

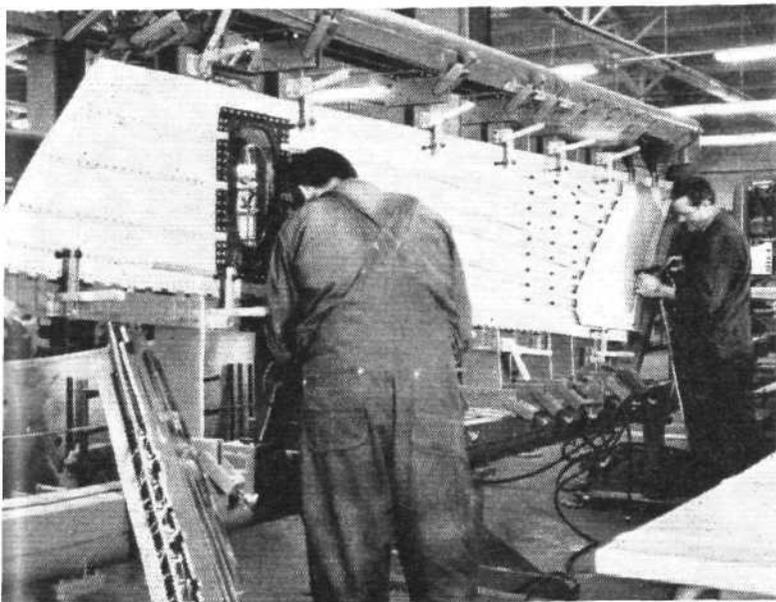
F-104G centre fuselages being made by Dornier at Neuauwing

The German Industry

THE AIRFRAME MAKERS: FROM LICENSED BUILDING TO PROJECTS

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Fiat G.91R3 wing panel being made by Heinkel

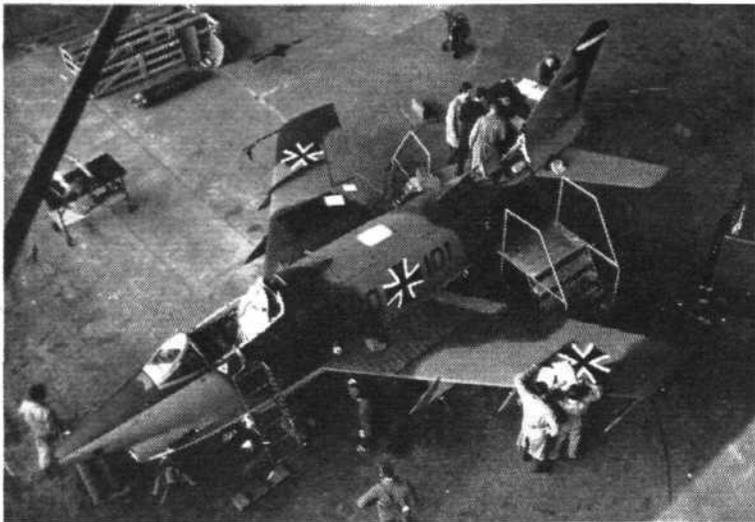


RISEN like a phoenix from the ashes of the Third Reich's industry, the new German aircraft companies have reason to be proud of the progress they have made in five years of post-war existence. From almost literally nothing, they have progressed in that time to the production in quantity of one of the world's fastest strike fighters and to the design of modern aircraft of their own.

By 1945 most of the factories had been destroyed by air and ground attacks and what had not been destroyed was then systematically dismantled and taken away. Skilled personnel were dispersed, either being taken to other countries or driven by necessity into other industries.

Then came an interval of ten years' enforced idleness during which no aircraft development was allowed. The workers who remained in Germany were perforce absorbed into other work, so that while aircraft technology and design were moving ahead faster than ever in other countries, German knowledge and skill lay virtually dormant. When sovereignty, and with it permission to make aircraft, were granted again in 1955, the companies had to start from scratch, the only ready-made resources being the former skill and knowledge they could attract back to aircraft-making from abroad and from other industries. The "Wirtschaftswunder" which set West Germany as a whole on its feet largely passed the aircraft industry by.

As soon as the German aircraft companies began to organize



Pre-flight inspection of a G.91R3 at Dornier's Oberpfaffenhofen factory



Assembly-line overhaul of Republic F-84Fs by Weser at Lemwerder

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themselves in 1955 and 1956 it was obvious that a major commercial opportunity existed for foreign companies to take part in one way or another. Many countries successfully took this opportunity, but Britain seems to have missed the boat. One German airframe manufacturer reported that, in 1955, approaches were made by almost every major manufacturer in the USA, France and Italy, but that not a single British company came forward. A very large number of licence agreements were signed or direct orders obtained, but Britain's share has been relatively small. Only in the engine field have we been at all successful. Subsequent efforts to struggle into the market from a position of inferiority have had only limited success.

Britain's apparent detachment from continental Europe is only now breaking down, but German companies have all along been thinking on a European scale. The Transall and Atlantic projects are to them perfectly logical procedure—in fact a necessity because of their relatively limited resources. Any reasonable co-operation proposed would have been entertained in the early days of 1955 and 1956. Those arrangements that were most forcefully shown to be of advantage were accepted and have since been implemented. It must be said, however, that the sales campaign mounted by certain American companies, notably Lockheed, has proved virtually invincible and far broader and more ruthless than almost any European company would have envisaged. The F-104G programme has itself led to numerous minor commercial competitions which have been fought with equal ferocity—again with little success for British companies. There is a complicated story behind the replacement by the Lockheed C.2 ejection seat of the Martin-Baker unit originally specified for all F-104Gs. Martin-Baker seats have been retro-fitted to most Luftwaffe aircraft of American origin.

A considerable campaign is now being run by Northrop for adoption of the T-38 Talon as companion trainer to the F-104G, but on the whole the "battling days" may be coming to an end. The German companies themselves will now to a greater extent be able to take the initiative and make their own alliances. So long as genuine co-operation is offered, the prospects for non-German participation will probably be more evenly distributed.

The resurrection of the German industry seems to have fallen quite naturally into two phases. The first phase was to establish the ability to build up-to-date airframes with all that this implied in relation to the ten-year hiatus—training, re-training and re-equipment. The resources and orders necessarily came from government contracts for military aircraft within the framework of Germany's own contribution to NATO.

During the hiatus, some of the old German aircraft firms, notably Heinkel, Messerschmitt and Dornier, had preserved a commercial existence by taking up precision engineering of one kind or another. Scooters, precision machinery, domestic appliances, textile machinery, sewing machines served to build up new factories, keep skilled labour on hand and to retain at least the commercial existence of some companies. A few designers worked independently abroad before 1956 to develop new aircraft—as opposed to working with foreign companies on foreign projects. Notable products were the Pulqui fighters in the Argentine, the Hispano 200 and Dornier Do27 in Spain, the Beja Flor helicopter in Brazil and, most recently, the Hindustan fighter in India.

Of these projects only the Do27 and Beja Flor returned to Germany after 1956; and only the Do27 has survived there. Nevertheless the Dornier project and its derivative the Do28 proved highly successful; and they are still the only indigenous designs to have reached substantial production.

Despite the remarkable achievements of the first five years, the

industry is still based of necessity on the production of specific military airframes, engines and equipment. But indigenous design and civil production are increasing fast, even though they still account for a small proportion of the total effort. The industry itself, employing between 20,000 and 30,000 people, represents a very small portion of the national industry.

If the first phases of reconstruction consisted mainly of putting into production modern, but established and straightforward, foreign airframes; the second stage has involved a similar process, but on a broader basis and with much more advanced aircraft. Engine building in the first years was confined to the licence production by BMW of Lycoming piston engines, and very little was done in the equipment, instruments and electronics field. But the next stage saw the licence production of the mighty General Electric J79 by BMW and the production of a considerable part of the complex equipment for the F-104G and G.91. At the time when the F-104G programme was begun, a similar programme would have exercised the abilities of even the established European aircraft industries, but the German industry has shown itself fully capable of tackling such an ambitious task. Productionwise, as the Americans would say, it has achieved its maturity, for the F-104 involves virtually every modern technique and material. Make no mistake about it, the F-104G is in production in southern Germany, on schedule and well made.

The resources of the industry as a whole are, however, still fairly limited, both in financial backing and in design capacity; and both of these can only be improved with the passage of time, with an accumulation of business turnover and profits, and with the building-up of experienced design teams. Participation by Dornier in the NATO Atlantic programme and by Weser, Hamburger and Blume in the Transall is a first step towards design experience and towards a sounder, broader basis for the competitive future.

Individual companies in the southern area were not able to assemble sufficient design capacity to tackle major projects by themselves. Heinkel, Messerschmitt and Bölkow therefore contributed teams to the Entwicklungs Ring Süd in Munich, which is charged with development of a variety of projects under government order. The Ring has no financial capital and the men continue to be members of their respective parent companies. No German company would at this stage risk losing its most highly prized asset, the able designer.

As far as the future is concerned, neither government nor industry are planning any major increase in the overall capacity of the industry. But the companies are keen to broaden the basis of their activity and to introduce civil work as a leavening to the necessarily unpredictable military order-book. Indeed, the military work should ideally take second place. The balance of work and capacity is at present even, at least in the south, but in three years' time new projects will be required, and design for these, if they are to be indigenous, must begin now. Financial support from outside is a basic necessity. It remains to be seen whether the new ventures, whatever they are, will be predominantly national, with groups of companies working together in Arbeitsgemeinschaften, or internationally, with Germany, Italy and France working together, or European, with Britain joining in.

Because the early orders for military aircraft built under licence had to be equitably spread between the companies, co-operative groupings known as Arbeitsgemeinschaften were set up, but were not based on any actual commercial merging of the companies concerned. Such co-operation is still very much the normal procedure and indeed dates from the days of the Third Reich. The Entwicklungsring is just such an organization under a different name.



Hamburger Flugzeugbau works beside the Elbe at Finkenwerder

In the present activity an Arbeitsgemeinschaft consisting of Messerschmitt, Dornier and Heinkel is making the Fiat G.91, with Dornier responsible for final assembly and test flying at Oberpfaffenhofen, near Munich. The same companies and Siebel are co-operating to make the F-104G, Messerschmitt having built the new works and airfield at Manching for final assembly and testing. Weser, Hamburger and Focke-Wulf have more recently joined the North group, with Fokker and Aviolanda, to form a second source for F-104Gs.

An Entwicklungsring Nord has just been formed by Hamburger, Weser and Focke-Wulf, and one of its tasks perhaps will be to tender for the NATO Military Basic Requirement 4 for a V/STOL transport to support the Traumaeger project. Focke-Wulf exhibited at Paris a multi-engined lift pod for a transport aircraft and they have established a close relationship with Hawker Aircraft at Kingston. Weser are working with Sikorsky on helicopter development, particularly on the WF-S-64 crane helicopter. They are likely to be involved in manufacture of the cargo helicopter for the German army, when the type is decided. At present it seems likely that the Sud Super Frelon, in which Sikorsky are also co-operating, may be chosen.

On the whole, the rumours are far ahead of the facts, according to the German companies themselves. There are many ideas, but the ultimate decisions are not for the companies to take and the web of international agreements and NATO schemes must first be smoothed before a concerted programme can emerge. Certain it is that Germany prominently figures in the market, both as customer and as manufacturer.

As far as government direction and financing of the industry is concerned, there is some room for complaint in that not only does the industry deal with three federal ministries (Defence, Transport and Economics), but it is at least influenced by the equivalent offices in the various Länder or provinces. Such a partial decentralization creates considerable difficulties and there is some agitation for the formation of an equivalent to the British Ministry of Supply or Aviation.

The German industry's main customer is the federal ministry of defence, which maintains an aeronautical test establishment (Erprobungsstelle der Deutschen Luftwaffe) at Oberpfaffenhofen. The ministry of transport is responsible for all civil affairs such as airworthiness and personnel licensing. The economics ministry

also has some control of the aircraft industry in the national economy.

While the Erprobungsstelle der Deutschen Luftwaffe, as the name implies, deals only with specific air force projects and equipment, basic research is distributed among a variety of large and small organizations whose work and financial support is co-ordinated by the Deutsche Gesellschaft für Flugwissenschaften at Martin Strasse 24, Bonn. The various organizations are, apart from the central co-ordination, independently run; and finance is contributed not only by the federal defence, transport and economics ministries but also by the governments of certain of the Länder, notably Nord Rhein Westfalen and Bavaria.

The most important basic research organization is the Deutsche Versuchsanstalt für Luftfahrt (DVL) at Mülheim, shortly moving to Cologne. Others are the Deutsche Forschungsanstalt für Luftfahrt (DFL) at Braunschweig (Brunswick); the Aerodynamische Versuchsanstalt (AVA) at Göttingen; the Flugwissenschaftliche Forschungsanstalt München (FFM) at Munich; the Deutsche Studiengemeinschaft für Hubschrauber, the helicopter research station at Stuttgart; the Forschungsinstitut für Physik der Strahlentriebe, directed by Dr Saenger at Stuttgart; and the Arbeits- und Forschungsgemeinschaft Graf Zeppelin. Outside this main grouping is the Wissenschaftliche Gesellschaft für Luftfahrt (WGL). The last two organizations mainly organize conferences and specific studies and have no installations of their own.

The manufacturers have an association equivalent to the British SBAC in the Bundesverband der Deutschen Luft- und Raumfahrt-industrie. The Raumfahrt portion, referring to space flight, has been added recently as a result of Germany's participation in the European space programme.

Messerschmitt AG

ONE of the larger companies, in terms of man-power, in the German aircraft industry is Messerschmitt AG, which is re-established at its traditional headquarters at Augsburg. The old test airfield is now a US Army helicopter and light aircraft base and 75 per cent of the original buildings were destroyed during World War II. The old headquarters building is now the apprentices' training centre and the new factory has been built farther down the road. Head- and design-offices are in Munich.

Factory floor area is now 42,500sq ft and work force about 3,000. Of the 10,500,000 DM capital (about £950,000), the Messerschmitt family holds 51 per cent and the Bavarian Government the remainder. Messerschmitt also holds a half-share in the Flugzeug-Union-Süd GmbH, the remainder being held by Heinkel. FUS holds all the stock of Junkers Flugzeug- und Motorenwerke AG of Munich.

On a small scale, Messerschmitt made sewing machines after World War II and began the production of the well-known three-wheel scooter. The first aircraft programme, for which modern new buildings were erected, was the manufacture of the Fouga Magister in association with Heinkel. Messerschmitt made the fuselage and assembled and tested the finished aircraft. Magister construction is now completed, 210 having been made, but the company retains the major overhaul work, the base for which is now being moved from Munich Riem to Manching. German air force T-33s are also overhauled.

Messerschmitt is now concentrating almost exclusively on making the forward fuselage and tail of the Fiat G.91 and on making the forward fuselage of, and assembling and test-flying, the F-104G. For these two projects the factory at Augsburg is extremely well equipped and laid out, with the most modern machinery. Just one tool has survived from pre-1945 days—a noisy but still effective drop hammer. Presses, stretch-presses, electronically controlled copy miller, several types of spot-welder and a large assortment of smaller machine tools are all new.

A rail siding leads straight to the reception stores with adjacent

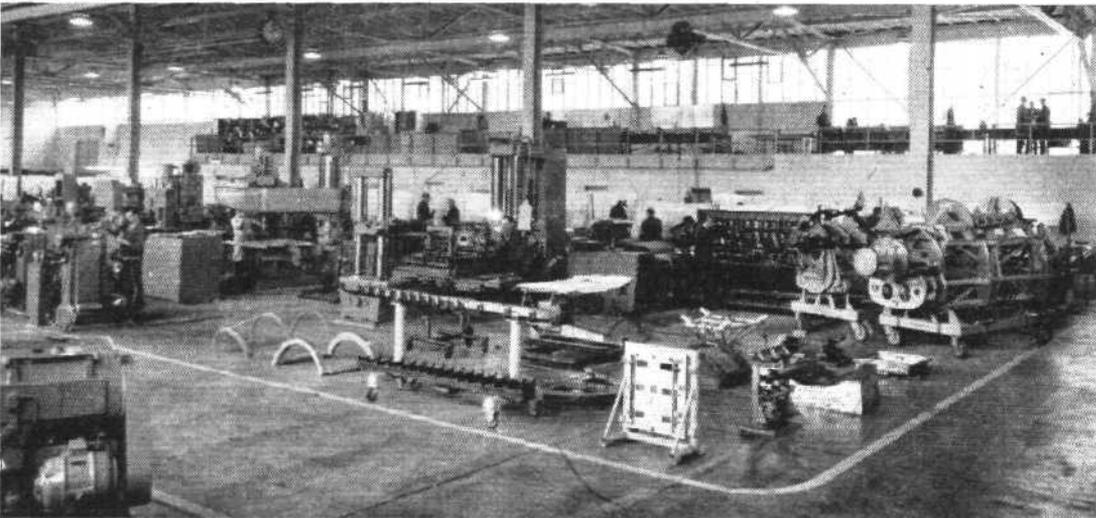
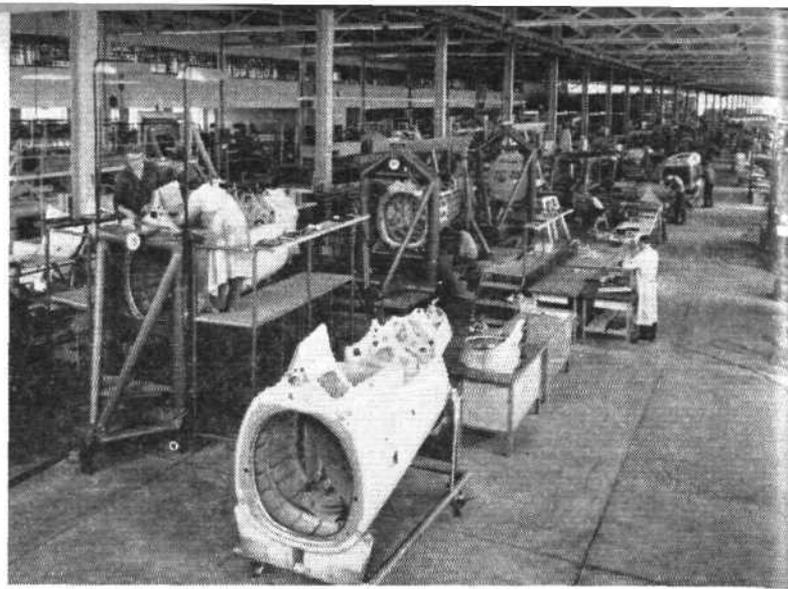
Final assembly of German-built F-104Gs by Messerschmitt at Manching



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inspection building. Materials are transferred to the fabrication shop whence cut and shaped sheet parts are fed out to the presses and welding machines. A very large heat-treatment oven is set some 10ft off the ground so that the parts can be dropped within 2sec into a quenching tank set in the floor. An outside refrigerator is available for storing large or small parts at -20°C to keep them workable for as long as necessary.

Detail parts are finally inspected and stored in a pen at the end of the detail section of the main works. From here kits of parts are issued at appropriate times direct to the small jigs on which sub-assemblies are made up, eliminating any fetch-and-carry movement by assembly-line workers. Progressively larger sections of G.91 and F-104G are then progressed along the parallel production



Above, parallel assembly of G.91 noses and tails by Messerschmitt and, left, the jig and tool department with the G.91 master jigs on the right

lines until the G.91 nose and tail are complete and the F-104 nose is mated in its two-level access platforms to the centre-section contributed by Dornier. The F-104 fuselage is piped and wired while still in its split left and right halves—preformed piping and wire looms are universal—but the G.91 assemblies are completed only structurally before being transferred to another hall for furnishing. G.91 sections finally emerge for shipment to Dornier complete with their 30mm guns, nosewheels, instruments and powered control units.

Messerschmitt are proud of their jig and tool department where they make their own stretch-press dies and have constructed their own massive master jigs for the G.91 nose and tail. The latter were sent to Fiat in Turin for checking before they were used. For the G.91, but more especially for the F-104G, complete interchangeability of major components built in any one of several countries has been specified. The airframe itself calls for much close tolerance work, but very considerable trouble is also taken to ensure adherence to master dimensions supplied to all licensed manufacturers by Lockheed. Some master jigs and patterns come from Lockheed at Burbank.

Master drawings at full scale on highly stable plastic sheet are photo-projected by Messerschmitt on to metal sheet, using a process by which a number of sheets can be marked as accurate positive prints from a single projection. Some of the sheets are used as drilling matrices for sheet parts. From the master drawings, too, large numbers of master templates are made, for there is hardly a straight line or uncompound curve anywhere in the F-104 airframe. It says much for both Messerschmitt and Dornier that they have taken to this high-precision work with obvious efficiency and determination. There seemed to be no problems and no hold-ups.

While the two G.91 fuselage sections are shipped by road from Augsburg to Oberpfaffenhofen, the mated Messerschmitt and Dornier F-104 sections are taken to the brand-new assembly and pre-flight centre at Manching, where a new 11,400ft \times 390ft runway has been laid through the woods parallel with that of the existing Luftwaffe F-84F base. The Lockheed-built F-104Gs are already being assembled here and the first three German-built aircraft were in assembly when I paid it a flying visit. The first one was in fact in its final pre-flight check and could have flown within hours. It is due to be handed over formally to the Luftwaffe as this issue goes to press.

At Manching a 440ft-long open-ended hall is being prepared for

line-assembly of F-104Gs and a two-storey electronics block stands hard by. An engine test-stand is also being built. Manching's task is to assemble Heinkel wings to Messerschmitt/Dornier fuselage, fit Heinkel fin and tailplane to Siebel steel and titanium tail, install the BMW J79 engine and the battery of RCA and Litton grey boxes of electronics and the Vulcan gun. The Lockheed C.2 seat, now standard on all F-104Gs, is offered up through the former downward-ejection hatch and pre-flight check-out begins. Flap-blowing is checked with "rakes" of wool-tufts behind each wing. Incidentally, that first German F-104 was a fully operational aircraft, complete with gun, Nasarr radar and all other electronics. It was in no sense a pre-production aircraft and carried no test instrumentation.

Although the production line for F-104s at Augsburg is not yet fully loaded, the flow is well under way and the side panels of No 15 forward fuselage were in jig and nearing structural completion. The G.91 line appeared fully loaded.

Messerschmitt has the firm intention of entering the civil field and of diversifying its production. Prof Willy Messerschmitt is taking part in design studies and a group of designers is working with the Entwicklungsring Süd. The company firmly stated that a VTO fighter, nicknamed Traumjaeger (dream fighter) and frequently given the designation VJ-101, is only one of several possible ER Süd ventures and not necessarily a firm project. In their own right Messerschmitt are investigating civil projects and seriously considering entering the commercial space-flight field.

Dornier-Werke

AS a family-owned, private-stock company which maintained its existence and individuality during the ten-year post-war hiatus, Dornier holds a distinctive position in the German aircraft industry. It has taken part in the main Arbeitsgemeinschaft programmes and done a considerable share of overhaul work on F-86Ks and Sabre 6s and Vertol 44s through its subsidiary Dornier Reparaturwerft, but it also stole a march on the others with the development in Spain before 1956 of the Do27. More than 500 of these have now been made by Dornier and the last few for the German army and air force are being slowed down to allow export deliveries to be brought forward. More than 130 civil Do27s have been delivered. The Do28

is also successful and the 26th was in final assembly at Oberpfaffenhofen, where all 27s and 28s are made. The first Do28 to be delivered across the Atlantic, for Elenco of Plymouth, Wisconsin, was drying its red and white paint, and Do27s for the Belgian army were awaiting delivery. A Do28 was being prepared for Katanga.

Dornier makes the centre fuselage and assembles and tests the German Fiat G.91; and at least half a dozen, camouflaged and bearing Luftwaffe crosses, were in the neighbouring part of the pre-flight hangar. The first German-built G.91 flew on July 20. Each new aircraft is flown for between five and ten hours, in 45min to 1hr flights, while PHI, Doppler and other of its systems are checked. The two 30mm cannon are mounted with their barrels a foot or so proud of the fuselage, the muzzles being flanked by stainless-steel plates. Cameras are in the nose and four pylons under the wings, drop-tanks being hung inboard.

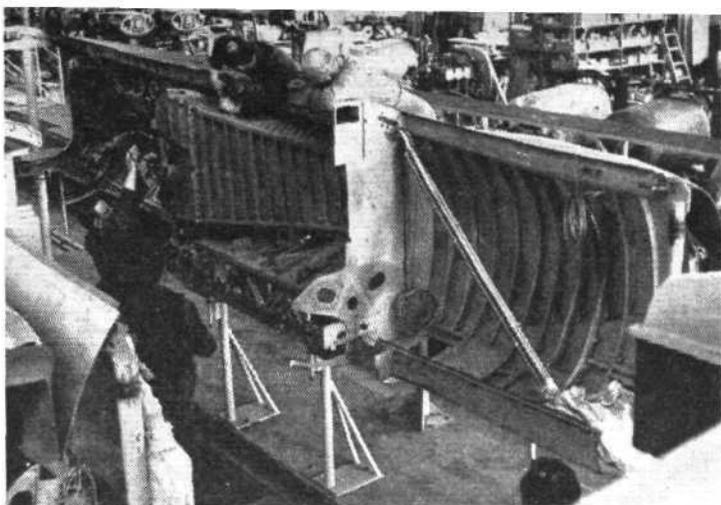
As in the F-104, the central blind-flying instrument in the G.91 is the PHI course and distance indicator, the two-coloured SFENA drum horizon being mounted rather insignificantly on the right. Most flight instruments appear to be miniaturized and two tiny turn-and-slip indicators are mounted side-by-side at the foot of the blind-flying panel—surely the original diagnostic challenge to the pilot in the unlikely event that one of them fails.

Dornier are still consistently pursuing STOL performance, having investigated Benson gyrocopters, various modifications to the Do27 and flown three of the remarkable propeller-tilting Do29s. Two of these are lying idle for the moment at Oberpfaffenhofen while the third is being flown by the Luftwaffe experimental establishment. It is hoped soon to start a series of trials designed to establish suitable airworthiness criteria such as minimum steady-flight speeds and approach techniques. At the end of earlier tests, some 50 per cent of the lift was being provided by the pusher propellers tilted down between 75° and 90°. No immediate development of the Do29 is intended at this stage, but a Do31 STOL transport project has been reported.

Next production aircraft in the line will be the new Do346, a three-engined 10-15 seat extrapolation of the Do29 with rear loading. It will have 380-390 h.p. Lycoming or Continental engines and extended Do28 wings. The Do346 is intended as a utility aircraft for undeveloped areas and might eventually be powered by Turboméca Astazou turboprops.

While the Oberpfaffenhofen factory is responsible for G.91 assembly and for complete production of the Do27 and 28, the factory at Neuaubing, nearer Munich, contains the head offices of the aircraft section of Dornier—the textile machinery works and overall head offices are at Friedrichshafen. Neuaubing is also the Dornier centre for production of the centre fuselage of the F-104G and centre fuselage and tailplane of the G.91. Ten of the F-104 sections and 14 G.91 sections have already been delivered and the rate of production, as elsewhere, will soon reach respectively six and seven per month.

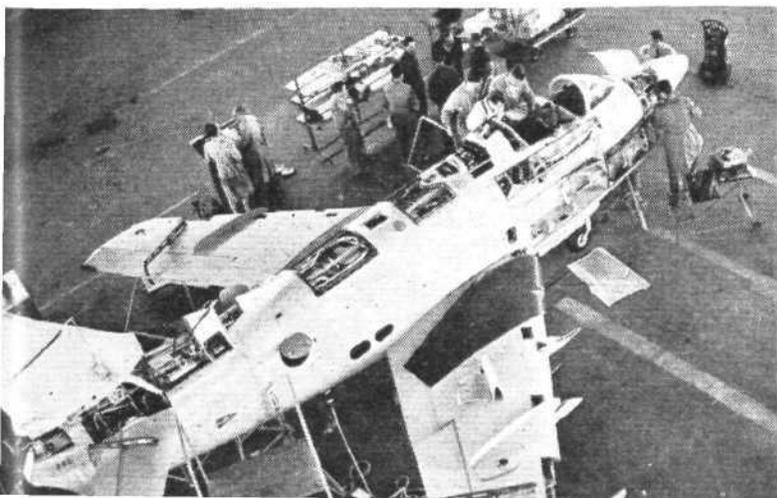
Like Messerschmitt, Dornier are extensively equipped with a 250-man jig and tool department and comprehensive modern machinery. Their portion of the F-104 also includes several titanium sections in the hot parts of the engine body. The building from detail parts through piped and wired side panels to fully equipped fuselage section with fuel tanks installed is similar to that at Messerschmitt and the same two-level travelling assembly frames are used. Dornier have departed from the Lockheed scheme only in employing much more massive jigs with optical alignment, a procedure which, they say, has already greatly assisted in obtaining the high accuracies demanded for international interchangeability of sub-assemblies. Dornier had designed their own quick-quenching system in which the whole oven, mounted at ground level, can be



Above, shells of the F-104G centre fuselage being equipped at Neuaubing by Dornier. The intakes are provided by Siebel



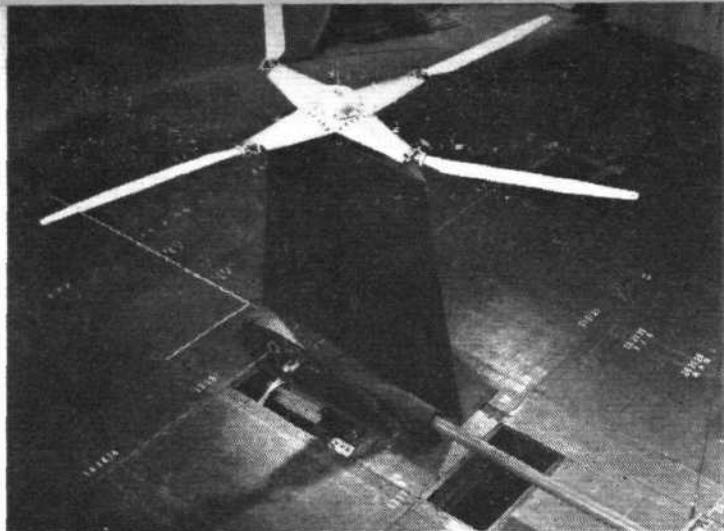
Below, final assembly of a G.91 by Dornier at Oberpfaffenhofen. Rate of production is working up to seven per month. Above, joining of Messerschmitt and Dornier fuselage sections, also at Oberpfaffenhofen



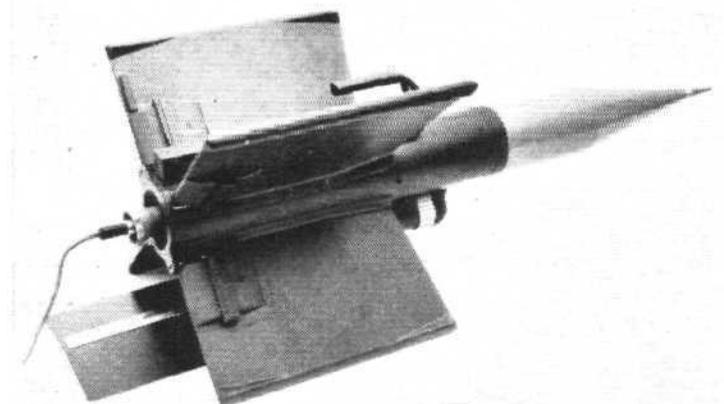
tilted to roll the hot parts down a sloping rail on a dolly and straight into the quenching tank sunk in the factory floor. There was also a -20°C cold-storage chamber for semi-finished components.

While Dornier have not joined the Entwicklungsring Süd, they have not remained aloof from the international design field. They have designed and made the tail cone of the Breguet 1150 Atlantic, the first section being already incorporated in the first prototype at Toulouse. The glued metal honeycomb portions of the structure have been sub-contracted to Siebel.

Dornier is therefore in the very sound situation of having a goodly slice of the licence building programme, a foot in the international design field and a flourishing design and production business of its own with considerable civil sales. In connection with the last-named activity, I was at Oberpfaffenhofen on a foggy evening when Dornier's famous demonstration pilot, Schäfer, came in in a



Above, Bölkow's high-speed rotor with lead-lag blades. Below, the Bölkow Cobra with its deflector plate under the tail. When the tail-cap is removed the spoiler guards spring away



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Klemm 107c, fresh from a Do28 demonstration in Greenland. Flying with a new ski undercarriage, he had made about 150 take-offs and had carried two oil-drums at a time into the high glaciers. Another task was to fly for up to 9hr leading ships through the pack-ice. The tour had obviously been a great success and sales prospects were bright. Do27s and Do28s have now made demonstration tours in most parts of the world.

Bölkow-Entwicklungen

ONE of the youngest and fastest-growing of the German aircraft companies, the Bölkow group was formed, and is directed by, Dipl. Ing. Ludwig Bölkow. While he himself retains ownership of the original nucleus, Ingenieurbüro Bölkow, the main organization is centred on the Bölkow Entwicklungen KG with head offices at the former Luftwaffe wind-tunnel site at Ottobrunn, a short distance south-east of Munich. The Ingenieurbüro specializes in design and development in precision engineering and electronics, while Ottobrunn is engaged on numerous defence ministry contracts in the missile, VTOL and helicopter field. The two most important among these are undoubtedly the Cobra anti-tank missile programme and the Bölkow participation with a sizable design team in the Entwicklungsring Süd.

The main member-company of the group, Bölkow-Apparatebau GmbH, based at Nabern/Teck, is responsible for Cobra production. A new factory at Schrobenhausen is devoted to Cobra assembly. With large orders in hand for the German army, an evaluation order for 250 from Holland and prospects of orders from Denmark, Italy, Norway and elsewhere, the Cobra programme is moving into top gear. Bölkow at Nabern includes the fixed-wing interests producing the F.207 four-seater, Phönix high-performance glider and Bölkow Junior. The score of 102 Heli-trainers so far made and a desk-top tape recorder called Conferette are also Nabern products. There is a new factory for fixed-wing aircraft at Laupheim.

Finally, Bölkow has a one-third interest in Waggon- und Maschinenbau GmbH at Donauwörth, north-west of Munich, which includes full ownership of Siebelwerke ATG, making Noratlas sub-assemblies, the 222 touring aircraft and 223 trainer, F-104 intakes and rear fuselage and metal honeycomb portions of

the tail of the NATO Atlantic under sub-contract from Dornier. The group certainly has exceptionally wide interests and versatile capabilities. In the mock-up stage is a one- or two-stage high-altitude sounding rocket with recovery parachutes for both stages and a system for returning the rocket to the launch site after burn-out. Bölkow are reported to be working on a semi-automatic version of Cobra and on infra-red techniques possibly intended to supplement defence radar at low altitudes. They will very probably feature prominently in the electronics portion of any new German weapon system.

In addition Bölkow claim to be the only company in Germany engaged on basic research in the helicopter field. Their high-speed rotor with pivoted lead-lag blading is quite new and a prototype helicopter to test the rotor should fly in 1963. The 102 Heli-trainer has been followed by the single-seat 103 helicopter, powered by an Agusta 82 h.p. piston engine, which is being used to investigate the single-blade rotor under government contract. First flights, made during this year, have proved encouraging and there is a possibility that the BMW 90 h.p. turboshaft engine might be fitted in a later version.

Bölkow feel that there are real applications for the one-man helicopter and that the one-blade rotor—its blade is of a manageably large size for production—turning at speeds above 600 r.p.m. is worth pursuing. They remain relatively unimpressed with the autogyro formula for vehicles of this size. Ability to hover, they say, is important. Autogyro payload is too small for economical agricultural use.

Although they are willing or allowed to release relatively little information concerning their helicopter ventures, Bölkow state that they want to extend their helicopter department and enter the international field with new systems and new ideas. They regard rotary-wing development as an important part of the company's work.

During my visit to Ottobrunn I spent some time "flying" the latest version of the 102 Heli-trainer, which incorporates a special pivoted mounting giving tilting freedom of up to 6° in any direction. Tilt and translation were formerly only possible in the water-borne trainer, but in this device the drag of the float in the water gave an unrealistic response and tended to teach pupils to over-control the cyclic stick. The fixed-base version previously allowed only vertical and turning freedom without roll and pitch attitude changes. Now, the trainer is mounted on an appropriately contoured hemispherical casting, with outrigger arms as limit-stops so that, once this portion is unlocked—and this can be done one axis at a time—the pupil must use the cyclic stick to control attitude and keep on an even keel. Bölkow state that the Heli-trainer can take the pupil right to the stage where he can fly solo in a real helicopter after only 30min dual, with consequent very considerable reduction in training cost and risk.

Earlier versions of the Heli-trainer have been supplied to the German army, France, Spain, Yugoslavia and Britain. The new land-based tilting system can be and is being retrofitted to existing machines. The normal Heli-trainer course takes pupils through all the main helicopter routines, including full pre-flight inspections—a dummy pitot head is even fitted and the cover has to be removed before "flight." First, straight lifts and descents are taught with the instructor sitting in a saddle alongside the pupil. Then turns using only rudder are taught and finally the tilt axes are unlocked one after the other. Even auto-rotative touch-downs can be induced by a second master switch controlled by the instructor.

I found that torque effects and throttle co-ordination were clearly

Bölkow's latest 102B Heli-trainer with tilting base



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evident and that noise and general feel were very realistic. During 360° turns wind effects were clearly evident and cyclic control had to be fully used to counteract them as the Heli-trainer turned. Everything helicopter-like was there, in fact, except the actual translational response to attitude changes and, of course, transition. But the trainer could realistically reproduce almost all that is difficult in helicopter flying—those exercises which take hours of wearing juggling at full power in a real machine before the basic co-ordinating habits are learnt. Stick forces, noise and feel were all quite realistic, although the noise from 20yd or so away was that of a well-silenced lawn-mower. The Heli-trainer costs 58,000DM in Germany (about £5,200) and can therefore offer very considerable savings for normal training.

I was also shown two films of the Cobra missile in production and in action. Bölkow are hopeful that Cobra might be adopted as a NATO infantry weapon because it is by far the lightest and cheapest weapon so far available and is already in production. Entac, Bölkow said, still exists only on paper. In addition to the orders noted above, Cobra has been evaluated by the US 7th Army and the US Marines; and a production licence has been granted to Daystrom Inc in the US. There seems to be a possibility that orders will come from the US services.

Cobra weighs 22lb at firing, has a normal range of between 400 and 1,800m and can be aimed by an average operator to be turned as much as 65° off its initial firing line. It flies at 190 m.p.h. roll-stabilized by a single two-axis gyro, controlled by fluttering spoilers and guided by wires from a joystick and binoculars mounted on a very small control box. The warhead is connected to the missile only by its screw-thread attachment, contains its own acceleration-actuated arming device and a hollow charge capable of penetrating 24in of armour plate. Warheads can be rapidly interchanged in the field without tools and without modification to the missile. The 0.6sec boost motor is inclined at 22° to the missile body so that the Cobra makes a "jack-rabbit" start from the ground without a launcher. A cord is wound round the gyro spindle and the gyro spins-up to 12,000 r.p.m. under a 4.4lb pull during the actual launch, controls being locked by acceleration-sensitive device until the missile has reached a height of over 10ft and is aerodynamically stabilized. Carrying handle, clip-on battery and flare case are mounted along the top of the body and all fly with the missile.

Most of the structure is in plastics and the four-segment, sealed storage and transport case will float. It contains the warhead in a separate compartment and, in a sealed plastic bag, a 65ft reel of cable for remote firing, a small stake for anchoring the gyro-running cord and a small metal plate which forms a solid background and dust suppressor for the boost motor. Eight Cobras can be connected by their 65ft cables to a standard junction box and thence by additional cable to the firing box, which has an eight-position selector. Two Cobras, extension cables, firing box and junction box can be carried by one man over open ground and set up in under two minutes. Batteries of ten or six Cobras have been mounted respectively on the Italian and on US and German field cars, as well as on armoured troop carriers and other vehicles.

Additional Cobra equipment includes a very compact field test set for checking all electrical paths in the system and a battery-charging adapter. Finally a simulator, based on a modified domestic television tube, has been produced to give preliminary guidance training. Moving or intermittently visible targets, full range/speed and wind effect simulation are possible and the "missile" will stop if it is allowed to fly below the controller-to-target line of sight. The simulator consists only of a t.v. tube console and desk bearing control boxes for instructor and student. No special buildings or large target screens are needed. The German army training course lasts four weeks, but includes instruction in the tactical employment and maintenance of Cobra as well as in actual guidance. A US army team became proficient in firing in three days and then achieved about 75 per cent hits in range trials with moving tanks.

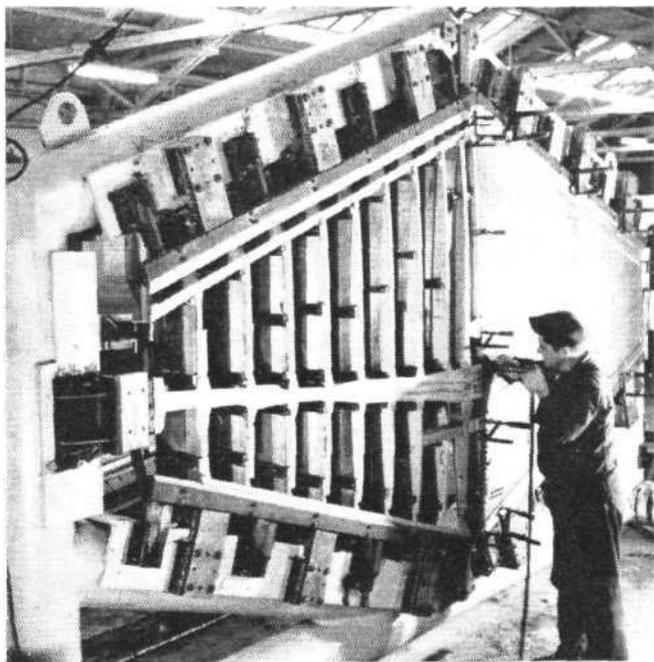
Ernst Heinkel Flugzeugbau

SOME six factories now form part of the Heinkel group and are responsible for the manufacture of the Heinkel scooter and for considerable sheet-metal working as well as aircraft production. Total works area is 3,920,000sq ft, of which 200,000sq ft are encompassed by the aircraft production factory at Speyer. Of the capital of 5,100,000 DM, some 74½ per cent is owned by Frau Lisel Heinkel and the remainder by Ernst Heinkel Motorenbau GmbH at Karlsruhe. More than 1,500 employees are engaged on aircraft work.

Within the Arbeitsgemeinschaften, Heinkel has completed the manufacture of part of the Fouga Magister and is now making the complete wing of the Fiat G.91 and the wing, fin and tailplane of



Above, adjusting the undercarriage in a G.91 wing panel made by Ernst Heinkel Flugzeugbau at Speyer



Above, an F-104G tailplane being made by Heinkel. Below, the cabin section of the Weser/Sikorsky S-64 crane, shown at the Paris Salon earlier this year



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the F-104G. The group also overhauls Marboré and Artouste engines for German Magisters and Alouette IIs, and Cessna L-19s for the US Army.

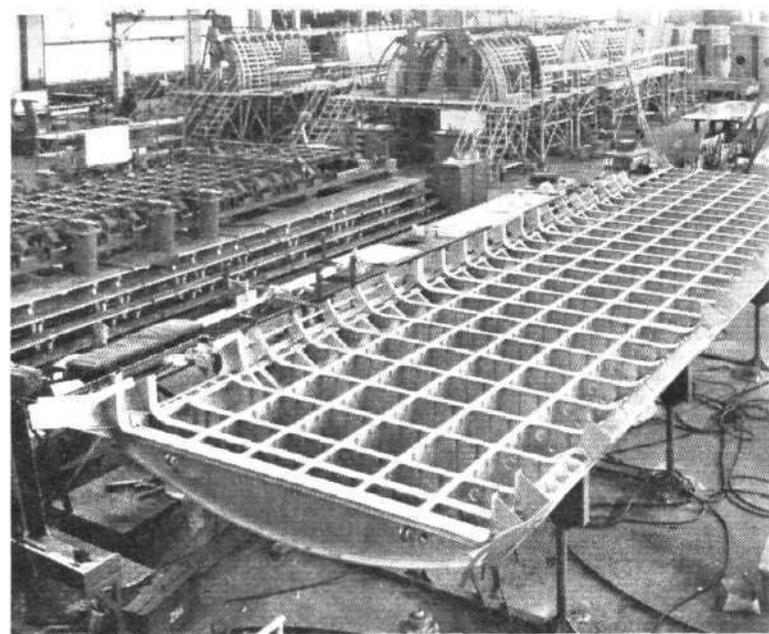
In the design field, Heinkel belongs to the Entwicklungsring Süd and has its own design offices in Munich. Shown for the first time at the Paris Salon earlier this year was the Heinkel development of the Fouga Magister, the Potez-Heinkel CM.191 four-seat executive jet and command transport. The first flight of this machine is expected during this autumn.

Weser Flugzeugbau

WITH 4,500 employees and four factories, Weser is the largest of the German airframe-manufacturing companies. Of its capital, 43 per cent is owned by United Aircraft and the remainder by Krupp. Main factories are at Lemwerder, near Bremen, and at Einswarden, near Bremerhaven at the mouth of the Weser river. Both factories have docks and a specially built, flat-topped powered lighter can transport large aircraft between the two works. Other factories are a well-equipped and modern jig and tool and machine works at Varel, south of Wilhelmshaven, and another smaller works at Hoykenkamp, near Delmenhorst. There is an airfield at Lemwerder and a heliport at Einswarden.

Weser produced many different types of aircraft in large numbers during World War II, specializing to some extent in marine aircraft. Now Weser is overhauling F-84Fs and RF-84Fs in large numbers for the German air force, has virtually completed licence construction of the centre wing, powerplants and tail booms of the Noratlas and is overhauling complete Noratlas for the Luftwaffe. A certain amount of electric, hydraulic, electronic equipment and instruments are being overhauled. Just coming to an end at Einswarden is the overhaul of US Army Sikorsky H-34s. Before the connection with Sikorsky was established, Weser had overhauled Vertol H-21s and the German H-34s are being overhauled by

Now, Weser is also taking part in the F-104G northern group, assembling centre-fuselages and equipping them. These are then sent to Aviоланда in Holland who install the remaining equipment, such as fuel tanks, mate the Weser centre section with the Hamburger forward fuselage and dispatch the unit to Fokker for final assembly and flight testing. The jigs are now being set up at Einswarden and the familiar process of progressive local production is under way. Einswarden, too, is the scene of the construction of



Above, a Transall freight floor built by Weser at Einswarden and now delivered to Nord. Side panels are in jigs in the background. Below, coloured powder introduced to show the air-curtain in Weser's big paint shop at Lemwerder



Henschel at Kassel. Incidentally, Henschel Flugzeug-Werke has a 40,000sq ft factory, 300 employees and a heliport, and overhauls both the H-34 and Alouette II for the German army. It also runs a spares sales service for the Alouette II and III.

The Vertol agreement was subsequently transferred to Dornier and appears now to have passed to Westland in Britain. Weser "de-moth-balled" the F-84Fs when they originally were sent to Germany for the Luftwaffe. All overhaul work, except that of the H-34, is concentrated at Lemwerder, where there are extensive facilities for this type of work, including one of the most modern paint shops in Europe. A complete hangar, large enough to house several big aircraft at a time, has been "invisibly partitioned" with downward blowing air-curtains and extensive extractor fans so that several aircraft can be simultaneously painted in different colours. The various colours of paint are mixed in a basement and piped to taps on the hangar walls to which paint sprays can be directly attached. F-84F overhaul work is on an impressive assembly-line basis (see page 612).

the high-altitude research glider designed and made by Weser for the German ministry of transport. The machine bears a very slight resemblance to the Lockheed U-2, but Weser strongly deny any similarity between the operational roles of the two machines. The Weser glider is a two-seater intended to be able to climb to operational height under the power of a single P & W JT12. Its purpose is meteorological research. Extensive use has been made in the structure of Redux-bonded metal honeycomb, the entire webs and skins of the wing torsion-box being made in this way. A large Redux-bonding installation has been set up at Einswarden and a complete inner-wing skin panel was there at the time of my visit. Lying nearby was a 1 : 2.5 scale model of this skin intended for structural testing. Only one flying prototype has been ordered.

With a fair volume of work in hand in the factories, Weser is also determined to build up design capability. In 1956 the leading members of the Kurt Tank design team working on the Pulqui series of fighters in Argentina were brought back to Germany and Weser have also taken on part of the team which was developing Dr Focke's helicopter with Borg-Ward. Main design effort at the moment is the Transall, for which Weser are the co-ordinating and administrative authority. Einswarden is making the centre cargo section of the fuselage and has already delivered a floor section to Nord for the first prototype. Cabin side panels followed last week and subsequent sections for other flying and structural-test prototypes are well advanced. The construction programme is at the moment between four and six weeks behind schedule, but the first flight should be made at the end of next year or the beginning of 1963. The six pre-production aircraft should be delivered between the beginning of 1964 and the beginning of 1965. A large jig for the assembly of a complete fuselage is waiting at Einswarden to be used in the assembly of the first German flying prototype at Lemwerder. The third airframe is for static testing, for which a new installation is being built at Lemwerder; and the fourth airframe will be assembled and flown by Hamburger Flugzeugbau. The fifth and last of the prototypes will be sent to Toulouse for fatigue testing.

The principle is that the Transall is divided according to man-hours of work required equally between France and Germany; and the six pre-production machines will be built on this basis, possibly even being assembled individually by the three participating companies, each using components gathered together from the three manufacturers.

Franco-German co-operation has so far been going well. Each manufacturer receives drawings at 1 : 2.5 scale and enlarges them

for lofting and other purposes. Jigs used for the prototypes are more massive than usual because interchangeability has to be ensured from the outset. Transall structure appears to be conventional, employing a certain number of large forgings and a little Redux-bonded lamination. All sub-assemblies are designed to be of a size to be carried in a standard railway freight wagon, but Weser will assemble their complete fuselage at Einswarden and transport it on the barge to Lemwerder.

Weser are seriously considering a civil version of the Transall as part of their attempt to enter the civil field. They are also considering fitting two turbojets under the wings to provide additional thrust for take-off, not for flap-blowing. The engines would be Rolls-Royce RB.145s and later RB.153s.

Another major aim of Weser is to enter the helicopter field, a logical step in view of the Sikorsky relationship. Weser designers have been in America for a year helping in the development of the WF-S-64 turbine-powered crane, a cockpit section of which was exhibited at Paris earlier this year. The crane is a German military programme, two prototypes having been ordered, but Weser also look to civil possibilities. A second German military helicopter programme is for a medium cargo machine, the choice now lying, according to Weser, between the Sikorsky S-61D, the Vertol Chinook and a developed Sud Super Frelon. Preference will probably be given to the Frelon, in the interests of European co-operation and standardization, but the final choice has not yet been made. Sud are in any case co-operating with Sikorsky in connection with Frelon transmission and Weser would ultimately be involved in production of either the S-61D or the Frelon. There is apparently a possibility that the Frelon will have Rolls-Royce engines.

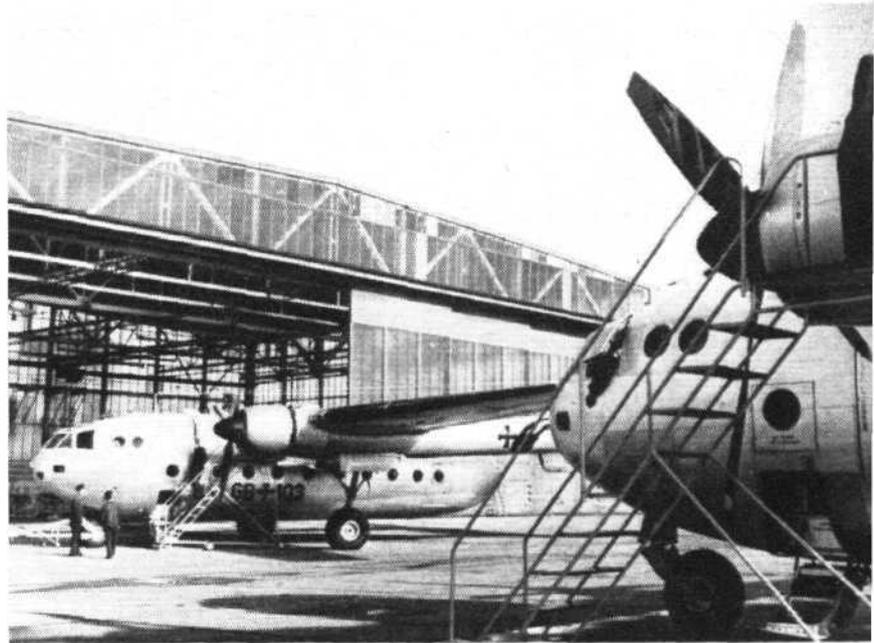
Weser are actively interested in developing helicopters for medium-range passenger transport. They envisage a system of only three international airports for fixed-wing aircraft in Germany; internal and feeder traffic would all be taken by helicopter services. There was also considerable scope for the simplification of transmissions and rotor systems for future helicopters.

Finally, Weser have joined the Entwicklungsring Nord to undertake joint development with Focke-Wulf and Hamburger Flugzeugbau. The company itself was not willing to discuss any projects the Ring might undertake, mainly because they said it had been so recently formed that there had hardly been time to begin constructive work.

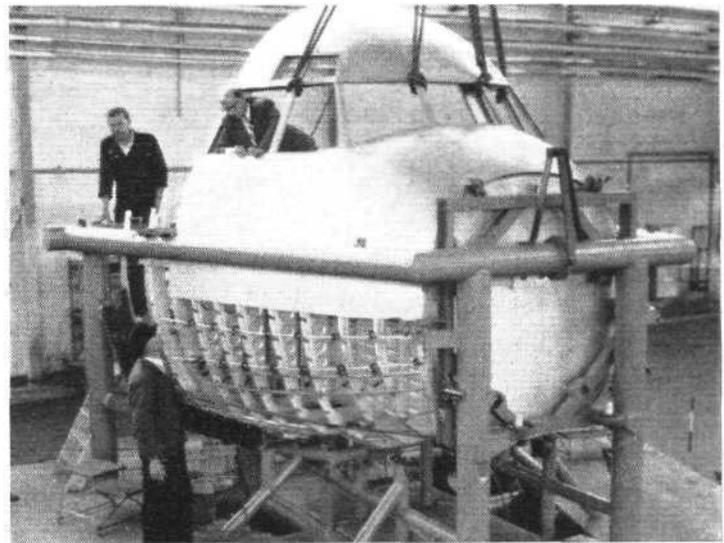
Hamburger Flugzeugbau

FORMERLY a division of the great Blohm und Voss shipyards, Hamburger Flugzeugbau was re-formed after World War II as an independent company. It is based on the factory buildings and airfield beside the Elbe at Finkenwerder, which were, surprisingly, undamaged by wartime bombing. During the ten year hiatus the buildings were used as tank-repair workshops and all the original aircraft equipment was stripped and removed. Present floor area is 954,125sq ft and work force 2,500. A considerable complement of modern machine tools and equipment is installed.

First post-war aircraft operation was the building, with the group of companies in Flugzeugbau Nord GmbH, of the Nord Noratlas under French licence. HFB made the fuselage and was responsible



Noratlas overhaul still occupies considerable space at the Finkenwerder factory of Hamburger

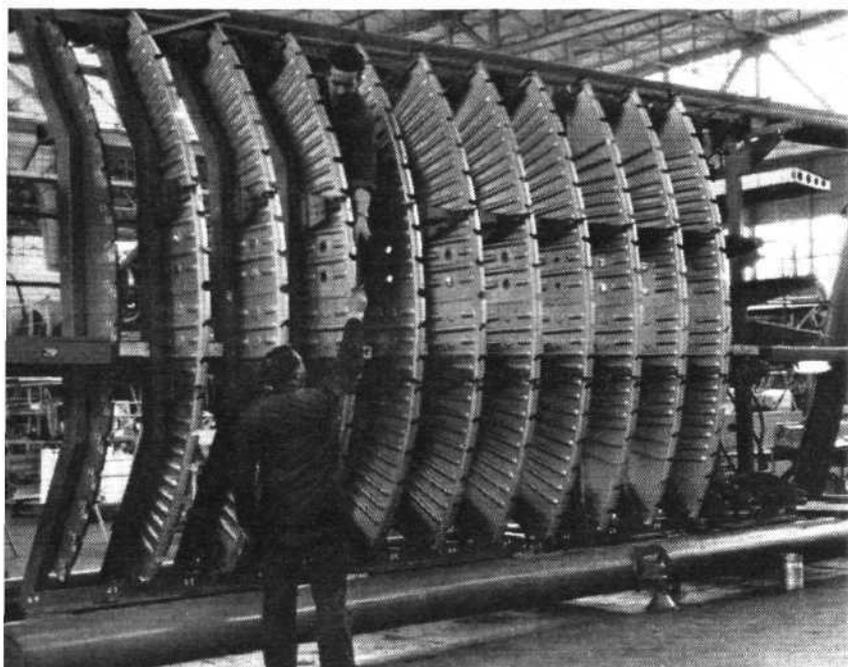


Above, the Transall nose at Hamburger's Finkenwerder works. It is now fully skinned and extended some way rearward. Below, part of the Finkenwerder assembly halls in the Noratlas days



for final assembly and flight testing of all the 130 machines built. Weser and Siebel made the other components. When I visited the factory, the last Noratlas was in final inspection before making its first flight. Noratlas work is, however, by no means finished as the manufacturers are carrying out the various major periodic inspections and repair. Noratlas are now camouflaged, with the top of the fuselage painted white, and older silver machines are repainted as they come in for major overhaul. Also in evidence at Finkenwerder were numerous German air force C-47s being fitted with new radio and electronic equipment. Pembrokes and Herons are being similarly equipped; and the Convairs used as government VIP transports were converted here.

Both at Finkenwerder and at their second factory at Stade, some 35 miles distant, HFB are now getting under way their part of the North group production of the F-104G. Both at Finkenwerder and Stade, lines of jigs are taking shape and the first sub-assemblies made up from Lockheed-made parts are being completed. As I reached Stade, the first half-shell of a forward fuselage was being crated for transport to Finkenwerder, where internal equipment would be added. HFB is making the forward fuselage complete, but also making certain unequipped portions of the centre-fuselage which are then sent to Bremen for incorporation in the Weser assembly. F-104G work in the northern companies is at a much earlier stage than in the south. HFB are working for the first time in inches, as opposed to metric measurements, and are in



Transall rear fuselage top section in jigs at Hamburger's Finkenwerder factory. Noratlas overhaul is under way in the background

Tourist class airline seats awaiting completion and delivery at the Stade factory of Hamburger Flugzeugbau



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the process of making their production jigs from master jigs and patterns supplied from Burbank. Individual pieces are still sent from Lockheed, but German detail parts will be progressively incorporated. This is probably the most difficult stage of all in the licence production procedure.

The capacity of HFB is by no means fully taken up with licence production. Since the company was re-formed it has been building up a design team, and systematically trained personnel from shop-floor to design-engineering level. Three years ago, HFB was able to propose to the German Government two new transports, the HFB 219 turboprop and the HFB 314 short-range jet transport. Although the design capacity was there, government financial support was essential if these projects were to get under way. But the government did not provide the necessary assistance. HFB continued to work until Boeing announced the 727. After this, the HFB 314 was abandoned.

In the meantime, design and manufacture of airliner seats was taken up and HFB seats have been supplied for Lufthansa Viscounts

and Super Constellations and for South African Airways and others. HFB are tendering for the Lufthansa Boeing 727 seating. The Stade factory is responsible for seat production and a batch of them is shown in col 1.

A major design and production venture is, of course, the Transporter Allianz C.160 Transall, during the early stages of which HFB submitted a complete design study of their own. For the C.160 itself, HFB are designing and making the forward fuselage and tapered aft-fuselage section for all the companies concerned. They will also assemble and fly one of the three prototypes themselves. Altogether, five sets of components are needed, three for the flying prototypes and two for static testing. It has been generally reported that orders have recently been confirmed for a pre-production batch of six Transalls.

HFB have joined in the formation of the Entwicklungsring Nord, which has been formed as joint design centre for new projects of various types. It has been reported, although the companies themselves were either unwilling or unable to confirm it, that ER Nord will design an STOL or VTOL transport to NATO Military Basic Requirement 4. At all events, the Ring has only just been formed and the first meetings were only recently held. A good deal of administrative work still remains to be done before the Ring can start constructive design work at a specific headquarters.

For the present, the prospects for HFB are good. They have completed the first licence-building stage successfully and are taking the first and most difficult hurdles in the F-104 programme. But they have also built up a reasonably strong design team over a period of years and are eager to develop their own aircraft. During the development period, whether it be solely an HFB venture or through participation in the Ring, the F-104 and Transall programmes will provide factory work and considerable additional experience.

Focke-Wulf

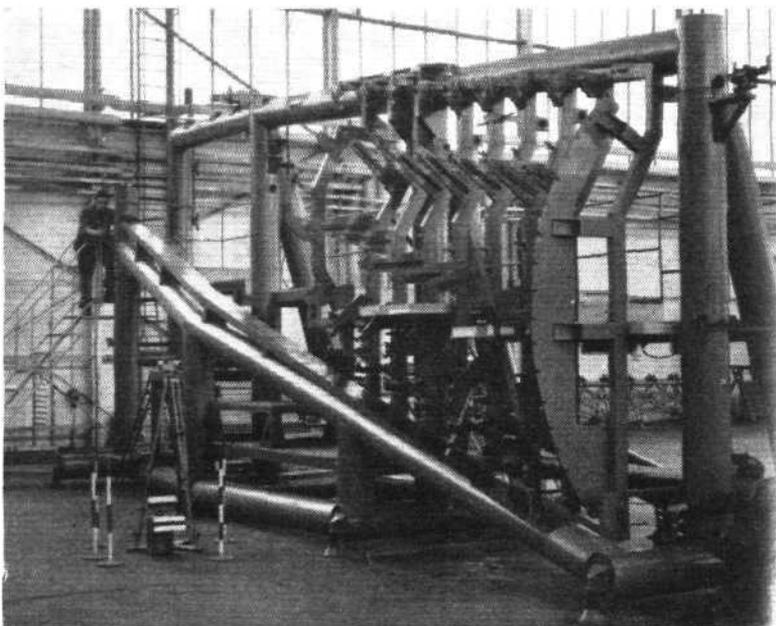
AFTER a brilliant pre-1945 history of aircraft design under Prof Kurt Tank, Focke-Wulf began building gliders in 1951 and then made the Piaggio P.149D trainer under licence. They also started hydraulics and plastics departments and made the two prototypes of the Blume B1502. The P.149D, Sea Hawk, Gannet and Grumman Albatross are being overhauled. Focke-Wulf are joining in the North Group of companies making the F-104G. They provide the engine access-door with the central hydraulic installation mounted on it, and the intakes and air ducts.

In 1960 Focke-Wulf signed an agreement with SNECMA for further development of the Coléoptère and at the Paris Salon this year a multi-engine lift pod for a transport aircraft was exhibited. Now, Focke-Wulf have begun to co-operate closely with Hawker Aircraft at Kingston for the development of a VTOL fighter.

The factory is at Bremen airport and most of the 3,000,000 DM capital (about £270,000) is held by Standard-Elektrik Lorenz and Böttcherstrasse GmbH. Employees number about 1,000 and factory floor area is 42,600sq ft.

MARK LAMBERT

This jig for the side panels of the tapering Transall tail is now well filled at Finkenwerder



GERMAN INDUSTRY DIRECTORY

The companies listed below are members or associate members of the **Bundesverband der Deutschen Luft- und Raumfahrt Industrie**, the association which is equivalent in Germany to the **Society of British Aircraft Constructors**. The list was provided by the **BDLI**.

AEG Allgemeine Elektrizitätsgesellschaft, Frankfurt/Main-Süd 10, AEG-Hochhaus.
 Aluminium-Walzwerke Singen GmbH, Singen/Hohentwiel.
 Aluminiumwerke Nürnberg GmbH, Nürnberg, Nopitschstrasse 67.
 Apparatebau Gauting GmbH, Gauting bei München, Ammersee-Strasse 31.
 Bergische Stahlindustrie, Remscheid, Papenberger Strasse 38.
 Prof. Dipl.-Ing. W. Blume, Leichtbau u. Flugtechnik GmbH, Duisburg-Ruhrort, Tausendfensterhaus.
 BMW Triebwerksbau GmbH, München 68, Dachauer Strasse 665.
 Bodenseewerk Perkin-Elmer & Co GmbH, Überlingen/Bodensee.
 Bölkow-Entwicklungen KG, Ottobrunn bei München.
 Robert Bosch GmbH, Stuttgart W, Breitscheidstrasse 4.
 Continental Gummiwerke AG, Hannover, Continental-Haus.
 Daimler-Benz AG, Stuttgart-Untertürkheim, Postfach 77/80.
 Deutsche Dunlop Gummi Compagnie AG, Hanau/Main.
 Deutsche Edelstahlwerke AG, Krefeld, Oberschlesienstrasse 16.
 Deutscher Aeroexpress GmbH, Luftwerft und Flugdienst, Hamburg-Fuhlsbüttel, Flughafen.
 Dornier-Werke GmbH, Friedrichshafen.
 Dornier-Reparaturwerft GmbH, Oberpfaffenhofen, München-Neuaubing, Brunhamstrasse 21.
 Drägerwerk, Heinr. & Bernhard Dräger, Lübeck, Moislinger Allee 53-55.
 J. Eberspächer, Esslingen/Neckar, Eberspächerstrasse 24.
 Kurt Eichweber, Hamburg-Altona, Schützenstrasse 77-79.
 Elektron-Co GmbH, Stuttgart-Bad Cannstatt, Glockenstrasse 36-38.
 Julius & August Erbslöh, Aluminium-Walz- und Presswerke, Wuppertal-Barmen, Berliner Strasse.
 Focke-Wulf GmbH, Bremen-Flughafen, Hünefeldstrasse 1-5.
 Frankfurter Maschinenbau AG, vorm. Pokorny & Wittekind, Frankfurt/Main-West, Solmsstrasse 2-26.
 Otto Fuchs KG Metallwerke, Meinerzhagen/Westfalen.
 Glasurit-Werke M. Winkelmann AG, Hamburg 1, Postfach 988.
 Goetzwerke, Friedrich Goetze AG, Burscheid bei Köln.
 Hamburger Flugzeugbau GmbH, Hamburg-Finkenwerder, Kreetslag 10.
 Wilhelm Harting, Werk für Elektrotechnik und Mechanik, Espelkamp/Mittwald, Kreis Lübbecke/Westfalen, Marienburger Strasse.
 Ernst Heinkel AG, Stuttgart-Zuffenhausen, Hellmuth-Hirth-Strasse 41.
 Ernst Heinkel Flugzeugbau GmbH, Speyer, Am neuen Rheinhafen 10.
 Henschel Flugzeugwerke AG, Kassel, Henschelstrasse 2.

Herbig-Haarhaus AG, Lackfabrik, Köln-Bickendorf.
 Junkers Flugzeug- und Motorenwerke AG, München 13, Franz-Joseph-Strasse 1.
 Klöckner-Humboldt-Deutz AG, Köln-Deutz, Deutz-Mülheimer Strasse 149-155.
 Fried. Krupp, Essen, Altendorfer Strasse 103.
 Kugelfischer Georg Schäfer & Co., Schweinfurt, Georg-Schäfer-Strasse 30.
 Chr. Lechler & Sohn, Nachf. Lack- u. Farbenfabrik, Stuttgart-Feuerbach, Kruppstrasse 30.
 Luther-Werke, Luther & Jordan, Braunschweig, Frankfurter Strasse 249-255.
 MAN Turbomotoren GmbH, München 68, Dachauer Strasse 667.
 Merkle Flugzeugwerke GmbH, Oedheim/Kreis Heilbronn, Im Hirschfeld.
 Messerschmitt AG, Augsburg, Postfach 322.
 Messerschmitt & Co. KG, München 25, Tölzer Strasse 40.
 Osnabrücker Kupfer- und Drahtwerke, Osnabrück.
 Dr.-Ing. e. h. Alfred Pierburg KG, Neuss/Rhein, Düsseldorf-Strasse 232.
 Rhein-Flugzeugbau GmbH, Krefeld-Uerdingen, Arndtstrasse 60.
 Röder-Präzision, Frankfurt/Main, Hanauer Landstrasse 155.
 Schaltbau GmbH, München 9, Hohenwaldeckstrasse 1.
 Siebelwerke-ATG GmbH, Donauwörth, Industriestrasse 4.
 Siemens & Halske AG, München 2, Wittelsbacherplatz 2.
 Siemens-Schuckert-Werke AG, Erlangen, Werner-von-Siemens-Strasse 50.
 SKF Kugellagerfabriken GmbH, Schweinfurt.
 Stahlwerke Sudwestfalen AG, Geisweid/Kreis Siegen.
 Standard-Elektrik Lorenz AG, Stuttgart-Zuffenhausen, Helmut-Hirth-Strasse 42.
 Süddeutsche Kolbenbolzenfabrik GmbH, Stuttgart-W, Rotebühlstrasse 125.
 Technavia GmbH, Lützelachsen b. Weinheim/Bergstrasse.
 Telefunken GmbH, Berlin-Charlottenburg 1, Ernst-Reuter-Platz.
 Alfred Teves, Maschinen und Armaturenfabrik KG, Frankfurt/Main, Rebstocker Strasse 41-53.
 VDO Tachometer-Werke Adolf Schindling GmbH, Frankfurt/Main W13, Gräfstrasse 103-7.
 Vereinigte Deutsche Metallwerke AG, Frankfurt/Main-Heddernheim.
 Vereinigte Leichtmetallwerke GmbH, Bonn, Am Nordbahnhof.
 "Weser" Flugzeugbau GmbH, Bremen, Werftstrasse 180.
 Westfälische Leichtmetallwerke GmbH, Nachrodt/Westfalen.
 Westfälische Metallindustrie KG, Hueck & Co, Lippstadt.
 Hermann Wiederhold Lackfabriken, Hilden/Rheinland.
 F. Wieland, Elektrische Industrie GmbH, Bamberg/Bayern, Brennerstrasse 10-14.
 Wieland-Werke AG, Metallwerke, Ulm/Donau, Olgastrasse 147.

Gebr. Winkelsträter GmbH, Maschinenfabrik, Wuppertal-Barmen, Postschliessfach 2048.
 Zentroguss GmbH, Werk Hirzenhain, Hirzenhain/Oberhessen.

ASSOCIATE MEMBERS

Aeroquip GmbH, Baden-Baden, Eichelgartenstrasse 2a.
 Alumetall GmbH, Nürnberg, Nürnberg, Nopitschstrasse 71.
 Askania-Werke GmbH, Offenbach/Main, Humboldtstrasse 8.
 Autoflug Gerhard Sedlmayer, Hamburg 11, Nikolaistrasse 25.
 Braunschweigische Maschinenbauanstalt, Braunschweig, Bahnhofstrasse 5.
 Brüggemann & Brandt KG, Volmarstein/Ruhr, Bachstrasse 22-26.
 Buderus'sche Eisenwerke Wetzlar, Wetzlar, Schliessfach 201.
 Busch-Jaeger Dürener Metallwerke AG, (22c) Düren.
 Deutsche Goodyear GmbH, Köln, Neumarkt Nr. 1c, Haus Fahrbach.
 Deutscher Luftfahrt-Beratungsdienst, W. Sachsenberg — E. Seibert, Wiesbaden, Burgstrasse 1.
 Rudolf Fischer, Metallwaren-Fabrik, Lüdenscheid, Schillerstrasse 22.
 Flug-Motoren-Reparatur-Werk Hanns Häusler, Baierbrunn bei München.
 Dr. Kurt Herberts & Co, vorm. Otto Louis Herberts, Wuppertal-Barmen.
 Hoffmann & Co GmbH, Propellerwerk, Rosenheim/Obb., Kuppferlingstrasse 15.
 Honsel-Werke AG, Meschede/Westfalen.
 Ilo-Werke GmbH, Kleinverbrennungskraftmaschinen, Pinneberg bei Hamburg.
 Kloth-Senking AG, Eisen- und Metallgiesserei, Hildesheim, Cheruskerring 38.
 Richard Kohnke, Fallschirmwerk, Heidelberg-Ziegelhausen, Heinrich-Stoess-Strasse 31.
 Walter Kostelezky KG, Weingarten/Württ., Am Hallersberg.
 Dr. Meleghy KG, Fabrik für Werkzeugbau, Bergisch-Gladbach/Köln, Dombach.
 Techno-Chemie Kessler & Co GmbH, Frankfurt/Main-West 13, Voltastrasse 71-75.
 Trossinger Metallstimmenfabrik Hans Eisen, Trossingen/Württ., Breite Strasse 29.
 Turco-Chemie GmbH, Hamburg 24, Postfach Nr. 3233.
 Vofa-Werk, Xavier Vorbrüggen, Düsseldorf/Oberkassel, Lörickerstrasse 106.
 Wotan-Werke GmbH, Werkzeugmaschinenfabrik, Düsseldorf-Holthausen, Reisholzer Werftstrasse 76.
 Robert Zapp, Düsseldorf, Zapp-Haus, Bleichstrasse 8-10.

LIGHT AIRCRAFT MANUFACTURERS WHO ARE NOT MEMBERS OF THE BDLI

Alfons Putzer KG, Bonn, Bornheimerstrasse 133.
 Scheibe Flugzeugbau GmbH, Dachau, nr Munich, August Pfalz-Strasse 23.
 Stark Flugzeugbau GmbH, Minden, Kaiserstrasse 9-11.