THE MODEL ENGINEER EXHIBITION

NEWNES

PRACTICAL MECHANICS

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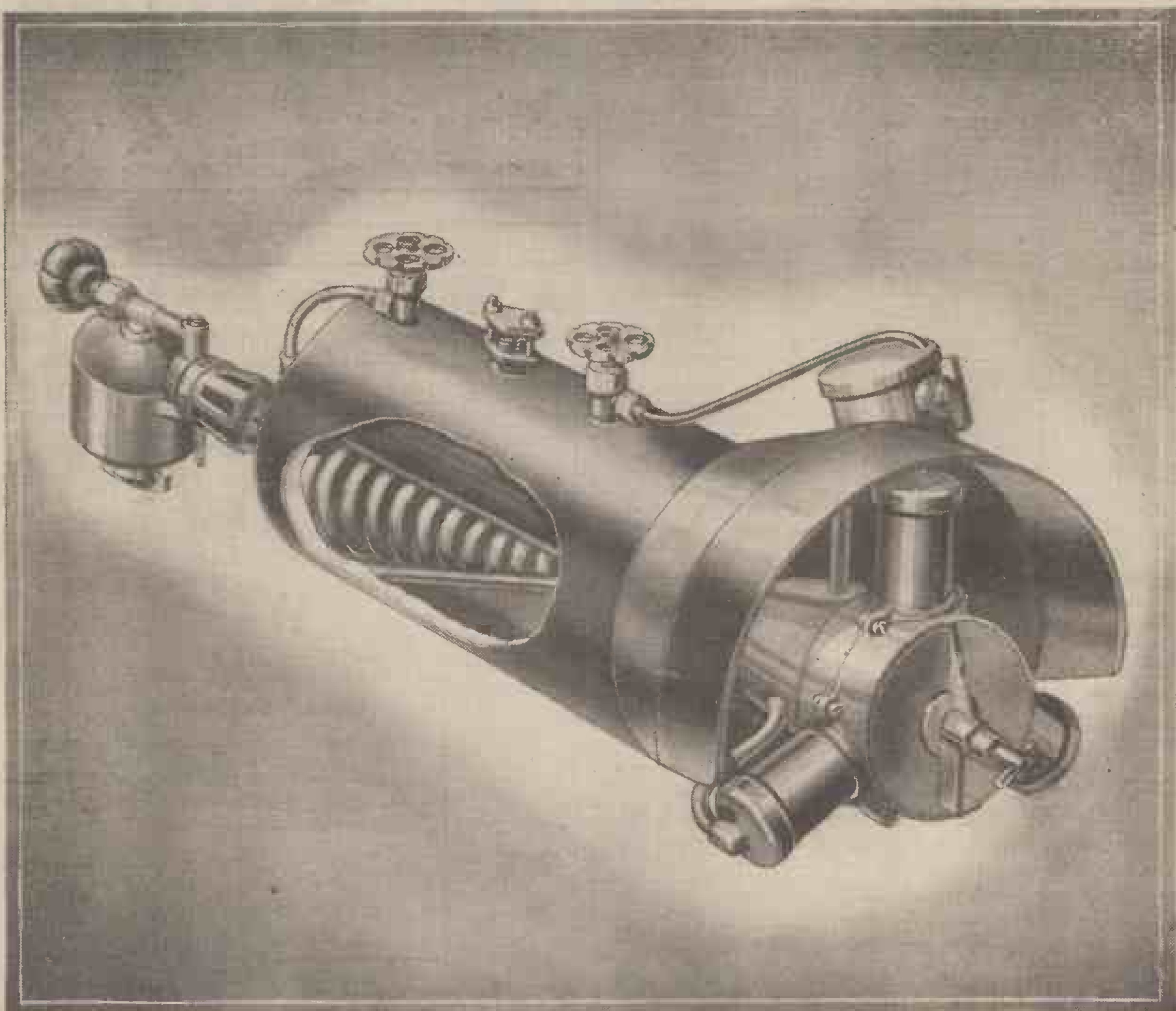


A GENERAL VIEW OF F. J. CAMM'S FLASH STEAM PLANT (See page 6)

Rocket Propulsion

The Ba. 349 "Natter"

By K. W. GATLAND

(Continued from page 422, September issue.)

HIGH in priority during the desperate months leading to Germany's final overthrow was another rocket-powered interceptor, the Bachem Ba. 349 "Natter" (Viper).

This machine resulted from a specification issued by the German Air Ministry towards the close of 1944 for a rocket propelled aircraft to defend specific targets. Four firms competed in the design, each producing a prototype: Heinkel, a type known as "Julia"; Junkers, the "Walli"; Messerschmitt, the Me 1104; and Bachem, a machine provisionally known as the BP. 20. The latter project was eventually accepted for development and given the designation Ba. 349, while the rest were dropped.

As closely akin to a guided missile as to a fighter aircraft, the tender for this design was submitted by Dr. Eric Bachem, founder of the Bachem Werke G.m.b.H., at Waldsee-Würtemberg.

Bachem based his design on a vertical take-off and an exceptionally high rate of climb.

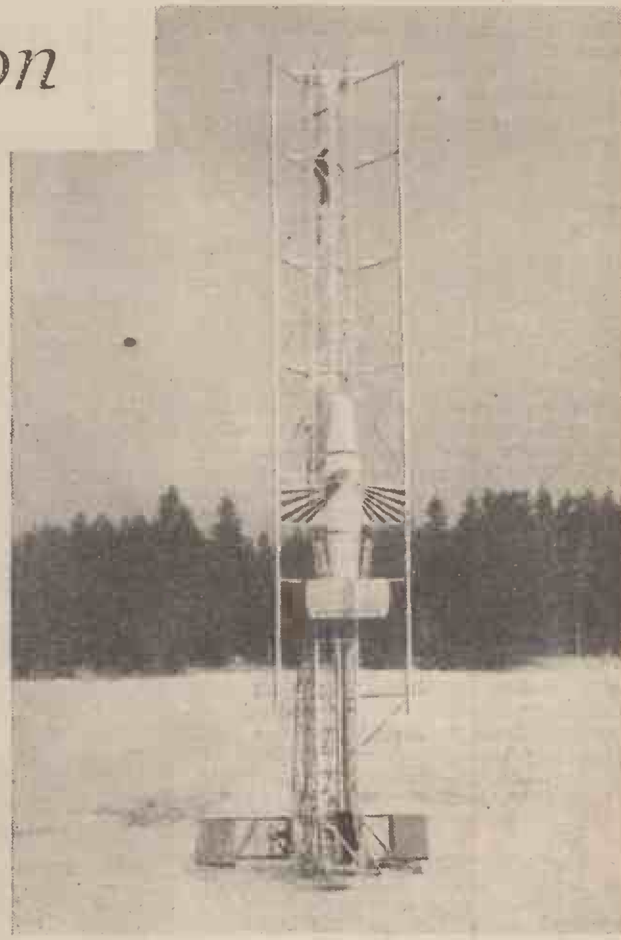
To satisfy these requirements, it was decided to concentrate on the speed factor and to effect no compromise such as maintaining a reasonable wing loading for usual flight manœuvres and landing. The design, in fact, was such that landing by normal means was impossible, and it was at first planned to sacrifice the complete aircraft.

The latter problem was overcome quite simply. It was arranged that the pilot abandoned the machine immediately after pressing home his attack and descended by parachute, the after section of the fuselage (containing the motor and accessories) following him down in a similar fashion, to be collected and later re-built into another "Natter." At least, that was the intended operation, but on the one occasion that the Germans carried out a manned test, the cockpit hood blew up when the machine was only 300ft. from the ground, causing it instantly to turn over and plunge to earth, the rockets still firing at full power. Needless to say, the pilot was instantly killed.

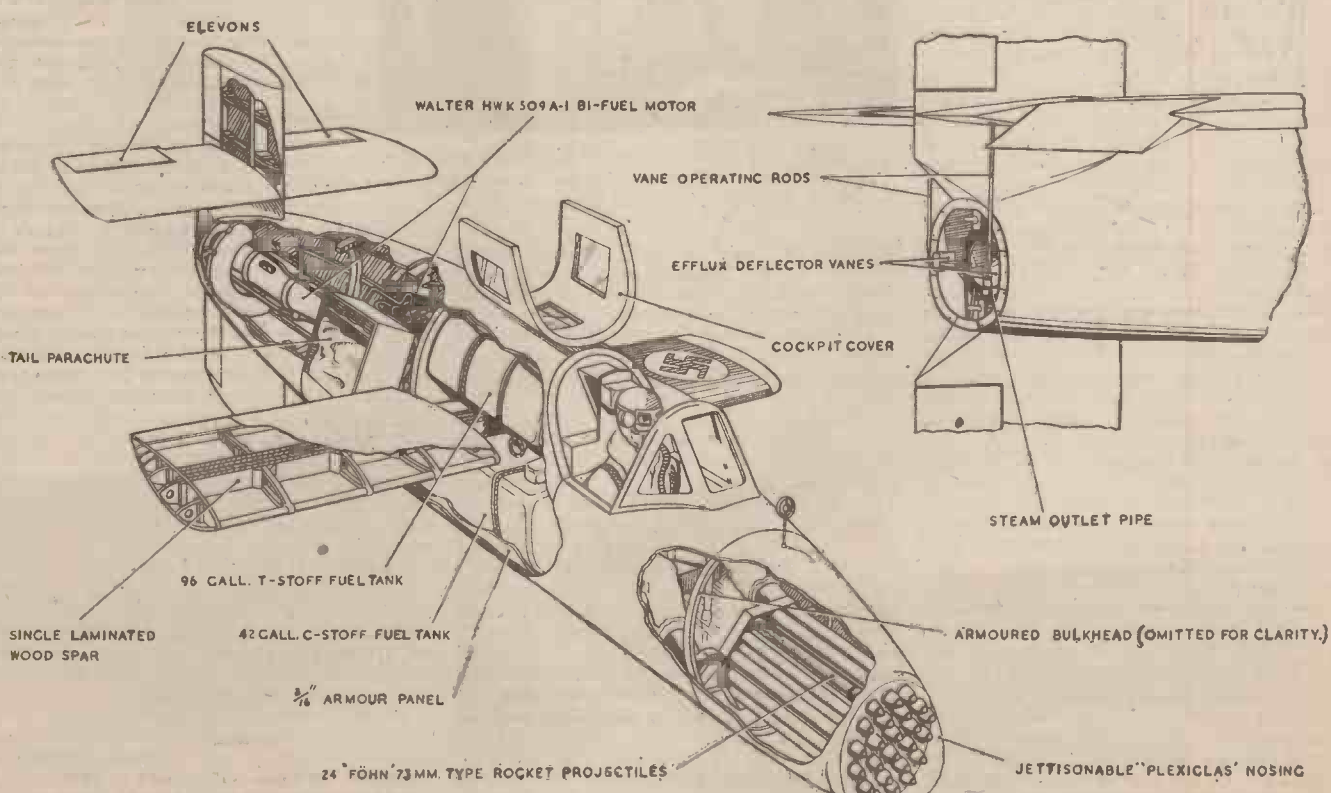
All other ascents were made under the control of auto-pilots.

The Ba. 349A

Powered by an HWK 109-509A1 Walter engine, the first production version of the "Natter" flew at a maximum speed of 540 miles per hour, climbing at the rate of 35,800ft. per minute to reach its ceiling at 49,000ft.



This picture gives a good idea of the small amount of space required to operate the "Natter." Intended to be launched from bombed sites, parks, or any convenient space near the factory it was assigned to defend, the Ba. 349B climbed at the phenomenal rate of 37,000 feet per minute.



A part-sectional drawing of the Ba. 349A "Natter," showing the simple construction of the airframe and the layout of the main components.

The construction of the fuselage was entirely of wood, being of semi-monocoque design, with a laminated wood skin, stringers and formers. It was built in two main sections and the pilot was installed inside a heavily armoured cockpit immediately behind his main armament of explosive rockets in the nose. These were mounted in a quadrangular or hexagonal frame (according to the calibre of the rockets used), the heads being faired by a "Plexiglas" domed nosing during flight, which was blown preparatory to firing by explosive bolts. In addition to the rocket armament, which could be either thirty-three R4M R.P., or twenty-four of the larger Föhn 73 mm. type, some production versions mounted two Mk. 108 30 mm. cannon.

For protection, there was the bullet-proof windscreen, and two armoured bulkheads at front and rear of the pilot, while the sides of the cockpit and fuselage local to the propellant tanks were also screened by 3/16in. armour panels. This heavy armouring, coupled with the small frontal area and high speed of the "Natter" made it almost invulnerable to harm from bombers' defensive guns.

The main controls were a control column, rudder pedals, auto-pilot and throttle box, whilst mounted on the front cockpit bulkhead were two buttons, one for firing the R.P., the other causing ejection. Levers for jettisoning sections of the aircraft were also fitted close at hand.

At the rear of the cockpit were two propellant tanks—96 gallons of T-stoff above and 42 gallons of C-stoff below—and farther aft still, the fuselage parachute, turbine pumps, accessories and, finally, the rocket motor.

The short-span wings, which did not detach from the fuselage, embodied a continuous laminated wood spar passing between the tanks, with wooden ribs, and metal-sheathed tips. There were no ailerons.

The tail-assembly, which was built in a similar manner to the wings, comprised fin and rudder area both above and below the fuselage, with the tail-plane itself mounted well above the centre-line on the topmost fin. The elevons, fitted on the tail-plane, were, of course, functioned by the control column, serving the dual purpose of elevator and aileron.

An interesting point about the control system is that the elevons were linked to corresponding vanes which worked in the exhaust stream at the rocket nozzle. Thus, not only were longitudinal and lateral movements made more sensitive by the offset reaction which resulted when the vanes were deflected, but flight with "hands-off" was excellent under the control of the automatic pilot.

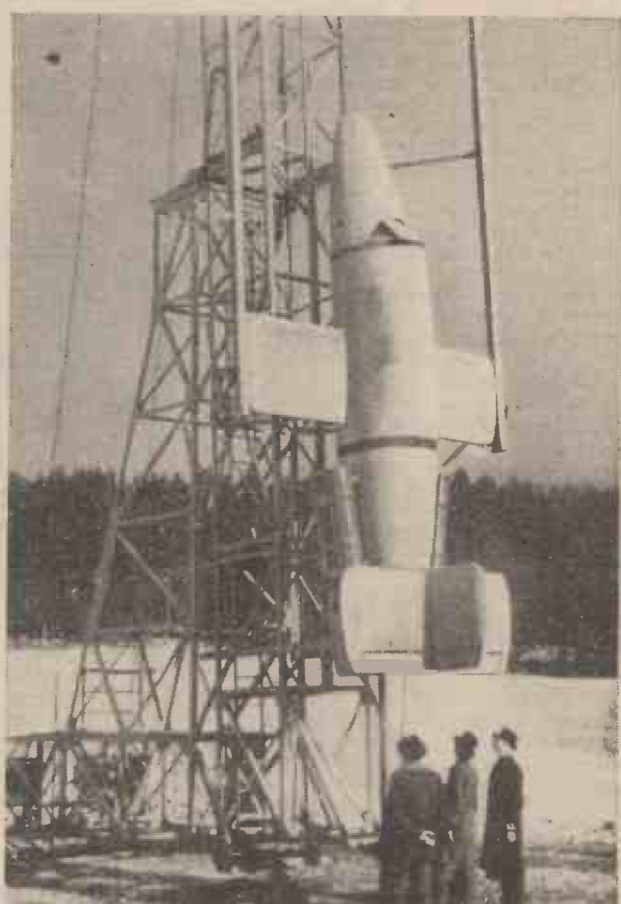
This method was yet another having its origin in the V-2 research at Peenemunde, and its application in the "Natter" certainly contributed greatly toward its well-stabilised climb. It will be noted in this regard also that no attempt was made at wing sweepback, despite the high speeds involved.

By the close of hostilities, the Germans were masters of high speed aerodynamics and had the very best of equipment for such research, having regard for both "tunnel" testing and actual free-flight experiments with aircraft they had specially built.

The Messerschmitt 163—Germany's first rocket interceptor—was not, however, a particularly good example of their work. One problem not easily overcome was the large degree of washout required at the wing tips which, though necessary as part of the general stability, did not contribute to the performance when the machine was throttled beyond the 500 m.p.h. mark. The incorporation of washout made for excellent handling qualities at low speeds, but although the wings were swept back to improve stability and to delay compressibility effects nearing the sound velocity, this factor was the one largely responsible for the machine becoming uncontrollable at M=0.82.

The German technicians, however, took no chances with the "Natter." They knew the urgency of its development, and consequently did not embody features that might break down in trials and cause delays in production.

Despite the fact that elevons displaced the more normal wing ailerons and tail elevators, the control system was really not that much untried. It had, in fact, proved highly effective in the Messerschmitt design, and coupled with the exhaust-vane stabilisers the results were very satisfactory.



All set for take-off. The tips of the wings and lower fin of the "Natter" were strengthened to run in the three guide rails of the 80-foot launching ramp.

The exhaust-vane system, incidentally, is likely to play a large part in maintaining control at trans-sonic and super-sonic speeds, and it will be interesting to watch developments.

The Bell Aircraft Corporation has, in fact, already produced an aircraft with which it is hoped soon to penetrate the sound barrier. This is the XS-1, fitted with a ram-jet "athodyd" and rocket booster, but the technicians in charge of its testing programme are first making certain of the 'plane's behaviour with "power-off." The machine has already accumulated several hours' flight time, having been taken up to height beneath a large bomber and released to obain first-hand knowledge of its stability and general handling qualities at low speeds. Only when complete data has been obtained in glide flight will the machine be tried under power: "Controllability is the big unknown," said Lawrence D. Bell, president and general manager of the company; "Should our pilot discover dangerous flight characteristics in the speed-of-sound range, it will be possible for us to continue our flight programme through the use of radio-control, a device we have brought to a high state of perfection in co-operation with the Army Air Force. We are prepared to substitute robot control for our pilot at any time it may be desirable."

Precise details of this machine have not yet been made known, but there can be little doubt that the best features of German research have been incorporated, and it may well be that the control system has been adapted from the "Natter."

The overall length of the Ba. 349A was 21ft. 3in., the span 13ft. 1in., and the wing area, 51.6 sq. ft. From tip to tip, the vertical stabiliser measured 7ft. 3in.

Operation

Launched almost vertically, the machine rose from its 80ft. ramp under power from dry-fuel A.T.O. rockets mounted on the fuselage at the tail-end. Although it was usual to use four units each developing 1,100lb. thrust and operating for 6 seconds (probably the Walter 109-505 di-glycol powder type), the Schmedding 553 producing 2,200lb. thrust for 12 seconds was the alternative. In the latter instance, only two charges were employed, and these were the units originally developed in the final research of the BP-20 prototype. The initial acceleration was slightly greater than 2g., and the rocket assisters were jettisoned at a height of about 5,000ft., by which time the main bi-fuel engine was developing full power.

The take-off ramp was pivoted near its base so that it could be brought horizontal to enable the "Natter" to be conveniently loaded from its transport; the tips of its wings and lower fin having been strengthened to run in the three guide rails.

Upon receiving the usual warning of raiders approaching, the pilot climbed into his cockpit and was elevated by his crew into the launching position. The course of the bombers was to be checked by a standard radar predictor, and the setting passed direct to the auto-pilot in the interceptor through an electrical link broken at the instant of take-off. Thereafter, the machine was steered automatically on the pre-set course until the pilot took over to make corrections to his flight path caused by the movement of the bombers since the time of launching. The course of the raiding aircraft was, of course, radioed from the ground to assist the pilot in his manœuvres.

Closing in on the bombers, the pilot jettisoned the plastic nose fairing exposing his rockets. His machine drew rapidly to firing range and levelling up with the aid of a simple ring and bead sight, the nose racks were suddenly empty, with flame and blast encompassing the target.

Evasive action by the bombers would have been difficult because breaking formation would have meant lone bombers fighting off conventional patrol fighters without the covering fire that would otherwise have been afforded by supporting machines. Thus, had it been found possible to guide the fast climbing "Natter" with a reasonable degree of accuracy, there can be little doubt that its development would have been most beneficial to Germany's air defence.

Having expended his armament, the pilot was no longer able to control his aircraft because of the displaced C.G.

The remainder of the story suggests little more than a fight for survival. The pilot's first action was to operate a lever, which detached the complete nose section of the machine. When the air pressure had carried it clear, the pilot, still sitting in his seat, was exposed in the open. By this time he had snapped open the buckle of his harness and the operation of the second lever then caused the ejection of the tail parachute. This applied a violent braking effect on the aircraft, pitching the pilot forward out of his seat, whereupon—after perhaps being in the air for barely two minutes—his parachute opened automatically, and he was wafted back to the ground. At the same time, the remaining section of the interceptor divided and the more valuable portion, containing the engine and accessories, also descended beneath its separate parachute for re-use.

It is clear that the job of a Luftwaffe pilot towards the close of hostilities was no basis for planning a future.

Production of the "Natter"

The "Natter" was produced in two type series, the original production version, Ba. 349A, and a development, Ba. 349B.

There was little difference between the prototype (BP. 20) and the early production models, and all that was noticeable to the observer was a modified lower fin. This was short and brought forward in Bachem's original design, but in production the vertical stabiliser was square-cut and almost equal in length above and below the fuselage. The only other alteration was that, on some machines of the "A" series, an austerity engine had been substituted, the HWK 109-559.

Originally projected at the time when recovery of the power plant had not been considered, this unit embodied an uncooled combustion chamber, a simplified pumping arrangement and was without electric starting. Its development was obviously no mean achievement, despite the fact that it was only called upon to operate for two minutes. The motor, which probably embodied a ceramic liner in place of the cooling jacket, delivered a maximum thrust of 3,750lb. and was equally as controllable as the more durable types.

The Ba. 349B, of which there were only a few produced by the time of the defeat, was propelled by an HWK 109-509D Walter engine. This unit was not vastly different to the "C" version, having an additional "cruising" chamber which, operating with the main chamber, gave the machine a maximum speed of 621 miles per hour at 16,400ft. and boosted the climb to 37,300ft. per minute. The all-up weight was 4,920lb., only 120lb. greater than the earlier model, and the wing loading at take-off 95.5lb. per sq. ft., reducing to 37.6lb. per sq. ft. when expended of propellant. Flying at an average of 495 miles per hour, and by careful use of the two chambers, the machine could be operated under power for four and a half minutes.

The overall length of the "B" sub-type was 20ft. 7in., all other leading dimensions remaining as in the Ba. 349A. Thus, the wing area, too, was unchanged. The all-up weight at take-off, including four dry-fuel assisted take-off units totalling 1,000lb., was 4,925lb., reducing to 1,940lb. at the time of break-up for landing. The parachute for landing the tail fuselage and motor weighed 88lb. At take-off the wing loading was 95.5lb. per sq. ft., diminishing to 37.6lb. per sq. ft. with tanks dry.

Designed from the mass-production view-point and using only semi-skilled labour in its construction, the machine was not sufficiently advanced in production to see service during the war. Its development had apparently been greatly hampered by Allied air assaults, and eventually, in view of the highly satisfactory results achieved in tests of the rocket-boosted Messerschmitt 262 jet-fighter, production orders were cancelled.

A "Natter" streaks skywards under the control of its auto-pilot. The climb was assisted in the initial stages by four dry-fuel rockets which contributed 4,400lb. thrust. These fired for six seconds and were jettisoned at about 5,000 feet, leaving the internal bi-fuel Walter engine to operate for the remainder of the flight at a maximum thrust of 3,520lb.

The Heinkel "Julia"

Of the three designs for rocket interceptors rejected in favour of Bachem's "Natter," the Heinkel "Julia" would seem to have been the most promising.

The general layout was really quite orthodox despite a prone piloting position, and although launching was vertical the 'plane was able to glide and land in the normal manner. Again, sweepback and all unconventionalities were avoided, the obvious intent being to produce a simple and easily produced structure. It did not, however, incorporate the degree of simplicity that Bachem's team had embodied in the "Natter." It is true that the airframe of the "Julia" was more to the form of a normal fighter, but the fact that the 'plane could be operated repeatedly did not carry much weight with the German Air Ministry. It was obvious that the loss of an easily replaced interceptor did not matter so long as Allied bombers were knocked out before they had a chance to reach their objectives. In any case, the pilots of local defence interceptors were fortunate to find a suitable landing field within gliding range and forced landings would invariably "write-off" a returning machine as surely as if it had been abandoned in mid-air.

(To be continued.)

Technical and Scientific Register

A RECENT meeting of the Electrical Engineering Committee was attended by Sir Arthur Fleming, Col. Sir Stanley Angwin, Mr. J. R. Beard, Mr. W. K. Brasher (secretary, Institution of Electrical Engineers), Mr. E. S. Byng, Mr. C. W. Marshall, Mr. E. A. Mills, Mr. H. J. Nunn, Dr. C. C. Paterson and Mr. C. Rodgers (B.E.A.M.A.).

Amongst the various questions considered by the committee were proposals for securing employment for men who joined the technical branches of the Forces immediately on graduation and are now being demobilised. They have not previously had industrial experience, but many have had the advantage of commissioned service in technical corps and have shown qualities of leadership and initiative which should be of great value to industry. Suggestions made by the committee are likely to lead to experimental schemes of training in industrial concerns with a view to preparing these ex-Service personnel for responsible posts after training. The committee realise that adequate pay arrangements will be required in order to make training schemes of this kind economically practicable.

The committee stressed the importance of developing still further the close co-operation which already exists between the Ministry's Technical and Scientific Register and the Professional Engineers Appointments Bureau, and expressed the hope that industry generally would make use to the fullest possible extent of the facilities offered by the register.

The Technical and Scientific Register of the Ministry of Labour's Appointments Department, which is operating from York House, Kingsway, London, W.C.2, has the benefit of the guidance of advisory committees, composed of leading representatives of the various professions catered for by the register, to ensure that it is providing the greatest possible service to employers seeking professionally qualified technical and scientific staff, and to those seeking appointments.

The chairmen are Sir Arthur Fleming (electrical engineering), Sir William Stanier (mechanical engineering), Sir Peirson Frank (civil engineering), Sir Robert Pickard (chemistry), Sir Lawrence Bragg (scientific research) and Mr. T. E. Scott, F.R.I.B.A. (Architectural and Public Utilities Advisory Committee, including surveying, town planning and valuation).