such length, of a single continuous mooring cable that was "threaded" to each pontoon by a special launch (carried during towing on the deck of the bridge) and picked up and secured by men working on the floats during the mooring process.

Caissons for the breakwaters were constructed in six different sizes, the largest of which displaced 7000 tons. They were designed to suit various depths up to 5½ fathoms at low water. Dry docks, wet docks (including at least one of the London docks), and basins excavated alongside river channels were used for their construction. Frequently in the case of basin construction it was impossible to provide anything approaching the depth of water required to float a completed caisson. Little more than the "keel" could be constructed and was then floated out or completion elsewhere. Difficulty was then naturally encountered owing to the "hogging" of such partly built structures, a deflection that took place even in those with square ends, but was naturally more pronounced where the end was boat-shaped. It was overcome in various ways, the more successful being the partial flooding of central compartments, the adjustment of which had to be continuous as new "lifts" of concrete were added and the structure sunk deeper into the water. So many contractors were involved in building the caissons that no general description of the methods employed can be given. Each contractor developed his own practice according to the circumstances ruling at the particular building site concerned. No less than 146 caissons were built, all within a period of about six months. Problems were encountered in the storage of completed structures, since moorings available around our coasts in reasonable proximity to Normandy were limited. Many, if not all, were actually sunk in suitable carefully chosen areas and pumped out and refloated after D-day in preparation for towing across Channel.

There are other items of equipment, such as special floating ramps for use at the shore ends of the floating roadways and erection floats used at the tow end of lengths of that roadway while under tow, that might be described. But the really astonishing fact is that though the various units could to some extent be tested on this side, no really satisfactory trials could be carried out without that knowledge of the precise conditions at the selected length of beach which in the nature of things was unobtainable; yet within a few days of erection on site the new "harbour" stood up successfully, though not wholly without damage, particularly to the breakwaters, to the worst June storm in living memory. It would be hard to pay a greater tribute to the foresight and ingenuity of designers and to the resource of those on the spot who had to handle and manœuvre the equipment.

Near the end of the year an exhibition of models of this harbour was opened to the public at the Institution of Civil Engineers, Great George Street, Westminster, where a film is also on exhibition.

(To be continued)

Aeronautics in 1944

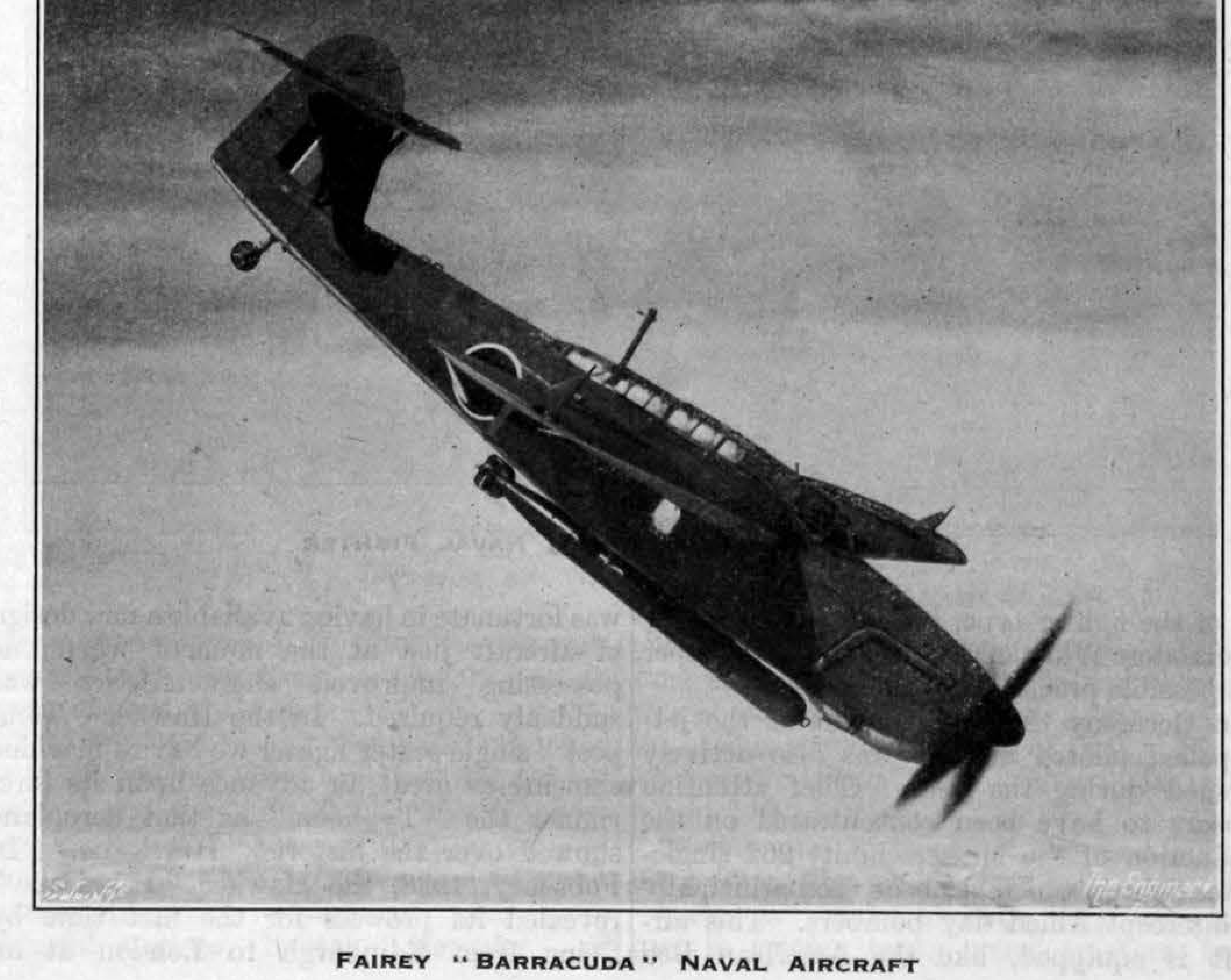
No. I

Military Aircraft

THE year just closed was a momentous one in the history of aeronautics, because of the number of developments which were brought to fruition during its passage. It was scarcely a few days old when it was officially disclosed that Great Britain possessed a jet-propelled aircraft, which had reached an advanced stage of development, and was in production for military use. The announcement of this interesting fact can be seen now in retrospect to have contained, intentionally or otherwise, an indication of the shape of things to come in the immediate future. One way or another, the propulsion of aircraft or missiles by jet reaction dominated the aeronautical prospect which the advancing months revealed. In addition to the pure jet-propelled aircraft, making use of a gas turbine and compressor as the sole source of power, we have seen during the year the application of jets as an auxiliary means of propulsion, either to assist take-off or to give an added burst of speed for a brief period during combat in the air. We have seen, too, the advent of the jet-propelled pilotless flying bomb, which may be regarded either as an aircraft or a missile, the piloted aircraft propelled entirely by rockets—such as the Me 163—the V2 long-range rocket, which is purely a missile, and the explosive rocket discharged from aircraft in substitution for cannon or machine gun fire. All these developments came to fruition during the year and made it one which seemed to presage great changes in the aeronautical world, changes involving a radical departure from old ideas and based primarily upon the reaction of jets. The significance of these developments will not be lost on those who have followed the history of aeronautics and have observed how frequently and notably progress directly inspired by aeronautical requirements has been advantageously applied in many other directions. Already, somewhat prematurely perhaps, the public mind is being attuned to the possibility of jet reaction becoming the prime source of propulsion on land and sea, as well as in the air.

The official announcement concerning the British jet-propelled aircraft did not disclose any important information concerning its detailed design. To-day, twelve months later, secrecy in this respect is still rigorously preserved. The key to it, however, lies in the internal combustion turbine, which it employs. Concerning the turbine it is desirable, we think, to record certain non-technical aspects of its development. Work on it began seriously in 1936. In that year Flight-Lieut. (now Air Commodore) Frank Whittle began to put into shape ideas which he had had in his mind for a number of years. At the same time the Royal Aircraft Establishment took up the study of axial compressors with a view to their incorporation in jet propulsion systems. The State encouraged both these lines of investigation. In the same year, 1936, a company, Power Jets, Ltd., was formed to exploit the Whittle inventions, with Flight-Lieut. Whittle as its chief engineer. The company placed an order for an experimental gas turbine with the British Thomson-Houston Company. In May, 1941, an experimental aircraft, designed and built by the Gloster Aircraft Company under direct contract from the Air Ministry and fitted with a Whittle gas turbine and a centrifugal impeller, made its first flight. Subsequently, Power Jets, Ltd., expanded its organisation and began to make its own engines. Other firms were encouraged by the Government to assist in the development work, and with the help of the experience gained by Power Jets, Ltd., the Royal Aircraft Establishment, and the B.T.H. Company, other designs of jet-propulsion equipment began to take shape.

In 1941 engineers of the General Electric Company of America and officers of the United States Air Force visited this country to study the progress being made with jet propulsion. As an outcome of this visit the British and American Governments came to an agreement whereby the engine used in the first flight test, together with a set of drawings of an improved design, were sent to the



FAIREY "BARRACUDA" NAVAL AIRCRAFT

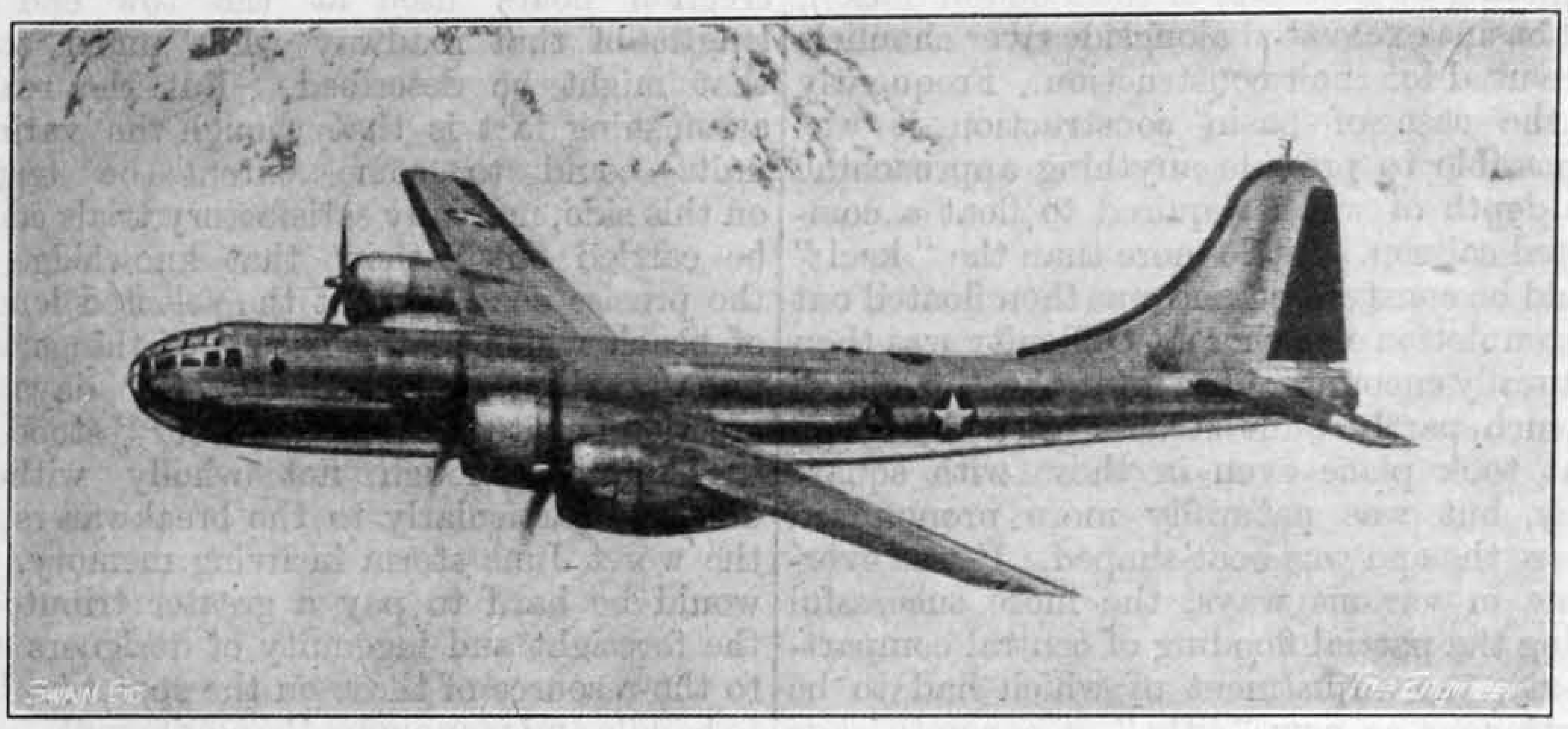
United States in October of that year. With the aid of a team of British engineers, the General Electric Company of America installed the first British engine in its test house and began the development of the improved design. Within six months the G.E.C. edition of the improved design was ready for testing, and by October, 1942, a fighter aircraft made by the Bell Aircraft Corporation and fitted with a twin arrangement of jet propulsion engines was ready to make its first flight.

Development work continued on both sides of the Atlantic during 1943. Early in 1944 the British Government, in view of the progress being made, decided that it was necessary for the country to possess a national gas turbine research and development establishment. It accordingly purchased the business of Power Jets, Ltd., and added to it the turbine division of the engine department of the Royal Aircraft Establishment. Both organisations thus came under the control of a State-owned company, which is known as Power Jets (Research and Development), Ltd. This new company is under the chairmanship of Dr. Roxlee Cox. It is being aided in its work by a technical advisory committee, representing sections of industry actively concerned with gas turbine development. While for the time being it is devoting the major part of its work to the aeronautical use of the gas turbine, it is not neglecting other applications. On the marine side, it is already in contact with the British Shipbuilding Research Association and with the Parsons Turbine Engineering Research and Development Association.

It has been officially stated that British-built jet-propelled aircraft are now in production, and it is understood that some of them have already been in action, notably during the flying bomb attacks against this country in the past summer. These aircraft are of the fighter type, but, according to Air Commodore Whittle, the jet-propelled bomber is a possible practical development.

SUPERMARINE "SEAFIRE" III NAVAL FIGHTER

In Germany the development of the jet-propelled piloted aircraft was also actively pursued during the year. Chief attention appears to have been concentrated on the production of the Messerschmitt 262 single-seater fighter, which has been used principally to intercept Allied day bombers. This aircraft is equipped, like the American Bell "Airocomet," with twin jet-propulsion units, one slung beneath each wing. The units are reported to make use of Junkers "Jumo" gas turbines. Another Messerschmitt production, the Me 163, appears to make use of jet propulsion for boosting its speed over short periods. It derives its jets apparently from rockets after the manner used for the purpose of assisting the take-off of several types of aircraft, notably the carrier-borne "Seafire." The Me 163 thus barely earns the description of a jet-propelled aircraft. It has been somewhat contemptuously described as a "flying firework." Other German jet-propelled aeroplanes which appear still to be in the experimental stage include the Heinkel 280 and designs by Avado and Junkers.



BOEING "SUPERFORTRESS" BOMBER

In spite of the attention paid to jet propulsion, the orthodox type of military aircraft continued during the year to register notable progress. Once again this country was fortunate in having available a new design of aircraft just at the moment when one possessing improved characteristics was suddenly required. In the Hawker "Tempest" single-seater fighter we have a machine showing as great an advance upon its forerunner the "Typhoon" as that aeroplane showed over the historic "Hurricane." In February, 1938, the Hawker "Hurricane" revealed its prowess for the first time by flying from Edinburgh to London at an average speed of 408·75 miles an hour. In the Battle of Britain it took a foremost share in the enemy's historic defeat. Subsequently it was adapted to combine its qualities as a fighter with other duties, notably those of light bombing. At the peak of its production the "Hurricane" was being produced at the rate of one every four hours. In August, 1944, it was announced that production of the "Hurricane" had ceased. From first to last more than 10,000 had been built. The "Hurricane" was succeeded by the Hawker "Typhoon," of which mention was made in this review a year ago. The new design was put into extensive production, and, like its forerunner, was adapted for several duties besides its primary function of a fighter. In one such adaptation it was fitted to carry a 1000 lb. bomb under each wing, and was employed as a dive bomber. Its most notable development during the past year, however, was its equipment with rocket-firing apparatus. Since the invasion of the Continent and on every suitable occasion, the rocket-firing "Typhoon" has proved a deadly weapon against the enemy's tanks, gun positions, strong points, and transport.

Although the "Typhoon" cannot be said to be on the point of becoming obsolete, it is to be expected that the improved Hawker "Tempest," now in full production, will eventually replace it. This aircraft, the fastest fighter in the R.A.F., is driven by a 2200 H.P. Napier "Sabre" engine. It arrived at the stage of operational use just in time to prove an effective counter measure to the enemy's flying bomb attacks, both during the day and at night. Squadrons flying the "Tempest" are credited with the destruction of some 600 of the enemy's pilotless missiles. Details of its construction and performance are still secret.

The "Hurricane's" partner in the Battle of Britain, the Vickers-Supermarine "Spitfire," is still prominently in service, although the modern versions of it are as different from the original as probably is the "Tempest" from its grandparent. Its power has been increased by 100 per cent., its rate of climb by 80 per cent., its weight by 40 per cent., and its speed by 35 per cent. Since in the original version the speed was stated to be over 300 m.p.h., it can be inferred that in the latest development the speed is well over 400 m.p.h. Like the 'Hurricane," it has been adapted for purposes other than pure fighting. One such adaptation is the "Spitfire XI," which is used as a long-range, high-speed, unarmed photographic aircraft. This version is driven by a Rolls-Royce "Merlin" engine of 1650 H.P., and a "Rotol" four-bladed propeller. It carries two extra fuel tanks in the leading edges of the wings.

The marine version of the "Spitfire"

appeared during the year in an improved form as the "Seafire III." This carrier-borne naval single-seater fighter is driven by a "Merlin" engine of 1470 H.P. and carries two 20 mm. cannon and four 0·303 Browning guns. It is fitted with arrester and catapult gear. It has also been fitted with four rockets, two at the root of each wing, containing cordite, which, burning for 4 sec., assist the aircraft to take off. The wings, as usual in carrier-borne machines, are arranged to fold in order to economise stowage space.

GLOSTER JET-PROPELLED AIRCRAFT

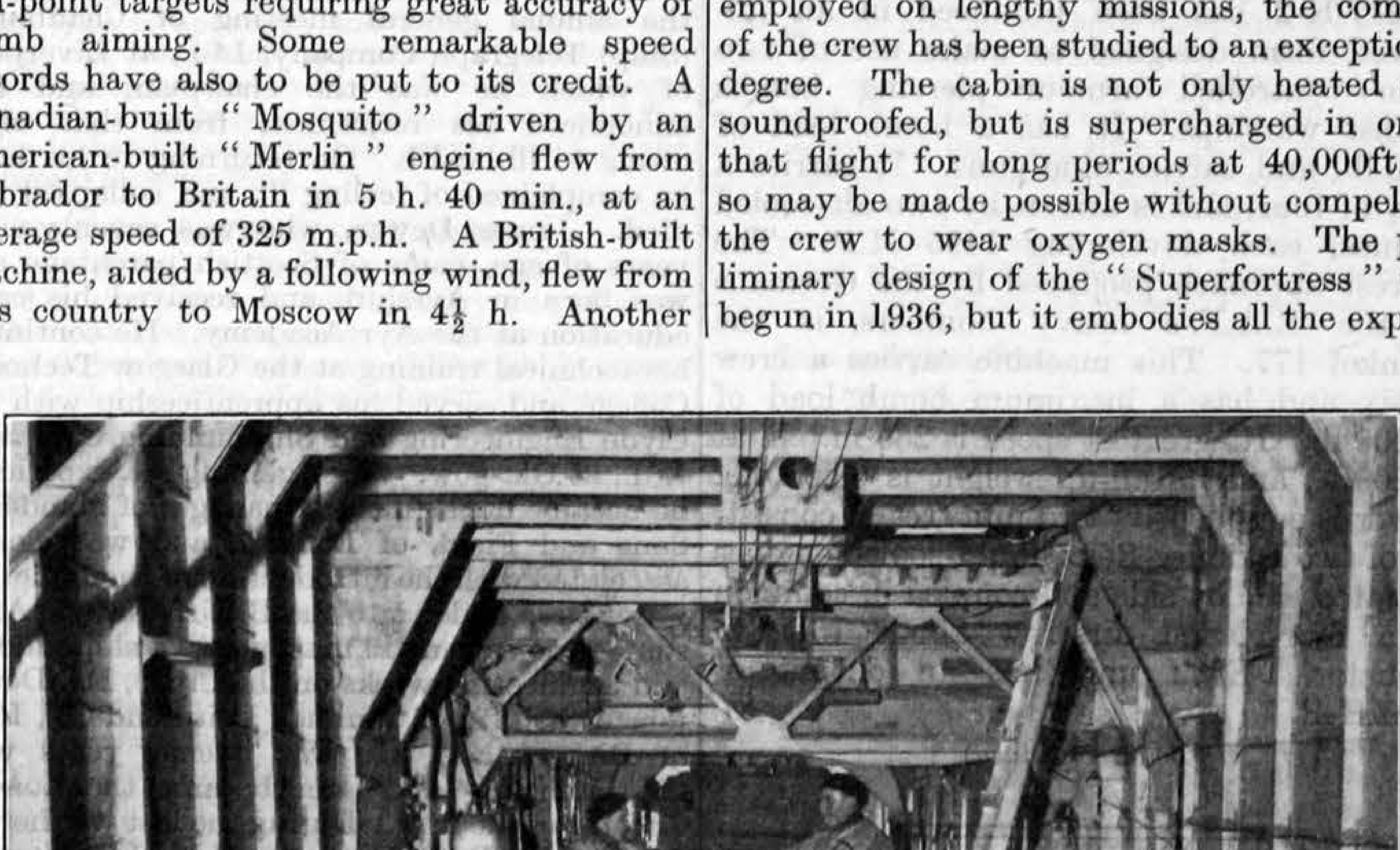
Other notable progress was made during the year on the marine side of aeronautics. An important addition to the Navy's strength in the air was provided by the coming into service of the Fairey "Firefly," a two-seater fast reconnaissance fighter, armed with four 20 mm. cannon and driven by a Rolls-Royce "Griffon" engine, an enhanced version of the "Merlin." The "Firefly" is fitted with Youngman flaps, and is claimed to have a greater range of speed than any other aircraft in the world. The Fairey "Barracuda" is another marine aircraft which attracted attention during the year by its attacks on the German battleship "Tirpitz." Although of the Fairey company's design, this aircraft is being built by the Blackburn and the Boulton-Paul aircraft companies, assisted by numerous sub-contractors. It is fitted to carry one 18in. torpedo under the fuselage or four bombs, two under each wing. Alternatively, it can carry sea mines or depth charges. In April "Barracudas" attacked the "Tirpitz" in Norwegian waters, and scored, it was claimed, at least twenty-four hits on her. The warship, however, survived the attack. Her final destruction in November was brought about by a force of thirty-two "Lancaster" bombers.

The development of these carrier-borne aircraft led naturally to the supersession of the biplane machines, such as the "Swordfish" with which the Fleet Air Arm had for long to rest content. Nevertheless, a new marine biplane made its appearance during the year, "Sea Otter, Mk. I." This aircraft is not, however, designed for use from a carrier. It belongs to the once-popular amphibian class and is used for reconnaissance and general-purpose duties over the sea, including air/sea rescue work. It is driven by a single Bristol "Mercury" engine of 870 H.P., and is armed with three Vickers guns and either bombs or depth charges. It carries a crew of three or four, according to the duties required of it. The main planes have a span of 46ft. and are arranged to fold. Provision is made for catapult launching.

In the bomber class of aircraft no radically new designs appeared during the year, although development of existing types continued. The de Havilland "Mosquito," probably the world's most versatile aircraft, was extensively employed for bombing. It was developed to carry an increased bomb load, and can now take a 4000 lb. bomb to Berlin or the coast of Norway. In groups or squadrons of considerable size, it has attacked important targets on a scale far beyond that of a "nuisance" raid. In addition, it has been used with conspicuous success against pin-point targets requiring great accuracy of bomb aiming. Some remarkable speed records have also to be put to its credit. A Canadian-built "Mosquito" driven by an American-built "Merlin" engine flew from Labrador to Britain in 5 h. 40 min., at an average speed of 325 m.p.h. A British-built machine, aided by a following wind, flew from this country to Moscow in 4½ h. Another "Mosquito" covered the distance between Toronto and New York in 55 min., at an average speed of 411 m.p.h.

The principal heavy bombers employed by the Royal Air Force remained the "Lancaster" and the "Halifax." The Handley Page "Halifax" was produced in an improved form, the Mk. III, the principal modification being its equipment with more powerful engines, Bristol "Hercules" of over 1650 H.P. each. New types of fins and rudders and de Havilland "Hydromatic" propellers were also incorporated in the new version. The result was a much improved all-round performance. The armament of the machine now consists of nine 0·303 machine guns, one in the nose, four in the upper turret, and four in the tail turret.

In the United States the Boeing "Flying Fortress" appeared in an improved and enlarged form, the "Superfortress." This aircraft was prominently employed during the year on attacks upon the Japanese mainland from very long range. It is stated to have a wing span of 141ft., a length of 100ft., and an overall height of 27ft. The power equipment consists of four Wright "Cyclone" engines of 2200 H.P. each, driving Hamilton propellers, 16½ft. in diameter. The armament consists of 0·5in. machine guns and 20 mm. cannon. The cruising speed is reported to be about 250 m.p.h. at 25,000ft. Over a range of 1000 miles, it is said to be capable of carrying a bomb load of 16,500 lb. to 17,500 lb. For a 3000-mile range the bomb load is 6000 lb. The all-up weight is between 100,000 lb. and 200,000 lb. The fuel is carried in thirty self-sealing tanks. According to an American newspaper report, the first example of the "Superfortress" to be built cost 3,392,396 dollars. Current production models cost 600,000 dollars, approximately £1 sterling per pound of all-up weight. The "Superfortress" carries a crew of eleven men, and as it is designed to be employed on lengthy missions, the comfort of the crew has been studied to an exceptional degree. The cabin is not only heated and soundproofed, but is supercharged in order that flight for long periods at 40,000ft. or so may be made possible without compelling the crew to wear oxygen masks. The preliminary design of the "Superfortress" was begun in 1936, but it embodies all the experience derived from its forerunner the "Flying Fortress" in wartime. The advance in size which it represents can be judged from the following dimensions of the "Flying Fortress":—Span 103ft., length 74ft. 9in., height 19ft.



INTERIOR OF "HAMILCAR" GLIDER

During the invasion of Normandy and later during the air landings in Holland, the "Hamilcar" glider played a very important part in getting tanks, guns, tractors, bulldozers, Bailey bridge details, and other equipment quickly into action. The forerunner of the "Hamilcar" was the "Hotspur" glider, designed to carry eight men and their equipment. The "Hotspur" had an all-up weight of 3600 lb. The "Hamilcar," fully loaded, weighs 36,000 lb., of which about half is accounted for by the load carried. Both gliders were produced by General Aircraft, Ltd. The "Hamilcar" is stated to be the largest wooden aircraft ever constructed. In use it is generally towed by a "Halifax" bomber. It is equipped with an undercarriage, on which it lands, and by means of differential brakes the pilot steers it clear of the landing strip out of the way of following gliders. The oil in the chassis shock absorber struts is then released, and the glider sinks down on to its skids. The tank or other vehicle inside the body, with its engines started before the landing, then emerges through the door at the nose end without the use of ramps, and can be in action 15 sec. after the glider comes to rest.

Of new German military aircraft, a few details are available. Apart from the jet-propelled machines already mentioned, the enemy produced a new Messerschmitt single-engined fighter, the Me 109 G-6, with a top speed of 400 m.p.h. at 22,000ft. This aircraft is also used as a fighter-bomber in which form its speed is 385 m.p.h. It carries three 20 mm. and two 13 mm. guns, and is driven by a twelve-cylinder liquid-cooled engine developing 1350 H.P. The Dornier Do 217 K-2 has been produced in an improved form designed to make use of two radio-controlled armour-piercing bombs against warships. It has a bomb load of 6600 lb. and carries nine guns. It carries a crew of four, and is driven by two air-cooled engines, each developing 1495 H.P. The nearest approach produced by the Germans to the R.A.F.'s heavy bombers is the Heinkel 177. This machine carries a crew of six and has a maximum bomb load of 12,300 lb. Its greatest speed is 285 m.p.h. at 20,000ft., and its all-up weight is 68,000 lb. Power is supplied by two units, each consisting of two Daimler-Benz liquid-cooled engines mounted side by side and coupled in common to a four-bladed airscrew about 15ft. in diameter. Each unit has an output of 2460 H.P.

(*To be continued*)

Sixty Years Ago

1884

IN our review of the events of 1884, published in our issue of January 2nd, 1885, we described the year which had passed away as one of almost unmitigated disaster so far as the trade of Great Britain was concerned. It was difficult, we said, to find a single branch of manufacture or production which had not suffered. Our neighbours were said to be as badly off as ourselves, and the cause of their misery was alleged to be identical with our own. That, however, we thought, was poor comfort. It was commonly believed that the prominent evil of the moment was over-production. There was more iron, cotton goods, ships, and railways in the world than its inhabitants could use. The situation was one which completely contradicted the teachings of the political economist. He argued that food, clothes, houses, and transport could not be cheap unless they were plentiful, and that that country was best off which had most of these things. Yet never before, perhaps, since money acquired its modern value had all the necessities, comforts, and luxuries of life been so cheap, and never had a more direful tale of starving men, women and children, of failing trade and loss of capital in all directions, been told. Our exports were falling, our revenue was decreasing, and nowhere could we see any indication that trade was becoming better or was likely to improve for many months to come. We looked in vain among any class or rank of life for that happiness and prosperity which cheapness ought, in theory, to give us. Upholders of the doctrine of free trade pointed out that protection had not prevented France, Germany, and other European countries from similar suffering. It ought, however, to be remembered, we said, that the Continental nations, without exception, had burthens of foreign debt to pay from which we were practically exempt and were laden with the weight of enormous military establishments of which we knew nothing. If, therefore, they had held their own, protection had been less disastrous for them than those who believed in free trade would have us associate with it. Years ago, we said, we had pointed out that but one result could ensue from the determined efforts being made to cheapen production and augment output. The time had now come when supply outstripped demand and there was nothing for it but to wait in the hope that stocks would be absorbed and the balance of trade was restored.

Obituary

JAMES McKIE DEWAR

IT is with deep regret that we have to record the death, on Friday, December 29th, of Mr. James McKie Dewar. Mr. Dewar had attended the annual general meeting of Chadburn's (Ship) Telegraph Company, Ltd., at Liverpool, of which he was the chairman, and had announced his retirement from that office owing to ill-health. On returning to his hotel he complained of feeling ill, and collapsed and died. James Dewar, who was seventy-eight years of age, came of Scottish parentage and was born in Ayrshire and received his early education at the Ayr Academy. He continued his technical training at the Glasgow Technical College and served his apprenticeship with the Clyde Engineering and Shipbuilding Company, Ltd., at Glasgow. After gaining sea experience he became departmental manager of Maudslay, Sons and Field, of London, and was closely associated with the introduction of the Belleville water-tube boiler into the British Navy. After some time as general manager to a shipbuilding and engineering works on the Clyde, Mr. Dewar joined the firm of Cammell Laird and Co., Ltd., of Birkenhead. He was twenty years with that company and later became the London director of the firm. During the last war he was Adviser on Refit Work to H.M. Inspector of Dockyards and saw service in the naval establishments at Chatham, Portsmouth, and Devonport. He was also adviser to the Ministry of Shipping and Director-General of Merchant Shipbuilding on the conversion of merchant vessels for transport and armed merchant cruiser service, and was also responsible for the building of barges and floating docks for inland waterways and docks. As a director of Gwynnes, Ltd. he introduced the "Clerget" rotary engine for aircraft work. In the course of his business he travelled widely and made many friends in all parts of the world. After leaving Cammell Laird and Co., Ltd., he joined with the late Mr. Arthur Wall in marine engineering and naval architectural consulting work, in which capacity he was responsible for the high-power motor liners "Saturnia" and "Vulcania," which were built and engined at Trieste for the Cosulich Line. He established his own business as a consultant under the name of James M. Dewar and Son in partnership with his son Norman. He was a director of several engineering companies and had wide interests. He was a member of the Institution of Mechanical Engineers and the Institution of Naval Architects, and was a Vice-President of the Institute of Marine Engineers. He was a liveryman of the Worshipful Company of Shipwrights and a founder member of the Men of Maudslays. James Dewar will long be remembered for his geniality and his capacity for never forgetting the face or the name of those who were associated with him, whether in the works, the office, or among his very wide circle of friends.

Heavy-Oil Engine Working Costs (1942-43)

AT a meeting of the Diesel Engine Users Association, which took place in London on Thursday, December 14th, the Working Costs Committee presented its report for 1943. All the tables in the report have been brought up to date, and modifications have been made where it was thought that their usefulness will be enhanced thereby. An important alteration in many tables is that the entries have been divided into two sections in order to separate the stations containing mechanical injection engines only from those including air blast engines and engines of both types. The old table showing liner wear has been omitted, and information on this subject is now included in another table, where an attempt is made to show, by tabulating the number of starts per 1000 hours' run, the effect of starting upon cylinder wear. The diagram showing renewal and replacement costs is retained, but is brought up to date by adding a dotted curve indicating what the costs would have been if they were based on contractors' charges ruling in 1943. Long-term records of station performance are also retained, and the hope is expressed that in course of time many additional stations will be included in the table, and as these will include newer types of engines as development increases, the table will provide a ready means for observing the performance of these engines, both from the economic and technical points of view, compared with those of the plants which have appeared over a long period of years. A diagram is given which shows fuel oil consumption and running plant load factors for certain stations in relation to a standard curve from a 220-kW air injection engine. A curve representative of a modern mechanical injection engine is also shown, together with the point indicating the general average of all stations. The cost of repairs and maintenance is given in tables which provide a considerable amount of information for comparing the station performance of the different engines included in the report. The number of stations enumerated in the report is fifty-five, compared with fifty-six last year. The Committee records its pleasure in the continued assistance of those members making returns, and points out that the usefulness of the report can be extended by an increased number of returns. The Association is to be congratulated on its publication of working costs during the difficult war year period, as the information given is of the greatest use to oil engine users in all parts of the world.

HEAVIEST TRANSPORT BY SWEDISH RAILWAYS.—The heaviest transport by rail ever undertaken in Sweden took place some time ago in connection with the delivery of two huge generators from the A.S.E.A. works in Central Sweden to the new Midskogsforsen power station in the northern part of the country, a distance of about 300 miles. Some idea of the difficulties involved can be gained from the fact that six months of investigations and measurements were required before the question of how to carry through the transport was theoretically solved and the adaptation of the railway trucks could begin. The generators weighed 510 tons each and had to be dismounted and transported on six specially designed trucks and thirty-three standard trucks. The transport of the four rotor rings was a particularly difficult problem in view of their large diameter of 19ft. and their weight of no less than 35 tons. It was finally decided to transport them suspended in such a way that they could be moved in different directions in order to clear various obstacles along the railway line. Except for some minor mishaps, the transport was successfully carried through. Along the final stretch of 40 miles from the unloading station to the power plant the generators were transported on a special highway trailer with a capacity of 100 tons and capable of carrying two rotor rings at a time. Two tractors were required for towing purposes.