SMALL PETROL-DRIVEN GENERATING PLANTS

NEWNES

PRACTICAL MECHANICS

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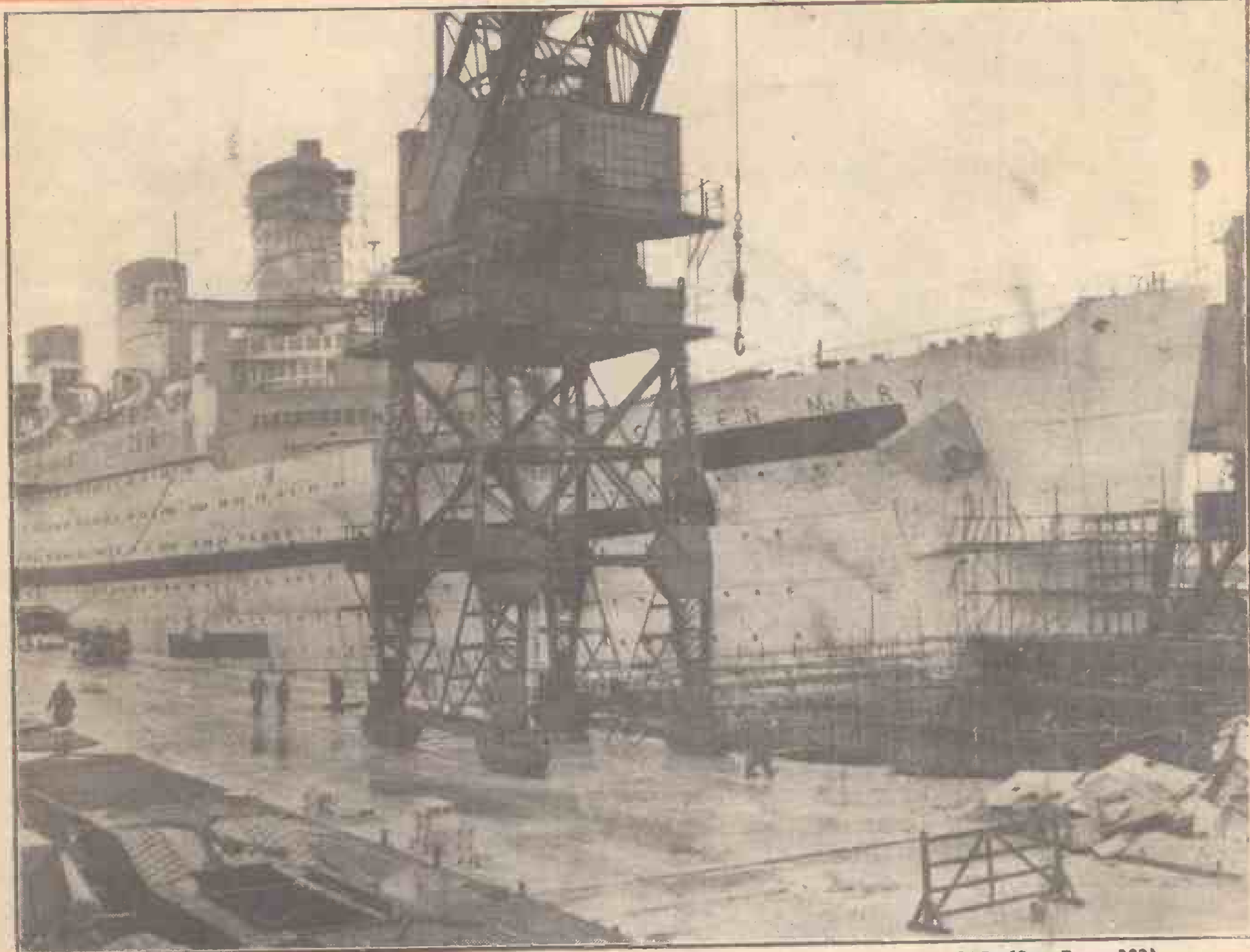


THE "QUEEN MARY" IN DRY DOCK AT SOUTHAMPTON FOR REPAIRS (See Page 283)

PRINCIPAL CONTENTS

Rocket Propulsion

German Rocket Gliders

By K. W. GATLAND

(*Continued from page 231, April issue*)

The DFS. 228V-1 mounted on its parent aircraft. The two machines were designed to fly together up to an altitude of 35,000 feet, when the glider would release and climb away under its own rocket power.

A FEW more months of work unhampered by the Allied air offensive and technicians of the German Research Institute for Sailplanes could have produced a rocket-boosted reconnaissance aeroplane.

This was the project DFS.228, a large single-seat glider (Fig. 95), which, during bursts of thrust, was reckoned to achieve speeds up to 560 m.p.h., and be capable of operating over England at heights well beyond the reach of flak and fighters. Its designed ceiling was 15 miles, and from that height the pilot could theoretically observe ground areas within a radius of 300 miles. The machine would thus have been particularly valuable for charting the explosions of flying-bombs and V-2 rockets.

In operation, the DFS.228 would have flown "Mistel" fashion on top of a Dornier Do. 217K, separating at 35,000ft. Its pilot could then more than double his height by firing spasmodic bursts from a bi-fuel rocket in the glider's tail, afterwards resorting to rocket power only if difficulty was experienced in maintaining effective altitude. The amount of propellant in the tanks permitted barely three minutes' sustained thrust, but as the wing loading dropped from 28 to 12lb./sq. ft. as the tanks were drained—and the propellant would be nearly all consumed in the climb to peak altitude—this, coupled with the speed inherited from the rocket, should have resulted in a reasonably flat glide, despite the low air density.

Having reached his ceiling, the pilot could afford to lose half this height before again thrusting the rocket, but by that time he would probably have completed the reconnaissance and be well set into the journey back to base.

The specification for the DFS.228 was first issued in 1941, and had the institute not been burdened by work given higher priority this glider might well have figured in the late war. As it was, the machine's development was delayed, and it was not until 1943 that the German Air Ministry gave orders for its immediate production.

Transonic Rocket Gliders

The DFS.228, designed by Dipl. Kracht and his staff, was actually the most advanced of several other rocket and jet-boosted gliders, among them the DFS.346 and DFS.1068, of which there were four versions of the latter. The accompanying table gives such particulars of these aircraft as are available. Each was intended for transonic and supersonic research and followed the same general pattern as the DFS.228; and hence the reason for explaining the reconnaissance glider at this stage.

However, before continuing, it will be as well to mention something of the D.F.S. itself.

Origin of the D.F.S.

The German Research Institute for Sailplanes had its beginnings in the early "twenties"—at the time when Germany, having lost her right to an air force under the terms of the Versailles Treaty, was fast becoming glider conscious. It was not that commercial aircraft were denied under the ruling; the war had evoked widespread interest in aviation, and the country's economic position simply did not leave anything over for the construction of pleasure

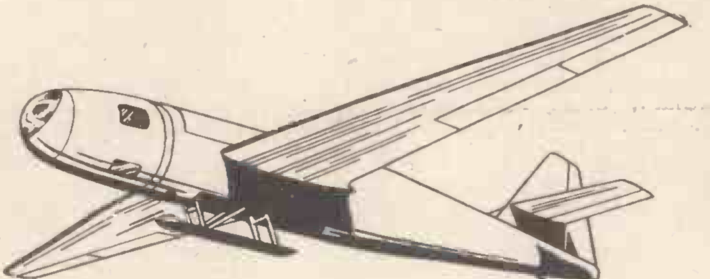


Fig. 95.—The DFS. 228. A ceiling of 15 miles with a top speed of 560 m.p.h. were the figures quoted for this rocket-booster reconnaisance glider.

aircraft. Gliders, however, were different. They could be built by any worthwhile engineer and, above all, could be turned out cheaply.

It was thus that gliding became one of Germany's foremost sports and to serve the needs of glider and sailplane enthusiasts, ever demanding improvements, the Forschungs Institut für Segelflug (Sailplane Research Institute) was founded in 1924.

The tragedy was that the Institute should have laid the foundation for the Luftwaffe, as it surely did, when Hitler saw fit to snub the binding treaty and embarked upon his programme of recreating the German "war machine."

Meanwhile German science was fast perfecting another form of aerial attack, the long-range rocket, which, ludicrous as it was tragic, was no infringement on the terms of the 1918 surrender—organised rocket development started in 1927 (see PRACTICAL MECHANICS, September, 1944, p. 441). It is significant to recall also that at least two rocket-powered gliders had flown before 1930.

Shortly after its formation, the Institute was established at Darmstadt, the name being changed to Deutsche Forschungsanstalt für Segelflug (German Research Institute for Sailplanes), referred to by the letters D.F.S. The original purpose of the group was to investigate, on a sound scientific basis, the aerodynamics and uses of gliders. However, the scope of the Institute was considerably widened in later years, and at the time of its occupation by the Allies it was subdivided into several research sections devoted to specialised studies of flight, both powered and power-less.

In 1939 the D.F.S. was moved to Braunschweig, and then finally, in the summer of 1940, to Ainring, in Upper Bavaria, by which time it had been fully developed as one of Germany's ten major aeronautical research stations.

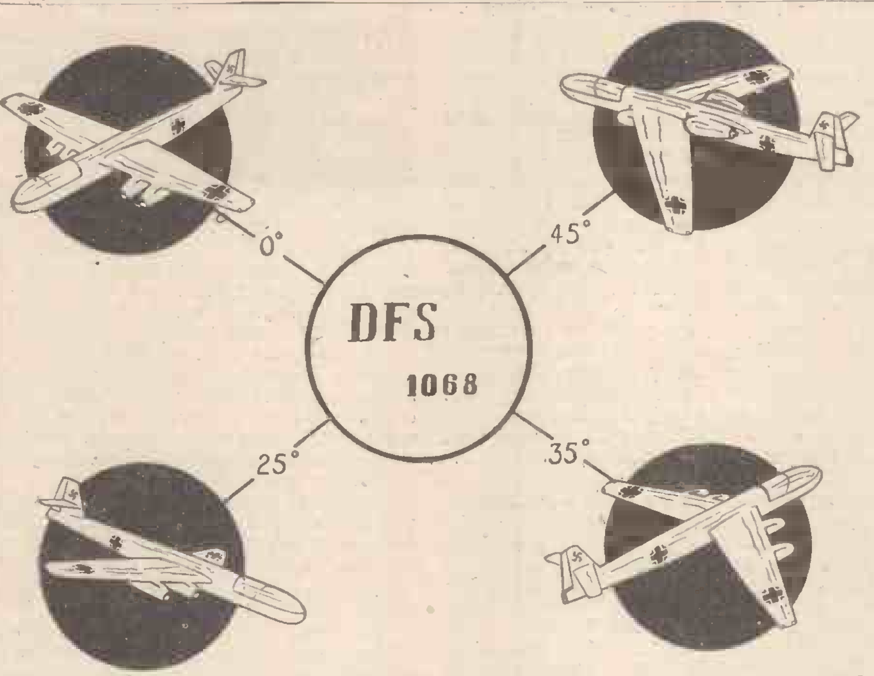
Key Technicians of the Institute

At the head of the D.F.S. "family tree" was Director W. J. O. Georgii (Prof., Dr., Dr. Eng.), formerly professor of flight meteorology and aeronautical research at the Technische Hochschule in Darmstadt; his deputies numbered two, Dipl. Temme on the technical side and Ing. Stamer representing the management.

Each of the ten technical departments had its own leading specialist, as noted in the following list, which will also serve to convey some idea of the institute's increased significance in recent years: (1) Institute for aerodynamics, Prof. Ruden; (2) Institute for glider construction, Dipl. Kracht; (3) institute for flight tests, Ing. Stamer; (4) institute for aeronautical equipment, Prof. Fischel; (5) Institute for physics of the atmosphere, Dr. Höhndorf; (6) department for high frequency, Dr. Folsche; (7) laboratory for special engines, Dr. Eisele; (8) department for engines, Dr. Sänger; (9) photographic section, Dipl. Harth; and (10) central workshop, Ing. Erbskorn.

Administration was in the hands of Herr Rauber.

Needless to say, most if not all of these technicians are now absorbed in various research activities adding to the technological advantage of the United Nations. Among



These four aircraft, descendants of the DFS. 228, were intended for research at Mach numbers between 0.8 and 1.2. Particulars of engines and propellants are given in the accompanying table.

the names that readers may have recognised is that of Dr. Sänger, pioneer rocket engineer and aerodynamicsist. In his book, the Technique of Rocket Flight, published in the days of bi-planes (1931), Sänger set out the fundamentals for a supersonic aircraft, and, as will be gauged from Fig. 50 (PRACTICAL MECHANICS, January 1946, p. 134), time has proved him a no mean prophet. His original research with liquid-fuelled rocket engines at the University of Vienna was none the less amazing; like the V-2 power plant, Sänger's engine of the early 1930s was fuel cooled. It operated on a refined diesel oil and liquid oxygen and was capable of thrusting continuously for periods of anything up to 30 minutes; in those days an unprecedented feat.

There still remains much to be said of Dr. Sänger, especially in his work at the Research Institute for the technique of Rocket Flight at Tauen, where, in 1936, rocket engines of 100 tons thrust were under project along with suitable airframes for withstanding travel at Mach numbers between 3 and 30. When, later, Sänger was incorporated into D.F.S., his main work consisted in developing the Lorin "athodyd" engine.

Beginnings of the Reconnaissance Glider

A complete account of the D.F.S. would fill volumes, and, in any event, by far the greater proportion of the work concerned slow-flight research, which is no concern in this writing. Sufficient to say of the experiments which led up to the rocket-gliders is that by 1940 a newly discovered technique, termed "wave-gliding," was permitting motor-less flights into regions of the sub-stratosphere. A sailplane had been successfully operated up to 38,000ft. in 1939 and, but for the ill-effects of cold and reducing atmospheric pressure on the pilot, it was evident that the machine could have flown still higher. Its flight depended upon rising waves which had been found to occur behind ranges of mountain when certain wind currents were prevalent.

There is a story told in Germany that illustrates vividly the possibilities of "wave-gliding," to say nothing of its hazards. It

Type No.	Description and Purpose	Power Plant	Propellant	Dimensions		Wing Area	Wing Loading		Speed/ Mach No.	Operational Ceiling	Range		Remarks
				length	span		loaded	empty			Safe	Max.	
DFS 54v-1	High-altitude research glider for testing pressure-cabin and emergency escape technique. Experimental prototype of DFS 228v-1	None	None	29ft. 5in. *	65ft. 6in. *			3.4 lb./ sq. ft. *					One completed and flown
DFS 228v-1	Reconnaissance glider, rocket-assisted, and similar in general conception to DFS 54v-1	Walter 109/509D rocket unit	T. and C. stoffs	34ft. 7in.	57ft. 6in.	323 lb./ sq. ft.	28 lb./ sq. ft.	12 lb./ sq. ft.	560 m.p.h. (max.)	75,000ft.	460 miles	650 miles	One (at least) completed and successfully tested under glide
DFS 228v-2	Identical to DFS 228v-1 but with couch for prone piloting in lieu of upright seating												One completed but destroyed during air-raid
DFS 332	Rocket-boosted research glider with twin booms, for testing various wing sections at high Reynolds numbers	Two Walter 109/501 rocket units	T. and Z. stoffs with petrol (burnt with liberated O_2)										One partially completed at Ainring
DFS 346	Rocket-boosted glider for transonic and supersonic research at high altitudes. Similar to DFS 228v-2 but with 45 deg. wing sweepback	Walter 109/509D rocket unit	T. and C. stoffs						Between .8 and 2.0	100,000ft.			Under construction by the firm Siebel at Halle
DFS 1068 v-1	Glider with turbo-jet and rocket boosters for transonic and supersonic research at high altitudes—no wing sweepback. (See illustration above)	Four Ju. 004 or four He. SO.11 turbo-jets, plus one Walter 109/509D rocket unit	J-2 (brown coal-oil) and T. and C. stoffs						Between .8 and 1.2	50,000ft.			
DFS 1068 v-2	As DFS 1068v-1 but with 25 deg. wing sweepback	As in DFS 1068v-1, less rocket unit				Almost completed by the firm Wrede at Freilassing, subsequently destroyed during an air-raid			.8 and 1.2	50,000ft.			
DFS 1068 v-3	As DFS 1068v-1 but with 35 deg. wing sweepback	As in DFS 1068v-1				Partially constructed by the firm Wrede at Freilassing, subsequently destroyed during an air-raid			.8 and 1.2	50,000ft.			
DFS 1068 v-4	As DFS 1068v-1 but with 45 deg. wing sweepback	As in DFS 1068v-1							.8 and 1.2	50,000ft.			

Figures marked thus: * are unchecked.

Table showing the nine glider projects which the D.F.S. had under development at the time of the surrender.

concerns two pilots of the Horten company who, intent on obtaining some first hand data of the buoying currents which they knew swept up from the Hartz mountains, contrived to ascend with them. Each took a separate Horten tailless glider and, after cutting loose from their respective tow cables, they entered the lower reaches of a rising stream. The immediate result was an unbelievably swift ascent which would have done credit to a high-powered fighter. So great, in fact, was the force at which they were driven that both were left nothing to do but hold their craft steady while each watched his altimeter as the needle rose, clocking thousands of feet altitude.

The aim had been to reach 20,000 feet and, coming up to that level, they set their controls for the long glide back to base—*but there was no response.* With noses pressed hard down and lift spoilers in full operation, the gliders continued to rise unchecked and, try as they may, their pilots could do nothing about it.

The reduced pressure and extreme cold at still greater heights were more than they dare risk and rather than gamble on the gliders becoming freed from the rising currents before they blacked-out and were frozen, the two men took what seemed the logical course and baled out.

One of the machines was flying higher than the other and its pilot was the first to jump. Watched by his companion, he dropped away and despite the freezing temperature, which by that time must have rendered his fingers almost useless, he succeeded in pulling the rip-cord. His parachute was seen to blossom out, but as suddenly as it had arrested his fall, so the vicious air current again took charge and he was blown upward, to be frozen to death somewhere in the sub-stratosphere.

The second pilot was more fortunate. Although he too decided to bale out and was again borne up for some distance when his canopy opened, the rising stream must have carried him near its fringe for at length he slowly began to descend. He lived to tell this remarkable tale, but so severely frostbitten were his hands that one of them had to be amputated. This, of course, is a very sketchy summary of the incident, but it does serve to indicate the nature and extent of the phenomenon.

In these and other tests, German pilots had broken all established altitude records for gliders, but that was incidental; their exploits had been watched with keen interest by the Luftwaffe chiefs.

To the D.F.S. eventually fell the task of designing a special pressure cabin; and thus was born the idea for a true stratosphere glider, and with it the possibility of reconnaissance from heights inaccessible to fighters.

Design Problems

The designers of the DFS.228 had three principal aims: to provide (a) the lightest possible structure, to contain (b) a pressure cabin, and (c) a controllable Walter rocket system.

It should be mentioned that there were two versions of this machine, the first having normal upright seating and the other—the one described—embodying its pilot prone. However, the design was initially built under the type number DFS.54, with which an extensive series of glide tests had been made before constructing the DFS.228V-1. (See the table on page 267).

At first, the incorporation of a pressure cabin in a glider, whilst still retaining in it reasonable soaring qualities, seemed entirely out of the question. There was obviously no use attempting to adapt systems of existing high-altitude aircraft for any one was far too heavy and would have put the wing loading up prohibitively. Thus, entirely original research was called for to achieve the seemingly impossible in providing super-light pressurisation, upon which depended the ultimate success or failure of the entire project.

A consideration of the weights involved in this extra equipment made it clear that a desired wing loading (all fuel gone) of 12lb./sq. ft. was impossible with a wing area of anything less than 300 sq. ft. The final figure worked out at 323 sq. ft. Other leading dimensions were: length, 34ft. 7in., and span, 57ft. 6in.

To assist in keeping the overall weight down to within practicable limits more than usual attention was given to eliminating unnecessary mass in the glider's structure. The bulkheads, stringers and spars were almost entirely fashioned from hardwood, and equipment was reduced to a minimum.

DFS.228V-2—Design of the Fuselage

The fuselage was cylindrical for the greater part of its length, having a rounded nose and a tapered after section.

The nosing housed the pressure cabin and took the form of a two-wall metal cylinder, the ends of which were sealed by a strong rear bulkhead and a moulded "Plexiglas" windscreen. There was no mechanical load whatever imposed upon the shells, the liner serving to withstand pressures within the cabin, whilst the outer skin was relied upon to check external forces. A satisfactory insulation was found in the use of aluminium foil packed into the space between the cabin walls—a similar arrangement now used to limit radiation in certain "prefab" houses.

Accommodation for the pilot was provided by a tubular metal couch attached to the rear bulkhead, on which he lay full length. This was a great improvement over the seating in the sub-type V-1 and, as well as affording better vision, it greatly facilitated the task of pressure sealing. To allow entry into the cabin, the nose—complete with couch—was designed to slide forward a distance of 3ft., and by this means all possible strain was eliminated from the delicate cabin walls.

The prone piloting position naturally involved a rearranged control system. It was necessary to place the rudder pedals at the rear of the couch, whilst a short control column was fixed at the front on the pilot's right, with trimming and throttle controls on his left.

The cabin, because of its light make-up, did not permit internal pressures greater than a figure corresponding to conditions at 26,000ft., and this made a separate oxygen supply essential. It was capable of holding a differential pressure of about 6lb. sq. in., with a loss of only 3 per cent. in 24 hours; the rotating joints through which the control rods emerged were the source of greatest leakage. There being no piston engine (or other suitable power plant) to drive pumps in the pressurisation system, it was necessary to install compressed-air bottles, and a point of interest is that the pilot's breath actively assisted the charging, undergoing a drying process before its reintroduction.

A means of heating was another problem, but this was eventually overcome by providing a tube through which cold, dry air was introduced, with slow-burning cartridges—ignited at frequent intervals—employed to apply heat.

Aft of the cabin in the glider's centre fuselage section, double-skinned with ply. and insulated, contained two Zeiss infra-red cameras; behind them were the C-stoff and T-stoff tanks and pumps and ancillaries which, complete with a single combustion chamber (housed in the rear of the tail), comprised the Walter 109-509D rocket engine. A hinged door extended along the top of the entire centre section, providing a convenient means for servicing the propellant system and cameras.

Housed in the lower part of this section was also a metal landing skid which faired flush with the skin during flight and was extended manually prior to landing.

Wings and Tail

Arrangement of the lifting and stabilising surfaces was orthodox, attachment for the wings being slightly lower than mid-depth of the fuselage, whilst the tail-plane bolted to the single fin a short distance above its root.

The wings were built up on a single laminated wooden spar, with hardwood ribs and ply covering. Two sets of fabric-covered ailerons were provided on each, the inner pair to operate as flaps during the landing approach. There were also lift spoilers, four in all, fitted on both the upper and lower surfaces.

The tail-plane and fin—the former adjustable—were also constructed in wood, with fabric-covered rudder and elevators of conventional design.

Escape from High Altitudes

There was obviously no future in baling out under stratospheric conditions, and the extreme operational ceiling of the DFS.228 demanded more than usual safeguards. A pressure suit had been suggested as a ready means for satisfying both pressurisation and escape problems, but for some reason it was not proceeded with.

It was arranged for the pilot to effect his release by severing his cabin from the aircraft, which he was to accomplish by operating a lever, detonating four explosive bolts. The cabin would fall away nose-first, trailing a small parachute to keep it upright, and thus it was possible to maintain pressurisation until the pilot had descended to a safe altitude. A barometric capsule then set in operation a piston and cylinder—actuated by compressed air—which thrust the couch and transparent nose forwards, at the same time freeing the pilot from his harness.

A static line attached to the cabin opened the pilot's parachute as he jumped clear.

Spreading Out

The Allied air offensive caused the Institute's personnel to disperse, and most of their equipment was found in cellars and barracks at the Ainring airfield, at dispersal laboratories and workshops at Reichenhalle, Feisenderf and in other neighbouring villages. Still more D.F.S. gear was uncovered in farmhouses and castles in the Ainring area.

This policy, however, did not prevent the destruction of some of the group's most treasured projects, including the prototype DFS.228V-2.

(*To be continued*)