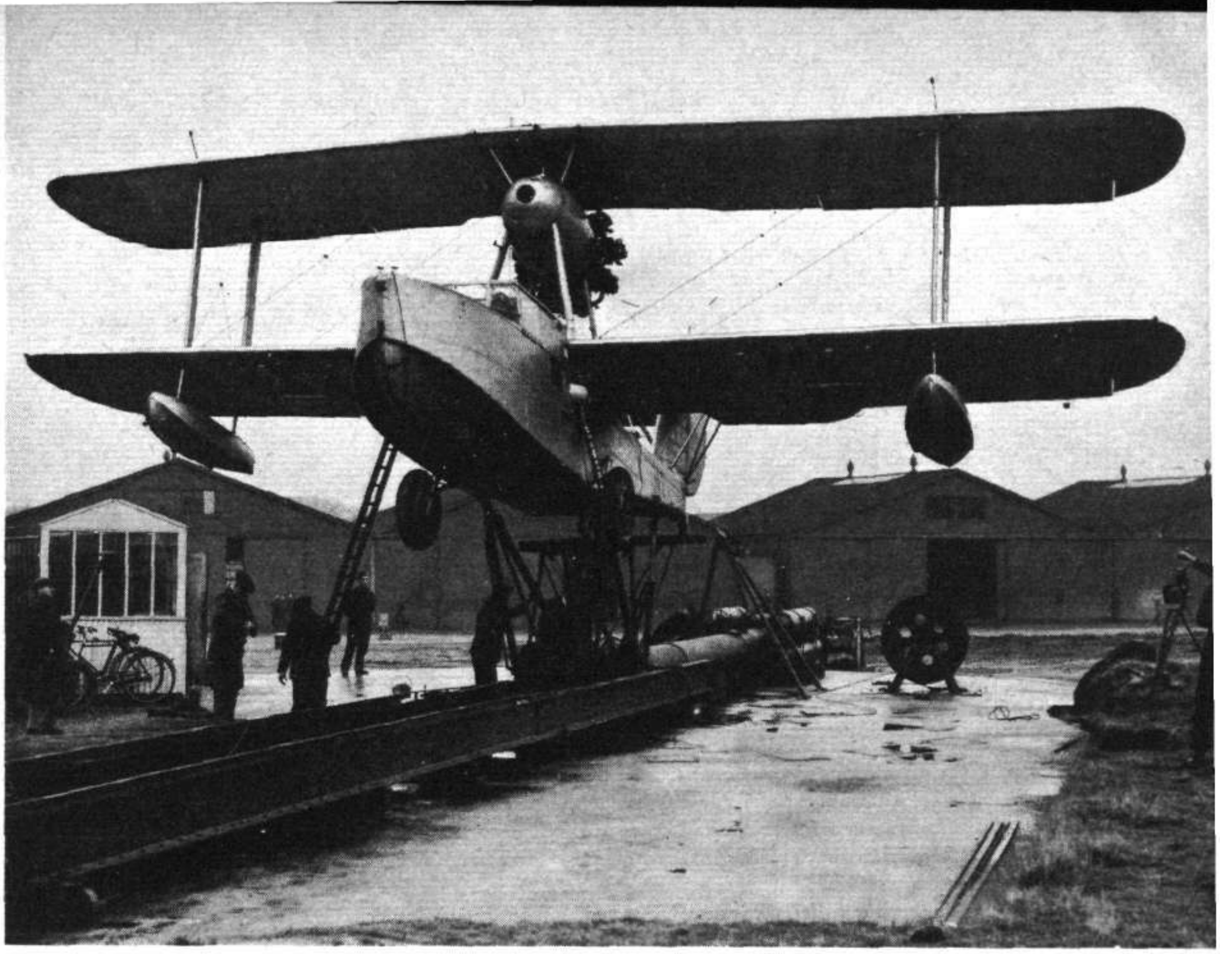


Preparing to catapult a Supermarine Walrus amphibian at the R.A.E., Farnborough. This catapult is of the expanding-ram type, without sheaves and wire ropes. (*Flight* photograph.)

Part II. Development of the Catapult : Data on Different Types : The Field Type or "Accelerator" : Future Requirements

ASSISTING the TAKE-OFF

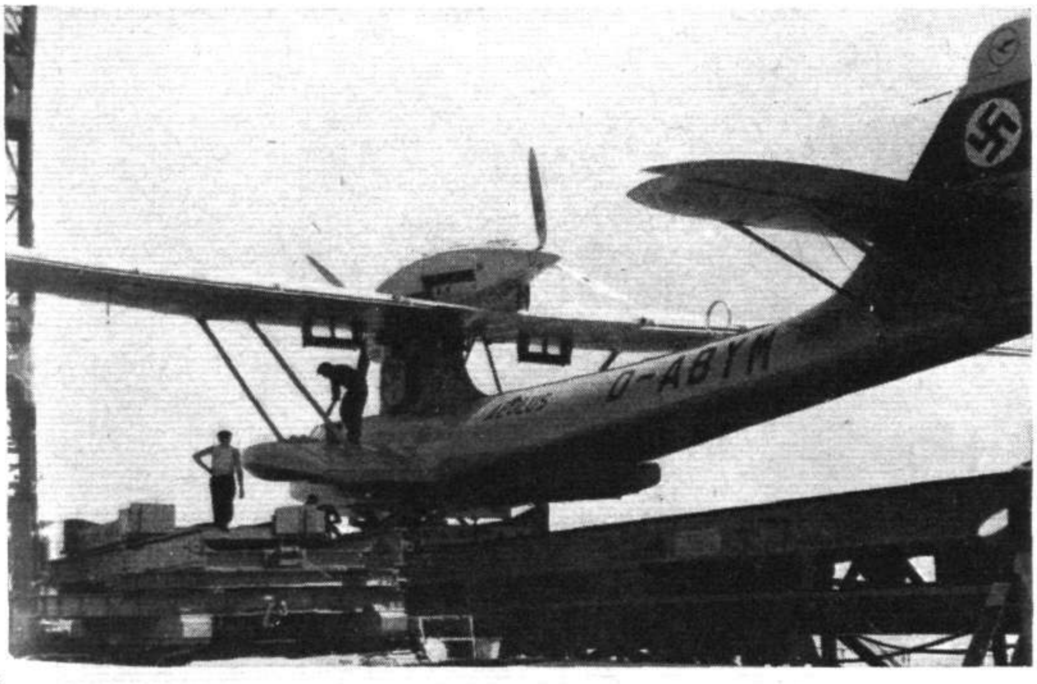
IN addition to the Mayo "Composite Aircraft" scheme dealt with in last week's article, there are two possible methods of assisting the take-off of aircraft. Probably the most promising of these is the catapult principle in some form or other; many variants of this are obviously possible. The other system aims not at getting a heavily loaded aircraft into the air by the aid of extraneous power, but by taking it into the air in a lightly loaded condition and then transferring the bulk of the fuel load to it from another aircraft, which may be termed the "tanker."

At the R.A.F. Display at Hendon in June a demonstration of refuelling in the air was given by a Boulton Paul Overstrand, which was refuelled from a Vickers B.19/27. The demonstration indicated that great improvements have been made during the last year or two, the process of making contact being much more certain and rapid than it used to be, and the automatic coupling with automatic fuel cut-off providing a safeguard as well as greatly facilitating the operation.

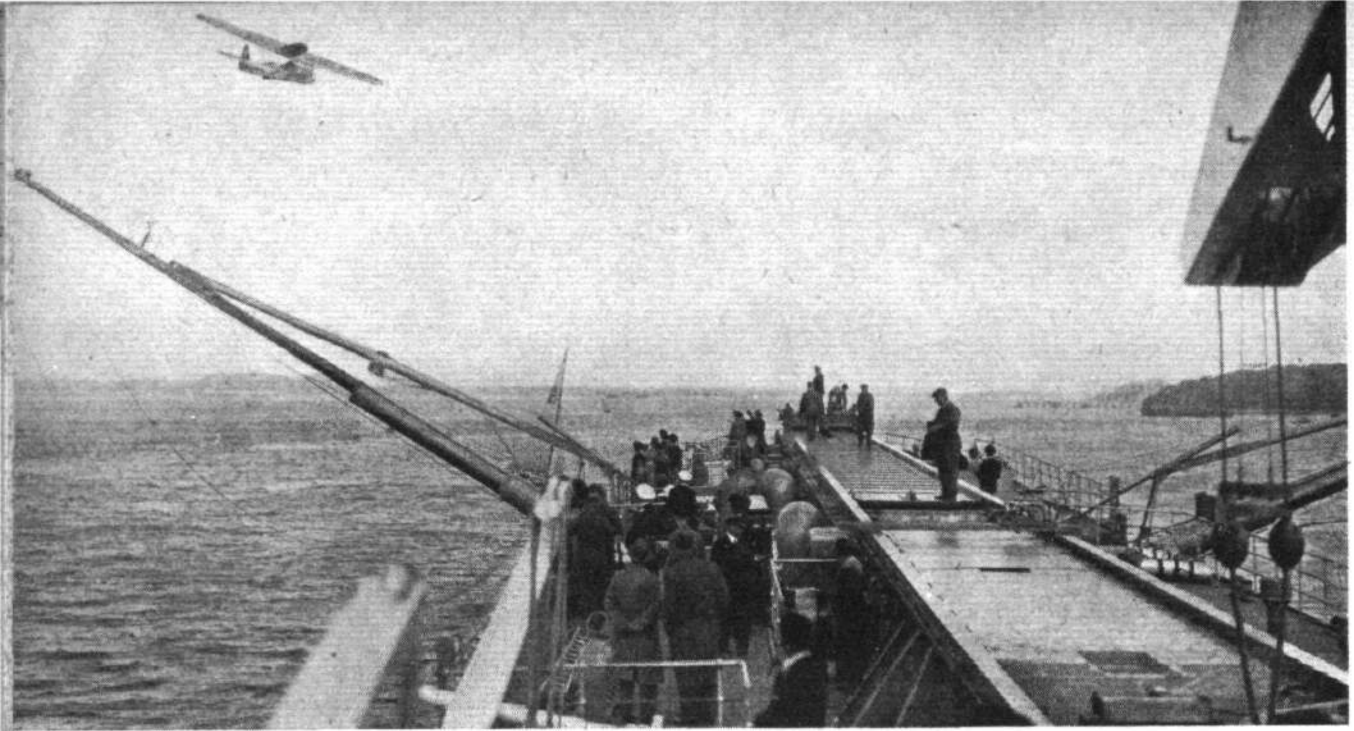
Briefly explained, the operation shown at Hendon begins with the aircraft to be refuelled trailing a line about 150ft. long and terminating in a grapnel. The "tanker" lowers about 80ft. of cable with a weight which causes the cable to hang nearly vertical. When the flight paths of the two aircraft cross one another, at different heights, of course, the grapnel catch and contact is established. The "tanker" next lets out the refuelling pipe, with the coupling line attached, and the pipe is brought over by the pull of a drogue attached to the coupling line. Trailing back in the wind, the drogue pulls the coupling line with it, the pipe line being pulled towards the other aircraft until the operator can make the actual connection.

In bumpy weather it is difficult to keep the two aircraft at a given distance and position in relation to one another, and this difficulty gave much trouble in the earlier refuelling tests. Now, however, a special type of automatic pipe coupling is used, which parts as soon as the pull reaches a certain amount. At the same time an automatic cut-off prevents the fuel from escaping. As soon as the two aircraft approach close enough again the drogue restores the union.

It may, perhaps, be said that the technical difficulties of transferring fuel from one aeroplane to another have been solved. The operation is quite quick, the rate of fuel



A Dornier Do.18 (two Junkers Jumo diesels) on the Heinkel catapult on board the mother ship *Ostmark*. This equipment was used for the German transatlantic experiments.



In this picture the Do.18 is seen circling the *Ostmark* after being catapulted off. The latest D.L.H. mother ship *Friesenland* carries a catapult capable of launching aircraft up to 37,000 lb. gross weight.

transfer being some 80 gallons per minute. There would, therefore, be no difficulty in refuelling the Short long-range boat *Caledonia,* for example, at the start of her flight across the North Atlantic. Obviously, the whole of the petrol supply would not be taken on in the air, but a considerable quantity could be added once the machine had left and was on her way. At present this is not necessary, as the boat gets off without difficulty with an ample margin of fuel for the flight, but later, when pay-loads come to be carried, the experiment might well be worth trying.

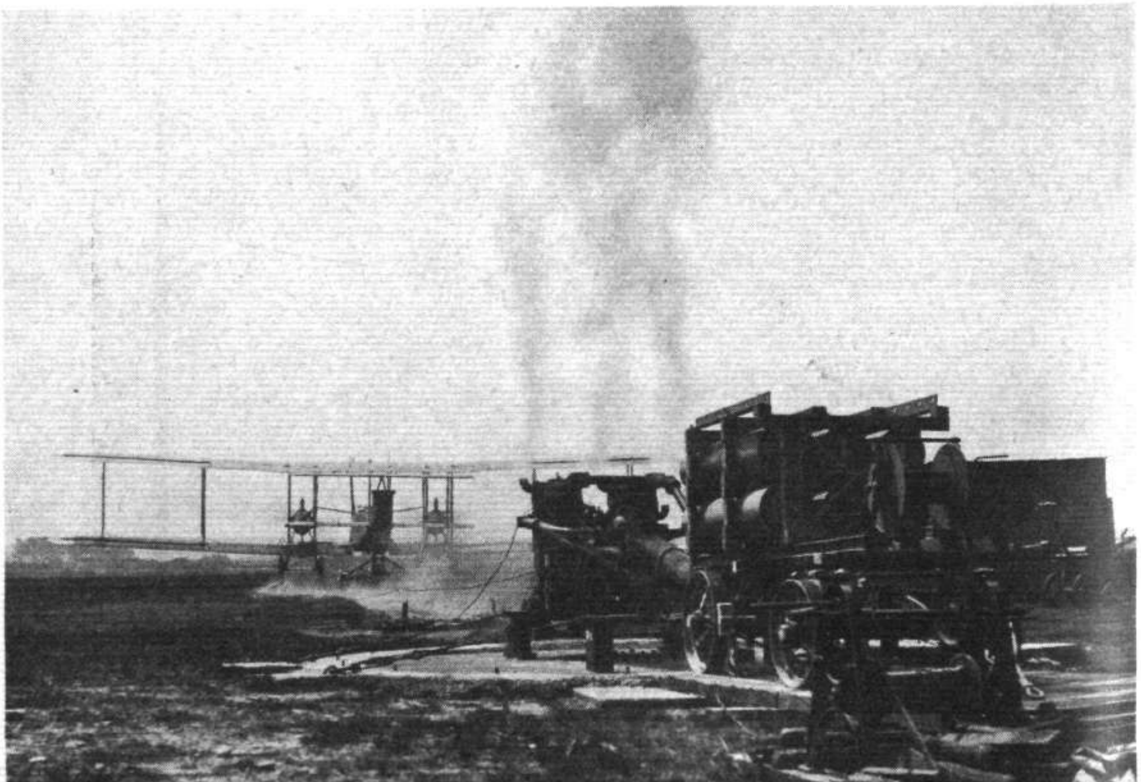
The main obstacle to the general adoption of refuelling in the air for long-range air routes is raised by weather conditions. On a clear day there are no technical or operational difficulties in establishing contact, but in thick weather it is likely that the two aircraft would experience considerable difficulty in locating one another.

Catapult launching seems to offer the most promising line of development, not only from the aircraft point of view, but also, possibly, in connection with getting heavily loaded aircraft out of aerodromes of reasonable size. There are obviously limits to the size which it is economically possible to make aerodromes near cities, and if the use of catapult starting in some form should enable the size of necessary land to be greatly reduced, the cost of the catapult might easily prove worth while. The objection is that an aircraft requires nearly as much space for landing as it does for taking off, particularly if the disposable load has not been appreciably reduced during the flight preceding the arrival. On the shorter air routes the amount of fuel consumed during flight is a fairly small proportion of the total load, and so its effect on landing space requirements is not great.

As mentioned in last week's article, the earliest use of catapults was made in America, where Langley and the Wright brothers adopted it. More correctly, the Wright dropping-weight system should be described as an accelerator for use in a field, as it was not a catapult in the sense the word is used to-day. The power-driven catapult for launching aircraft from ships, where the length of take-off run is necessarily limited, also owes its inception to the United States where, as early as 1912, a successful launch was made from the deck of a coal barge at the Washington Navy Yard. By the end of 1925 the United States Navy had 32 catapults in service on battleships and cruisers. In the early catapults compressed air was used, but in 1924 the first American powder impulse catapult was taken into use. The chief advantage of this was found to be that a larger number of aircraft could be catapulted in a given period, as the time taken in re-charging the compressed air cylinders was saved.

British Beginnings

In Great Britain a beginning was made in 1916, when a specification for a catapult was prepared. This required that the catapult should be capable of launching an aircraft weighing 5,500 lb. at a speed of 60 m.p.h. with an acceleration not exceeding $2\frac{1}{2}$ g. in a run of 60ft. Two catapults, both using compressed air, were completed to this specification, one being built by Armstrong Whitworth and Co. and the other by Waygood-Otis. Then came the end of the war, and it was not until 1922 that catapult work



An accelerated take-off: A Vickers Virginia being launched by the Farnborough field catapult. With this the aeroplane runs along on its own wheels and is air-borne after a run of 120 ft.
(*Flight* photograph.)

was resumed. Mr. R. Falkland Carey, who had designed the Waygood-Otis catapult, designed a new one, which followed in a general way the lines of the American catapults, with the motion of the ram transmitted to the launching carriage by wire ropes over pulleys. The Carey catapult was designed to launch aircraft up to 7,000 lb. weight, the run being 34ft. and the speed 45 m.p.h. The mean acceleration was 2 g. Compressed air was used.

Simultaneously with the design of the Carey catapult, the R.A.E., Farnborough, proceeded with the design of an entirely different type. The speed, run and acceleration were the same as for the Carey, but no cables and pulleys were used, the launching carriage being attached directly to the smallest of the series of telescopic tubes which formed the ram. Again compressed air was used as the motive power, the pressure in the bottles being 2,000 lb./sq. in. Two of these catapults were built by MacTaggart Scott.

Cordite Introduced

In 1928 the R.A.E. catapult was modified to use cordite instead of compressed air, and in later developments of it the forward half of the structure is hinged so as to stow alongside the rear half when the catapult is not in use. Larger versions will launch aircraft up to 8,000 lb. weight at 55 m.p.h., the run being 50ft.

In recent times the wire-ropes-over-pulleys type of catapult has come into favour, two Admiralty designs particularly being used extensively by the Navy. One of these was built by MacTaggart Scott and the other by Ransome and Rapier. The latter is known as the "slider" type from the fact that a subsidiary sliding structure is made to move along the main structure, and carries the actual launching carriage, which in turn runs along the sliding structure.

The MacTaggart Scott type has its main structure divided into three portions, the two end portions sliding inside the centre portion for stowage. This catapult will launch aircraft up to 8,000 lb. at a speed of 57 m.p.h., 7,000 lb. at 60 m.p.h., and 6,000 lb. at 63 m.p.h. The corresponding mean accelerations are 2.15 g, 2.38 g, and 2.62 g. The launching run is 50ft. 6in.

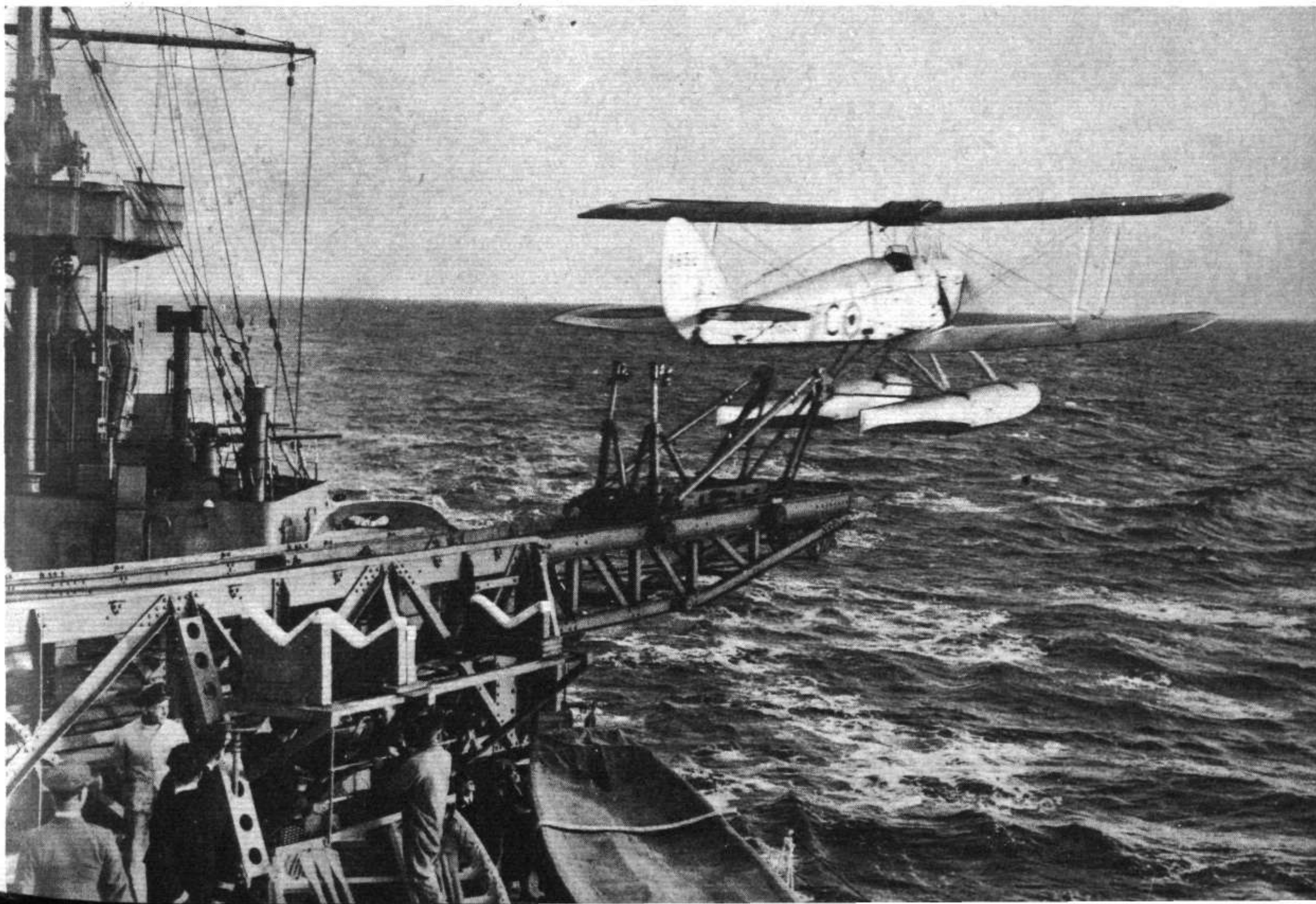
In Germany considerable catapult development has taken place, notably by the Heinkel firm, in connection with the "mother ships" used on the South Atlantic air route and, more recently, on the North Atlantic experiments. The most recent of these ships, the *Friesenland*, belonging to the Deutsche Luft Hansa, has a Heinkel catapult capable of launching aircraft up to 37,000 lb. gross weight, which is probably the most powerful catapult hitherto constructed. If, however, catapults of this size can be used successfully on a vessel, there would not appear to be any reason why catapults of even greater power should not be used ashore.

It will usually be found that space is nothing like so cramped on land as on board ship, so that a much longer starting run can be permitted. This means that either the power required can be smaller, or the take-off speed greater, or that the acceleration can be reduced to a much smaller figure. On military aircraft it is usually possible to design the structure to be strong enough to stand an acceleration of 3 g-4 g. It has been found that the crew can stand an acceleration of 5 g without very much discomfort, mainly due to the fact that the acceleration is in a horizontal direction, as distinct from certain aerobatic manœuvres in which the acceleration is usually in a direction parallel with the pilot's spine. In this connection it is interesting to note that experiments have shown that accelerations of 5.2 g sustained for less than 1 second were no more unpleasant than accelerations of 3 g for 1½ seconds.

The "Accelerator" Type

Some years ago the R.A.E. developed a totally different type of catapult, which has been variously described as a field catapult and an accelerator. It is not a catapult in the sense that the aircraft is not secured to a launching carriage but runs along the surface of the aerodrome on its own wheels. In order to reduce the angle of incidence of the wings, the tail is carried on a trolley, which is, of course, arrested when the aircraft leaves the ground under the control of the pilot. The Farnborough accelerator has an interesting power unit, in which two compressed-air engines are used, each developing 2,000 b.h.p. at 2,500 r.p.m. The engines drive, through a 6 : 1 gearing, a cable

Mechanisation: A De Havilland Queen Bee wireless-controlled target aeroplane is catapulted, pilotless, from H.M.S. *Neptune*.



drum of 4ft. diameter, the cable being led from the drum to a pulley anchored to the aerodrome at a point slightly ahead of that at which the aeroplane leaves the ground and thence back to the aircraft. With this type of accelerator aircraft up to 18,000 lb. weight can be started in a run of 120ft. at a speed of 60 m.p.h. The mean acceleration is only 1 g, which is low enough to be suitable even for passenger aircraft, provided passengers are warned beforehand to rest their heads against the backs of their chairs at the moment of starting.

Compressed air at 1,800 lb./sq. in. is contained in a number of steel cylinders carried on a tender.

Alternative methods of supplying the extraneous power for launching have been suggested. Capt. Frank T. Courtney, for instance, has spent a great deal of time and thought on the subject of shore-based catapults, and he has come to the conclusion that there is no serious objection to using a permanent track, laid in the direction of the prevailing wind, if the carriage on which the aircraft rests is permitted to rotate under the "weathercock stability" of the aircraft itself. In a wind blowing at an angle to the track, the machine would automatically adapt itself to the relative wind, which would vary in direction as the launching carriage gathered speed along the track. At the moment of leaving the carriage the aircraft would be at an angle to the track, but it *would* be facing into the relative wind. As Capt. Courtney contemplates launching speeds in the neighbourhood of 130 m.p.h., the angle caused by a wind of 30 m.p.h. blowing across the track would not be excessively large.

For what may be termed track-launching, obviously a great variety of power units might be suitable. Capt. Courtney suggests, for instance, that a light carriage driven by aero engines via airscrews might be suitable. Or a stationary power supply could be used, the power being transmitted to the launching carriage by an endless cable running over very large pulleys spaced the take-off run apart.

The permanent shore-based catapult or accelerator will obviously present problems not encountered in the case of catapults carried on vessels. For one thing, it is likely that they will have to be designed for launching aircraft of far greater gross weight than any likely to be used in the Navy. For commercial work the ideal site would appear to be an aerodrome adjoining a stretch of sheltered water on which flying boats could alight on arrival from overseas, afterwards being hauled up on to the track for the launch on the next outward flight. The same starting track and power plant should be available for assisting landplanes into the air, so that the same general base would serve for all long-distance air routes.

One hesitates to complicate the issues, already sufficiently difficult, by suggesting further expenditure, but it is quite obvious that it is very necessary to take the long view, and the Empire air base at Portsmouth seems to be the logical site for all material and equipment connected with long-distance commercial flying. Whether it is possible to provide for catapult launching in addition to other facilities in Langstone Harbour is another matter. It is, however, high time that we got our plans going, and they ought to include every foreseeable development likely to take place, so that instead of having to shift from one site to another in a few years time, additions of equipment could be made as and when they were required. Catapult or accelerator launching is very definitely one of the developments likely to be needed before long.

BADGES FOR EIGHT MORE R.A.F. UNITS

A further set of R.A.F. unit badges has been approved by His Majesty the King. Chester Herald's description of the badges, which are reproduced above, is as follows :—

No. 11 Flying Training School: Two dexter hands couped at the wrist holding a winged torch. No. 12 (Bomber) Squadron: A fox's mask. No. 40 (Bomber) Squadron: A broom. No. 41 (Fighter) Squadron: A double-armed cross. No. 74 (Fighter) Squadron: A tiger's face. No. 203 (Flying Boat) Squadron: A winged sea-horse. No. 230 (Flying Boat) Squadron: In front of a palm eradicated a tiger *passant guardant* School of Air Navigation: A star of eight points.