flying Controls
- Ailerons
- Elevators
- Rudders

Structure
- Wing Spar
- Hull Structure

Hydrodynamics
Wing Tip Floats
Planing Bottom

2. Flying Controls

2.1 Ailerons

It was observed on the BV.222 at Travemunde that the aileron was split chordwise into two unequal parts. The tip portion is about 1/4 of the total.

Dr. Voght explained that the tip portion was directly operated by the pilot in the conventional manner. The inboard portion is operated by a pure servo tab, i.e. the pilots effort is transmitted directly to the tab and there is no mechanical connection between the wheel and the aileron itself.

The two parts are designed to move to the same angle at all normal speeds, and in operation appear to be a single aileron. At very low speeds and when taxying down wind the tab control on the inner portion is obviously ineffective. Stops are therefore provided on the tip portion to prevent the inner portion getting more than a few degrees out of alignment. On coming onto the stops, the inner portion becomes directly operated but with progressive application of the tab.

The inner portion is balanced by an elliptical nearly symmetrical nose balance. (Dr. Voght had had no success with Frise balance). The tab operation is similar to a spring tab without a spring and therefore incorporates the safety feature that if the aileron is moved with stick fixed, reverse tab tending to restore the aileron to neutral is automatically applied. Mass balancing presents the same problems as on a spring tab. The tab like the main surface, has an elliptical nose balance.

The tip portion has a similar nose balance to the inner portion, roughly 30-33%. Adjustment is obtained by means of a "paddle"balance. This also was seen at Travemunde.

It comprises two small paddles or flags pointing forwards and geared to the aileron so that they spread sideways when the aileron is deflected. See Fig.1

Three main advantages are claimed for this type of balance.

1. Adjustability

It is easy to alter the length of arm or gear ratio so as to alter the heaviness of the control.

2. Corrections to Hinge Moment Characteristics.

Normal nose balances give an aileron which is lighter at small angles than at large. The paddle balance is most effective at large angles when the paddles approach a right angle to the wind. The use of paddles, therefore, makes it possible to get lightness without danger of overbalance at small angles. See Fig.2.

3. Correction to Lateral Stability

The use of two paddles moving in opposite directions was adopted so as to overcome the effects of sideslip. By judicious variation in the relative sizes and lever arms of the two paddles it is possible to arrange the requisite degree of aileron application with sideslip. This gives a similar effect to dihedral on the wings.

The possible variables are :-

Paddle area.
Lever arm.
Aspect Ratio which affects stalling angle.
Gearing to Aileron.
Relative sizes of the pair.

It was claimed by Dr Voght that this arrangement was so successful on the BV.222 that it ws adopted without change on the BV.238, the prototype of which was passed out after only four test flights.

We asked Dr.Voght why it was necessary to have a directly operated tip portion. His reply was that he had lacked complete faith in the pure servo tap and so incorporated the tip as an insurance. He kept it because it made it possible to give the pilots the "feel" they liked.

In answer to a question Schubert said that both parts of the aileron was designed to float neutral in the event of the control rods being severed.

The operation of the controls is by torsion tubes throughout. The reason given was that push-pull rods or cables suffer from lack of stiffness due to deflection of the structure and backlash due to temperature effects. Torsion bars avoid this and weight very little more. The stiffness criterion was the percentage of the maximum wheel movement which could be obtained with 50 kg. (100 lbs.) on the wheel when the control surface was locked. With torsion bars this was reduced to 8 – 10%.

Friction presented more of a problem but was finally reduced to 3 lbs. static load on the BV.222.

The torsion bar did 2½ revolutions in moving the aileron from one extreme to the other. The gearing was by pinion and quadrant. There were no universal joints in the system and a minimum of bevel gears where it was necessary to change direction.

2.2 Elevators

It was noticed on the BV.222 at Travemunde that the elevators were divided into three parts.

Dr. Voght explained that the outer portion was purely for trimming and was in the nature of a partly moving tail-plane. This had been abandoned on the BV.238

On the BV.238 the elevator is divided into two parts, the inboard portion (65% span) is operated by the pilot through a pure servo tab as on the inboard portion of the aileron.

The outboard portion (35% span) is operated by the auto-pilot. Dr. Voght maintained that auto-pilots are never 100% reliable and that this arrangement allows the pilot to overrule the auto-pilot by virtue of the larger elevator area under his control.

For take-off and landing the auto-pilot is switched out and the outer portion of elevator is operated through the auto-pilot servo motor by a potentiometer actuated by the control column. The two parts of the elevator then move together, though without mechanical connection.

In order to get synchronism between the two parts of the elevator it is then necessary to introduce a follow up mechanism. (Normally this is not included in the auto-pilot circuit. The auto-pilot continues to apply elevator up to the maximum available angle until the aircraft has responded).

If the follow up gear is left in circuit when the auto-pilot is switched in, the auto-pilot will make small movements of the outer portion of the elevator in the direction such as to oppose the action of the pilot. This condition gives greatly improved static and dynamic stability and, in the view of the designer, would, if acceptable to the authorities, allow considerably reduced tailplane sizes.

Finally, with the follow up gear out and the auto-pilot in, the aircraft is controlled by the auto-pilot in the usual way. The control column is then held central by a preloaded spring centraliser. This centraliser is arranged to give a very flat characteristic once the preload, which is designed to be equal to the static friction load has been overcome. The longitudinal trimming is also performed by means of this centraliser. No trimming tabs are fitted.

It would seem that a jerk must be felt on the stick when it is moved through the neutral position. No cams were used.

There are, therefore, three methods of operation available to the pilot.

1. Take-off and landing. Elevator moving as one piece.

2. Super-stability. With auto-pilot and follow up gear in.

3. By Auto-pilot. Follow up gear out.

2.3 <u>Rudder</u>

The rudder on the BV.222 and 238 was in a single piece, operated by pure servo tab. To cater for tail to wind taxying, there were stops similar to those between the two portions of the aileron. The rudder therefore became directly operated if its angle departed appreciably from that corresponding to the tab angle.

2.4 Tab Box

Dr. Voght had designed a very neat tab box for the large boats. Instead of separate wheels to trim in the three planes he supplied what amounted to a miniature replica of the main control column. This "stick" operated in a cruciform gate and was spring loaded to return to neutral. Operation was by means of a ratchet. To trim nose down, for example, the stick would be pushed forward and allowed to spring back as many times as was necessary. Directional trim was achieved by twisting the stick.

It was claimed that this method was equally suitable for mechanical or electrical operation of the tabs and was soon to be adopted as standard in Germany.

3. Structure

3.1 Wing Spar

The BV.222 and 238 employ a welded tubular steel wing spar. On the BV.238 the centre section spar, which was seen at Finkenwarder (Part I, 4.6) is about 3 ft. diameter and parallel though of varying gauge. This part carries the tubular engine mountings for all six engines.

The outer wing spar is tapered. This was seen in the experimental shop at Finkenwarder.

The fuel is stored inside the spar which is divided into separate tanks for each engine with a reserve tank in the centre section.

Oil tankage is also provided inside the spar.

Dr. Voght made the following claims for this type of construction.

(1) Lightness

When compared on the basis of complete wing weight including structure, tankage, fuel system and nacelles the tubular steel structure shows a small advantage over conventional. This, he said, was demonstrated by a comparison with a Dornier design built to the same specification and all up weight (3 engined boat ?).

(2) Production

Dr Voght claimed that the tubular spar presented a very simple production problem. The flange bolts do not need to be fitted with great accuracy. The holes were made 1 mm. oversize for bolts of 12-16 mm. diameter.

Alterations and corrections can easily be made by chipping off welded lugs and welding on new ones.

(3) Drawing Office work.

The simplification of a circular spar avoided many errors in wing detailing.

(4) Bullet-proof tanks

On the larger sizes the thickness of steel is sufficient to give protection to the tanks from machine gun fire. There is thus considerable weight saving as compared with self-sealing tanks.

3.2 Hull Structure

From the floor up, the hull of both boats is clear of all bulkheads. Bulkheads at close pitch extend from the keel to the floor. The floor is rivetted down and has circular water-tight manholes for access to the bilges.

The majority of angle members have lipped edges.

The frames, especially at the centre section are apparently light by British standards. It was therefore difficult to see how the stresses were carried between the wing spar and the hull 'pontoon'. (That part below the floor).

Dr. Voght said that no heavy structure was needed to carry these stresses. Tests had been made on a BV.222 at Travemunde in which the following observations were made during take off and landing.

Water pressure on planing bottom.
Strain gauging of structure round centre section.
Acceleration at the keel, floor level and spar.

He could not produce the report which he thought had been destroyed in a fire but quoted the following maximum acceleration figures on the hull.

At the keel	10 - 12g
At the floor	3 - 4g
At the spar	2.1/2 g

4. Hydrodynamics.

4.1 Wing Tip Floats

On the BV.222 the wing tip floats are in wo halves and retract sideways into the wing. See Fig.3.

The two halves are independent and do not touch at the centre.

They look very small by British standards but Dr. Voght claimed that in practice they were adequate. He attributed this to two things.

(1) Hydrodynamic form to give high lift.

(2) Impossibility of submerging because the float is continuous up to the wing.

Small steps or flutes about 2 inches deep were attached to the float as shown in Fig.4. Presumably these are to throw the water off and prevent it running up the float.

4.2 Planing Bottom

The main step of the BV.238 is transverse and unfaired. It varies in depth from 3.1/2 ins. at the keel to 12 ins. at the chine.

On the BV.222 the main step is similar but there are also 5 small steps of about 1 inch depth and 30 inch spacing in the afterbody behind the main step. These had holes in them at close pitch as if for ventilation. It is not known whether this feature was incorporated on the BV.238.

The BV.222 had a knife edge rear step with a hole as if for a fixed gun.

The beam of the BV.238 is 11 ft. 8 ins. which seems very small for a boat of 90 tons. On the BV.222 the beam is approximately 10 ft.

PART III.

PRODUCTION ASPECTS.

Blohm and Voss Factories.

The Finkenwarder works are of relatively new construction and consist of first class administration buildings, large scale physical test shops and two large single span erection shops plus other shops. They are ideal for the design, development, erection and flying of large flying boats, excepting that the land on which the factory is located forms an island in the river, and, therefore, the employees had to cross the river to and from work.

It was afterwards ascertained that the majority of the detail and sub-assembly manufacture was carried out at the Steinwarder works (situated a little closer to Hamburg) which also carried out detail manufacture for Blohm and Voss shipbuilding activities. The information regarding the Steinwarder works was obtained too late to enable a visit to be made, but for future information it should be noted that it is being guarded by the Navy and is understood to be substantially damaged by bombing.

The dispersal point located in the cellers of the Elbschloss Brewery on the side of the river immediately opposite the Blohm and Voss Finkenwarder works consists of a number of machine tools, fitting benches, face plates, items of testing equipment and a full scale photographic outfit, together with dark rooms. This machine shop was too small to do other than small quantities and was probably used to machine test pieces and make up trial fittings for testing purposes.

In discussion with Gaats it was ascertained that a Blohm and Voss 238 boat was also being built at Bremen by a sub-contractor named Weserflugzeug adress Bau, Bremen. This factory is in the American Zone. The detail parts such as frames, rib pressings, etc. for this sub-contractor were supplied from the Steinwarder works.

This information was obtained too late and time did not allow of a visit being arranged but such a visit is strongly recommended as the 238 boat being built there is understood to be about 80% complete.

2. Interrogation of Mr. Gaats, Production Engineer.

It would appear that this man, who was in charge of all aircraft production for Blohm and Voss, had not been interviewed by anyone previously. He was exceedingly free in supplying answers to questions via an interpreter and a longer time could usefully be spent in discussing more extensive and detailed queries regarding the production of large flying boats.

He stated that the construction of the 90 ton type 238 boat was basically the same as the 40 ton type 238 boat. Thirteen of the type 222 boats, which was designed well before 1939, had been built. One type 238 had been flying for two months when it was sunk by allied fighters four days before the end of the war. The second 238 was being assembled at Finkenwarder, the hull is about 60% complete and the main planes barely started. The third 238 as already noted is about 80% complete at Bremen.

Brief production facts regarding the 222 boat are as follows:-

(a) Production time for the hull bare in the gantry was reduced to six weeks, working day and night.

(b) Production man hours for aircraft bare (i.e. less equipment and motors) averaged 350,000 after initial boats.

Regarding the type 238, Gaats stated that the total time to build the first boat in the shops, working day and night, was 14 months. Accordingly, work on this boat was first started in the shops about January 1944. However, I did not find out how much time prior to this had been spent on design, but due to the similarity of the 238 to the previous type 222, it must have been a fairly straightforward design job.

The hull and main planes for the 238 were built in gantries ingeniously fabricated from tubular members and standard clamping blocks, etc. In other words a Meccano-like development of the orthodox tubular scaffolding system. More details of this gantry or jig design should be obtained as soon as possible because its chief feature is that the parts from which it is fabricated can be used over and over again for different sizes of aircraft. The cost of this type gantry would not be warranted for one or two aircraft and this was confirmed by Gaats who stated that it was hoped to build a large number of 238 type boats. The estimated production time for the hull in this gantry was eight weeks, working day and night (that is, after initial teething problems had been overcome).

The whole of the jigs and tools for the 238 boat had been completed and these took 600,000 man hours to make.

I queried with Gaats as to whether any special riveting equipment had been used but the answer was no, excepting that a number of automatic riveting machines had been used on sub-assemblies at the Steinwarder works. These machines, which he described to me, make the hole, dimple the sheet, insert the rivet and head up automatically. The machine was developed originally by the Heinkel Co., but was later manufactured by the following firm - Niepmann Nietautomat. Some of these machines may remain undamaged at the Steinwarder works and one or two should be brought to England. In any case, they should be available at other aircraft works.

Gaats stated that Blohm and Voss did not believe in the use of drop hammers as their chief designer considered they "damaged" the material too much. However, he said that they were extensively used in other parts of Germany with elektron (magnesium) dies. More information should be obtained about these.

I saw some very good examples of pressed ribs in the Finkenwarder works and Gaats explained that these had been made on a double action mechanical press.

Full scale lofted lines reproduced by a large scale camera were used on the 238 and a considerable improvement in faired lines was obtained.

I touched upon the prevention of corrosion in flying boats from a production point of view and Gaats said that no precautions other than painting were taken, despite the fact that Blohm and Voss were not allowed to use alclad sheet. He mentioned that they had extensive corrosion troubles until they had a special paint made for them, the address and details being asfollows:-

Address: Fa Ruth,
Farbenfabrik,
Hamburg, Wandsbeck.

Description: Patentfarbe fur augboat,
Aussenanstrich.

They applied two coats of this paint and he spoke very highly of it. More information and samples should be obtained.

In connection with this and the extent to which one can rely on the chief designer Voght, I mentioned corrosion to the latter and he said they just used the paint specified by the Air Ministry and did not mention this paint which Gaats said had been specially developed for Blohm and Voss.

At the end of the short interview with Gaats I asked him what had been his biggest production handicap during the war and he replied very expressively "paperwork".

3. Interrogation of Dr. Voght, Chief Designer.

I listened in partly to the interview with Dr. Voght, chief designer; Scherer, flight engineer; and Schubert, aerodynamics and hydrodynamics. The technical details are reported in Part II by Mr. Keith-Lucas, but in watching this interview I formed the opinion that Voght prefers to answer queries himself which could be better answered by members of his staff. Accordingly, I think very useful information could be obtained by further interviewing members of Dr. Voght's staff separately, when I think they would be more free to state their own experiences and opinions.

4. Blohm and Voss 238 Construction.

Time did not allow of a detailed examination of the 238 construction. It was obvious, however, that some considerable time could be usefully spent in going over this in detail as many of its features are of simple design and lend themselves to easy production.

The interior of the hull is free from bulkheads which must considerably help in laying out alternative seating combinations when used as a passenger machine.

The floor sheeting on the lower deck is riveted and access for inspecting the bilges is through man-holes in the floors. This must be cheaper than the detachable floors used by us.

As far as could be seen all the hull frames are equally spaced (32") and thus standard floor stiffeners made on a mechanical press are a practicable proposition.

Extensive use is made of extrusions.

A large portion of the boat skinning is of relatively thick gauge which gives good riveting conditions.

It would appear that the main stressed structure of the hull is formed by the bottom, two flat sides and the upper deck because the structure above the upper deck is of a relatively light design.

A number of photographs of the 222 construction which is similar to the 238 are available.

No magnesium is used anywhere in the boat.

5. Wiring

Although only a small number of examples were seen I was impressed by the neatness of the German wiring layouts and think that a special examination and report of this feature is warranted.

6. External Finish

A striking feature of the limited number of examples seen was the lack of high quality finish. It would appear from a superficial examination that the Germans have not been concerned with high quality surface finish to the extent that we are concentrating on this feature. Further investigation into this is necessary, together with interviews with people in a position to comment on the German experience.

7. <u>General comments on Visit.</u>

During this visit time did not allow of detailed investigations into many items of interest from a production point of view. On further visits, an endeavour should be made to investigate the following points:-

(a) Production problems actually experienced.
(b) Details of production methods such as welding, riveting, pressing.
(c) Construction of jigs.
(d) Production systems.
(e) Standardisation of parts and details.

In order to obtain the fullest benefit it would be advisable to have as many of the executive staffs as possible from each factory available for interview at some central source.

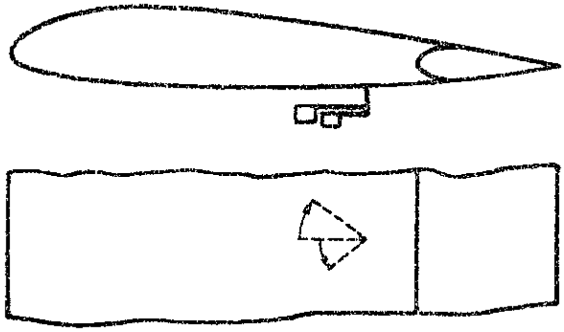

FIG. 1

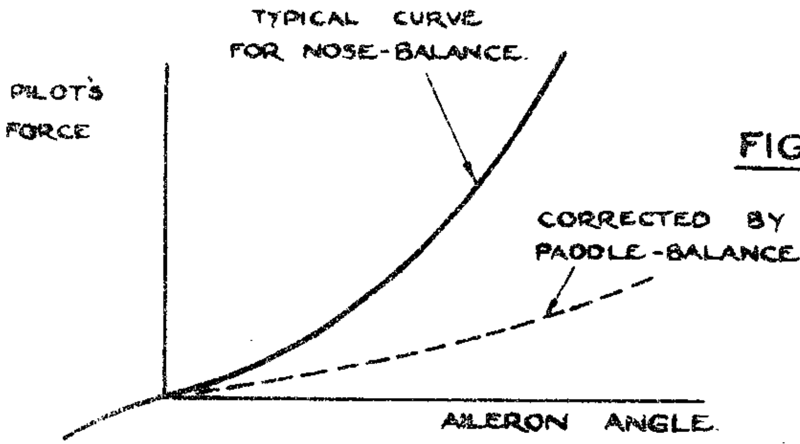

FIG. 2

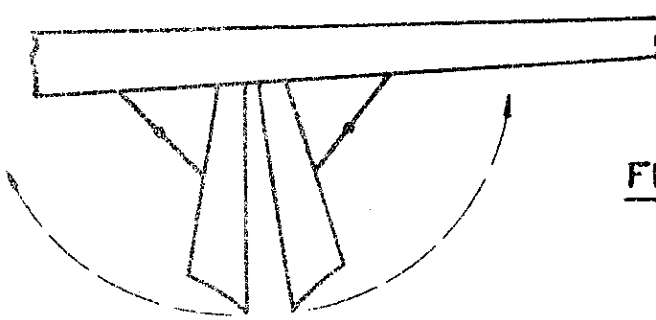

FIG. 3

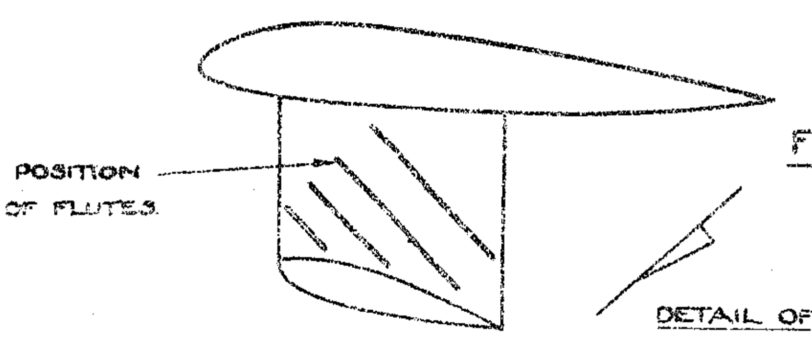

FIG. 4