tank design which in one way or other does not clash with other aspects. The result of these clashes is that the final design can never be better than a compromise, and any compromise leads to differences of opinion. If it is remembered that there is no parallel in industry to the relatively high speed yet very heavily tracked armoured fighting vehicle, it will be appreciated that there is no industrial experience from which to draw for the design of the tank. Hence, development facilities specifically for fighting equipment must be maintained and utilised vigorously if we are to keep in the forefront in such matters and to give the designers even a reasonable chance of meeting the accelerated demands which war, or the fear of war, inevitably bring.

# Aeronautics in 1945

No. I

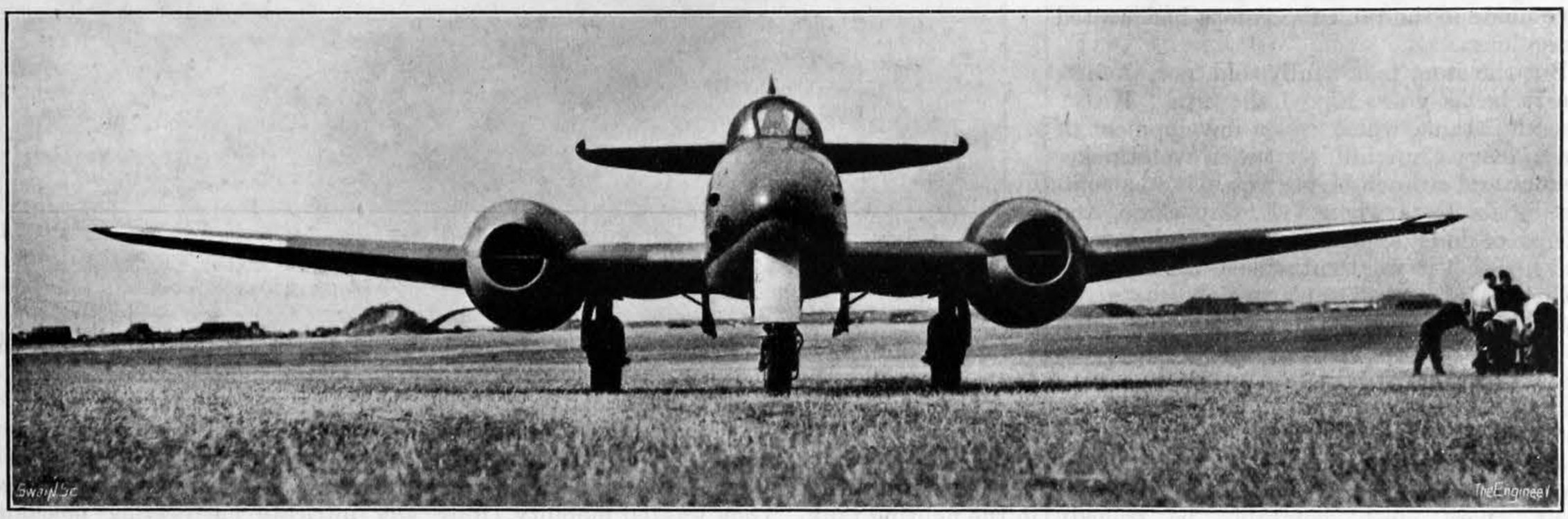
### Military Aircraft

HAD hostilities lasted a little longer than they did, we would undoubtedly have seen the introduction on a large scale by all the belligerants of some striking developments in the design of military aircraft, notably a rapidly increasing employment of jet propulsion for both bombers and fighters. As it was, the wars ended before these developments could be fully deployed, with the result that the aircraft in use during 1945 were in the main simply advanced types of those in service or about to go into service in the autumn of 1939. In this country, for instance, we continued to the end to place main reliance upon the "Lancaster" and "Halifax" bombers, "Sunderland" flying boats, and "Spitfire" and "Mosquito" fighters, all of them of pre-war origin, although by successive modifications they had been greatly improved in performance. The "Hurricane" fighter had dropped out of the running, but its place had been taken by two direct descendants, the "Tempest" and the "Typhoon."

In normal peacetime circumstances a period of about five years is generally considered to be the average interval elapsing between the conception of a new design and its production in quantity. In wartime an impetus towards shortening that interval exists, but it is counteracted by other factors, and on the whole it is probable that the interval remains much the same. Thus the wars ended at a time when an influx of new designs, begun as a result of operational experience in their earlier stages, was due and was taking place. From the information released concerning these new aircraft, it might be possible to obtain some idea of the probable trend of design during the next few years. Any deductions under this head must, however, be qualified by a large measure of uncertainty following the introduction of the atomic bomb. The world is at a solemn moment in its history. If, unhappily, the efforts now being made to restrict or outlaw the use of that terrible missile should fail, the consequences for humanity will be dire. Incidentally, the whole future of military aircraft design will be greatly affected. With a single light aircraft able to carry as much destructive energy as was released during a "thousand-bomber" raid in the late hostilities, bombers and bombing tactics as we have known them will become outmoded. And if instead of transporting the atomic explosive in an aircraft it is, as it might well be, carried in a long-range rocket, the interceptor fighter class of aircraft will become archaic.

In these circumstances we have the strange spectacle of military aeronautical design ready to reap all the fruits of six years of war experience and to enter a new phase in its evolution, and yet hesitating to commit itself lest the coming of the atomic bomb should render all improvements obsolete before they can be brought fully into service.

The year may be said to be chiefly notable as marking the fulfilment of the prolonged efforts to apply the jet propulsion system successfully to military aircraft. In this country chief public interest was focussed on the Gloster "Meteor" and the de Havilland "Vampire" jet-propelled fighters. Other firms, notably the Bristol Company, are, however, known to be well advanced with the development of similar aircraft The Gloster "Meteor" IV on November 7th at Herne Bay set up a new world speed record by travelling at an average of 606 m p.h. on four runs over the trial course. The previous internationally recognised record was 469 m.p.h., and was held by Germany. The "Meteor" IV is in operational service with the R.A.F. as a single-seater fighter, and is driven by two Rolls-Royce "Derwent" V jet engines. During the record-breaking flight the engines were not allowed to develop their full power. The flight is, in fact, claimed to have been made under almost "cruising" conditions. The performance of the "Vampire" has not yet been officially disclosed. It is driven by a single de Havilland "Goblin" jet engine, and its speed is stated to be in the neighbourhood of 540 m.p.h. A naval version of the "Vampire" has been produced.

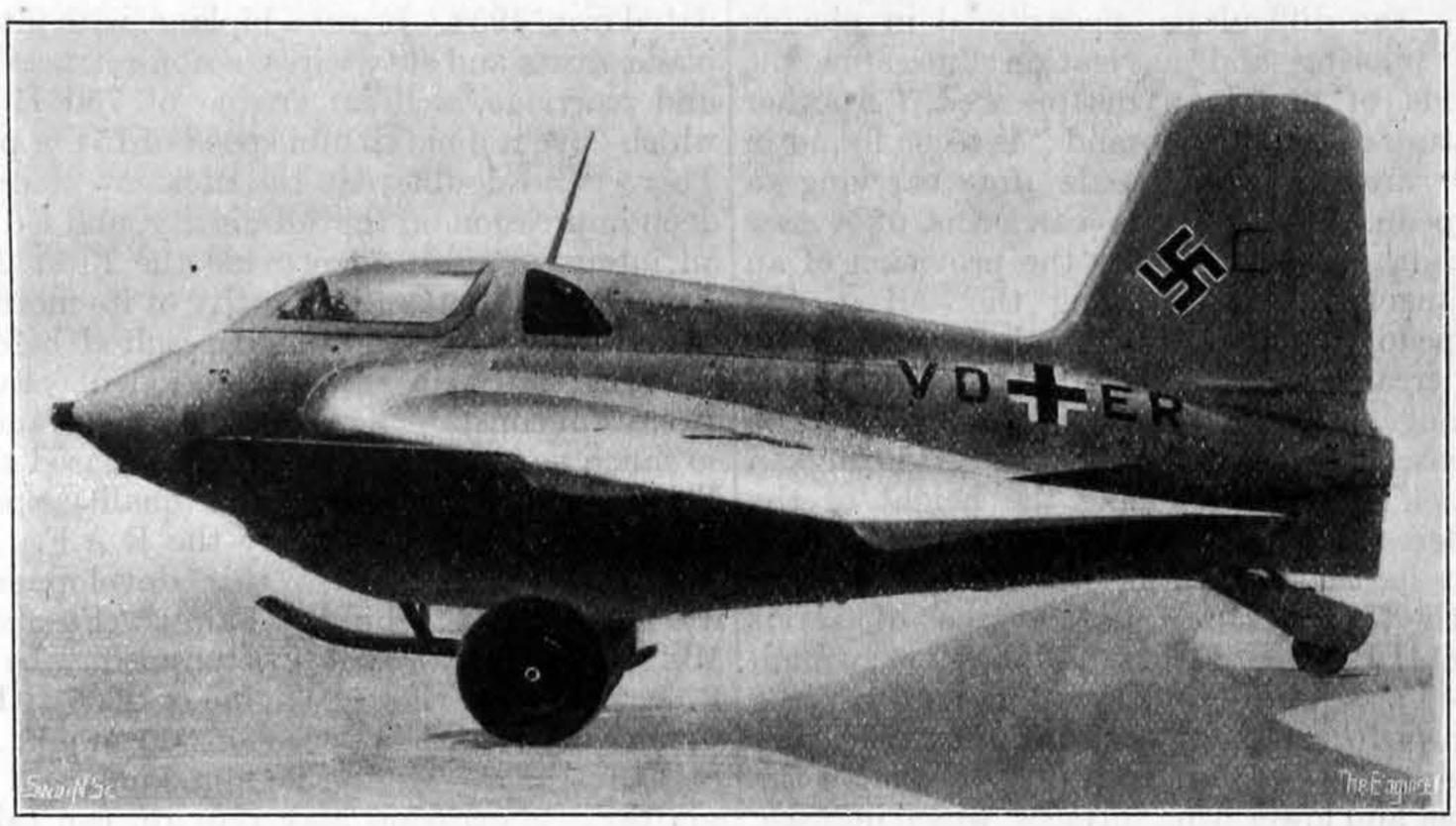


GLOSTER "METEOR" SINGLE-SEAT JET-PROPELLED FIGHTER

Little is known concerning other British jet-propelled aircraft now being developed, but it may be surmised that this country is not lagging behind the stage of development reached in Germany at the end of the war. How far the enemy had proceeded with jet propulsion was fully disclosed by the Air

ME 262A SINGLE-SEAT JET-PROPELLED FIGHTER

Ministry in a document released in September. Germany made an early start on jet-driven aircraft. Her first machine of this class to be flown was a small single-seater Heinkel, the He 178, which made its first flight on August 27th, 1939, four days before the Germans precipitated the war by marching into Poland. This aircraft was driven by a Heinkel turbo-jet unit, developing a thrust of only 1000 lb. It was used purely for experimental purposes, and from it there was developed a twin-jet fighter, the He 280 which flew in 1941, but did not show any great promise. In 1939 the Messerschmitt company also began work on jet propulsion, and by 1941 was ready with the Me 262 single-seater fighter driven by two Heinkel jet engines. A year or so later the Heinkel units were replaced by Junkers jet engines and a programme of intensive development was begun. At the end of the war this machine had been developed to give a top speed of 525 m.p.h. at 23,000ft., and a service ceiling just short of 40,000ft. It carried four guns, and could, if required, take a bomb load of up to 1000 lb. It proved to be the enemy's most useful type of jet-propelled aircraft.



ME 163B ROCKET-PROPELLED INTERCEPTOR

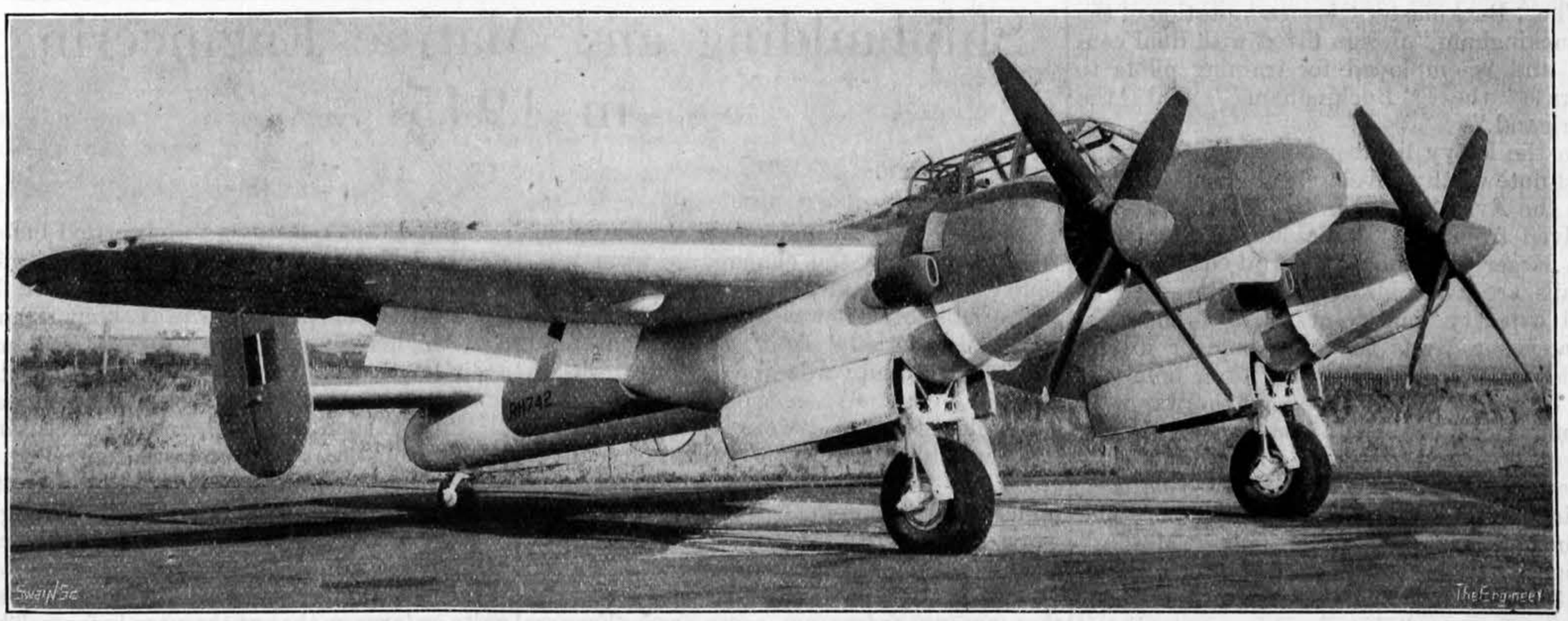
The Germans also made serious efforts to develop the jet-propelled bomber. One design which was flown towards the close of hostilities was the Arado 234C, fitted with four BMW jet engines. It had a speed of over 540 m.p.h., and was possibly the fastest bomber in the world. An even more powerful jet-propelled bomber was almost ready for service, when the enemy collapsed. This was the Junkers 287, fitted with six BMW jet units. This aircraft was designed for a range of 1175 miles with a bomb load of 3 tons. Its maximum speed was over 530 m.p.h.

In addition to jet-propelled fighters and bombers, the Germans paid much attention to rocket-propelled aircraft, mainly interceptors with very short duration of flight. One such which came into service several months before the end of hostilities was the Me 163, or "Komet." This small machine had a level speed of some 550 m.p.h., and could climb to 30,000ft. in just over $2\frac{1}{2}$ min. It took off under its own power, jettisoned its wheels, and landed on a skid. A later development of this design was equipped with a subsidiary rocket unit to give economy at cruising speeds. Under full power this aircraft had an endurance of 12 min., and a maximum speed of 590 m.p.h. A still more remarkable rocket type of interceptor was being developed when fighting ceased. This was the Bachem BP 20, "Natter." It had a span of only 18ft., and was driven by a single liquid rocket. It was to take off vertically with the aid of auxiliary rockets, climb at a rate of about 37,000ft. per minute, and attack a hostile bomber with rocket projectiles. The pilot was then to be ejected and to descend by parachute. Simultaneously, the rear half of the fuselage containing the liquid rocket was to break off and also descend by parachute.

Among other developments, the enemy, when the war ended, was working on a jet-propelled dive bomber, and on a helicopter with the vanes rotated by jet propulsion.

In this country information was released after the German collapse regarding several recently introduced aircraft with orthodox engine and propeller drives. One of the most interesting of these machines was the Westland "Welkin" stratosphere single-seater fighter, designed to deal with high-flying raiders. This aircraft has an armoured pressure cabin and carries four cannon. With its wing span of 70ft., it is the largest of the single-seater fighters. It is driven by two Rolls-Royce "Merlin" engines, each developing 1650 H.P., great power at high altitudes being maintained by means of two-stage, two-speed superchargers. The cabin pressure is automatically maintained by a valve arrangement at the correct value without attention from the pilot. To overcome ice and mist formation on the windscreen at the heights at which the aircraft may be called upon to operate, the windscreen—as well as other parts of the cabin—is formed of two layers of glazing between which warm air is pumped. It is stated that the cabin-heating arrangements are such that even when the external temperature is as low as — 78 deg. Fah. the pilot need not wear special clothing. No information is available concerning the service ceiling of the "Welkin," but its speed is stated to be 385 m.p.h., and its range about 1500 miles.

A single-seater long-range fighter which may be regarded as a development of the "Mosquito" is the de Havilland "Hornet." The fuselage of this machine is of wood, and the wings are of composite wood and metal construction. The engines are "Merlins," and drive de Havilland four-bladed propellers running in opposed directions. The armament consists of four 20 mm. cannon in the nose. The speed is said to be over 470 m.p.h., the range, with extra tanks, upwards of 2500 miles, and the ceiling about 35,000ft.



BRISTOL "BRIGAND" COASTAL COMMAND STRIKE AIRCRAFT

Among the aircraft which would doubtless have come into extensive military use had hostilities been prolonged would have been three types of Bristol machines, the "Buckingham," "Brigand," and "Buckmaster," all of which represent developments of the Bristol Company's "Beaufighter," an air-

craft which in the earlier days of the war rendered good service as a night fighter and as a land-based torpedo bomber. The "Buckingham" was designed in 1941 as a fast day bomber, carrying a crew of four. The navigator-air-bomber occupies the rear-most station within the fuselage, and has access to a nacelle in the floor having the aiming panel and bombsight at the forward end and a two-gun turret at the rear. This turret commands the field of fire behind and below the tail. The air gunner's dorsal turret is equipped with four Browning guns which can be rotated through 360 deg. and elevated through a range of 85 deg. Between this station and the pilot accommodation is provided for a radio operator. In addition to the turret armament there are four fixed Browning guns commanded by the pilot and firing ahead in the line of flight. All the crew stations are protected by armour plating. The aircraft is driven by two "Centaurus" engines fitted with "Rotol" fans for ground cooling. The fuel is carried in six flexible tanks designed to give protection against 20 mm. cannon fire, and having a total capacity of 1050 gallons. The aircraft has a speed of 330 m.p.h. at 12,000ft., a service ceiling of 25,000ft., and a full load range of 2000 miles at 200 m.p.h.

By the time the "Buckingham" was in quantity production, the development of Radar navigational aids had greatly improved the effectiveness of our night bomber raids against Germany, while for daylight attacks the "Mosquito" was proving highly successful. The need for an additional day bomber had therefore disappeared, and the "Buckingham" was adapted as a high-speed courier, carrying four passengers and a crew of three.

The Bristol "Brigand" is a faster edition of the "Beaufighter," and has the same wings and tail unit as the "Buckingham." It carries a crew of three and is driven by two "Centaurus" engines. It belongs to the "strike" class of aircraft used by Coastal Command and carries torpedoes and rocket projectiles. In addition, it is an effective fighter, and is fitted for use as a dive bomber.

The "Buckmaster" is an adaptation of the "Buckingham" design fitted with dual control and is employed for training pilots to operate the "Buckingham" and the "Brigand."

In the heavy bomber class of aircraft the most noteworthy development in this country was the Avro "Lincoln." This aircraft was evolved from the "Lancaster," of which it is a larger and more powerful edition. No details are available regarding its speed or load capacity, but from the fact that the "Lancaster" was the only bomber in the world which could carry a 10-ton bomb, it can be gathered that we ended the war with a bomber of quite exceptional capacity in our possession. So far as we know, however, its advent was too late to permit it to be used against either Germany or Japan. The "Lincoln" is driven by four "Merlin" engines. It is very heavily armed for a British bomber, its defensive equipment consisting of seven 0·5in. machine guns distributed between four stations. The only other particulars of the aircraft which have been released are its leading dimensions :—Span, 120ft.; length, 78ft. 3½in.; height, 17ft. 3½in.; wing area, 1421 square feet; weight, about 75,000 lb.

On the naval side a notable addition to our forces was the Blackburn "Firebrand," Mk. IV, a single-seater strike aircraft, designed to carry all forms of offensive armament, including a torpedo. It was developed from an earlier "Sabre"-engined model designed as a naval fighter. All the available "Sabre" engines were required for the Hawker "Typhoon" fighter, and, further, the "Seafire," then coming into full production, promised to provide the Navy with a fighter of high performance. It was therefore decided to convert the original "Firebrand" to a strike aircraft, and to redesign it to take a Bristol "Centaurus" engine. The resultant aircraft is notable because of the fact that it is a single-seater. Immediately preceding designs of naval machines of this class had been multi-seaters, but with the developments made in Radar and other navigational aids, the difficulties encountered in placing the piloting and navigation duties in the hands of one man disappeared. Another feature of the "Firebrand" is to be found in the arrangements made for carrying a torpedo. The torpedo carrier is of a new design, characterised by the provision of an arrangement for lowering the tail of the torpedo after the aircraft is in flight and the undercarriage has been retracted. This arrangement enables the torpedo to be released at a much higher speed during an attack, and by reducing the height of the undercarriage effects a considerable reduction in the overall height of the aircraft. With the "Centaurus" engine of about 2500 H.P., the "Firebrand" has a maximum speed at sea level of 320 m.p.h., and carrying a torpedo can climb at a rate of 2200ft. per minute. It is fitted with dive breaks on the upper and lower wing surfaces, which increase the normal drag some two or two and a half times, and limit the speed during a dive to about 350 m.p.h. The wings are arranged to fold to facilitate storage of the aircraft on a naval carrier and are fitted with hydraulically operated slotted flaps to increase the lift at take-off. The defensive armament consists of four 20 mm. guns mounted two in each wing, and electrically controlled from the cockpit.

The "Firebrand" clearly reveals the great advance which took place during the later years of hostilities in the design of naval aircraft. Whatever may be said of the R.A.F. machines with which we began the war in 1939, it cannot be denied that our naval aircraft were capable of being greatly improved. It may be recalled in this connection that as late as February, 1942, when the "Scharnhorst," "Gneisenau," and "Prinz Eugen" escaped from Brest, and, passing up-channel, succeeded in reaching ports in Germany, our initial attack from the air was made by six naval "Swordfish" aircraft, all of which were shot down. This type of aircraft was designed as a Fleet torpedo-bomber—or a strike aircraft, as it is now called—and dated from 1934. It was a biplane, with interplane struts and stay wires, a non-retractable undercarriage, and an engine of 750 H.P., which gave it a maximum speed of 154 m.p.h. There is no doubt that the incident made a deep impression on the Admiralty, and led to an intensive effort to provide the Fleet Air Arm with aircraft more worthy of its mettle.

The change then initiated resulted before the war ended in the production of naval aircraft of constantly improving performance, so much so that before hostilities ceased the Navy possessed aircraft of a quality comparable with those flown by the R.A.F. In the naval fighter class this development reached a high level in the Fairey "Firefly," Mk. IV. This aircraft is equipped with a Rolls-Royce "Griffon" engine of 2300 H.P., which gives it a top speed of 386 m.p.h. at 14,000ft. It carries four 20 mm. guns, and in addition, as occasion may require, can take sixteen rocket projectiles, eight heavier rockets or bombs up to 1000 lb. With long-range jettisonable tanks, it has a radius of action of 1400 miles.

In the latest version of the "Seafire"—the Mk. XV—the Royal Navy now possesses an even faster fighter, the top speed being 400 m.p.h. This aircraft—descended from the land-based "Spitfire"—is armed less heavily than the "Firefly." It carries two 20 mm. cannon and four 0·303 machine guns, and can carry a 500 lb. bomb.

(*To be continued*)

# Shipbuilding and Marine Engineering in 1945

No. I

DURING the year under review a beginning was made in the changeover from war-time to peace production, and with the cessation of hostilities it was found possible to lift the veil partially from much that had happened in shipyards and engine works in the war years. When the Lloyd's Register shipbuilding returns were again published last September, it was shown that close upon 1,500,000 tons of merchant shipping were under construction in British shipyards. The work now in hand will, we are informed, ensure good employment for eighteen months or two years, and it is satisfactory to note that among orders are some from France, Norway, Belgium, Holland, Portugal, and the Argentine. British shipowners, however, naturally hold back from placing all their orders, owing to the still outstanding settlement of questions of tonnage replacement, and the overhanging uncertainty with regard to the future of the large surplus of American-built ships and those vessels ordered by the Government and run by the Ministry of War Transport. Although it seems unlikely that there will be any Government step in the direction of the nationalisation of shipping, there are still many controls to be removed, and important questions to be settled before steady replacement of special tonnage, much needed by shipowners, can be made. At the present time the price of ships is about 100 per cent. higher than before the war, and not a little of this increased cost is directly caused by increases in the prices of basic materials, such as coal, iron, steel, and timber, most of which are still controlled in some way, to which has to be added the very high cost of transport, which throughout the war has been fixed by the Government.

The output for the year will be found to be not quite as large as that of the year before. This reduction was caused by the slowing down of the programme of warship construction and the refitting and conversion of merchant ships. Trawlers have had to be reconverted for fishing purposes, and merchant ships and aircraft carriers have had to be refitted for trooping, while in the case of other ships war fittings have had to be removed. All this work has interfered with the normal work of the shipyards and repair establishments. In most of the shipyards and engine works, however, the changeover has now been made, or is in process of being carried out, and it