WORKING IN TINPLATE

NEWNES

PRACTICAL MECHANICS

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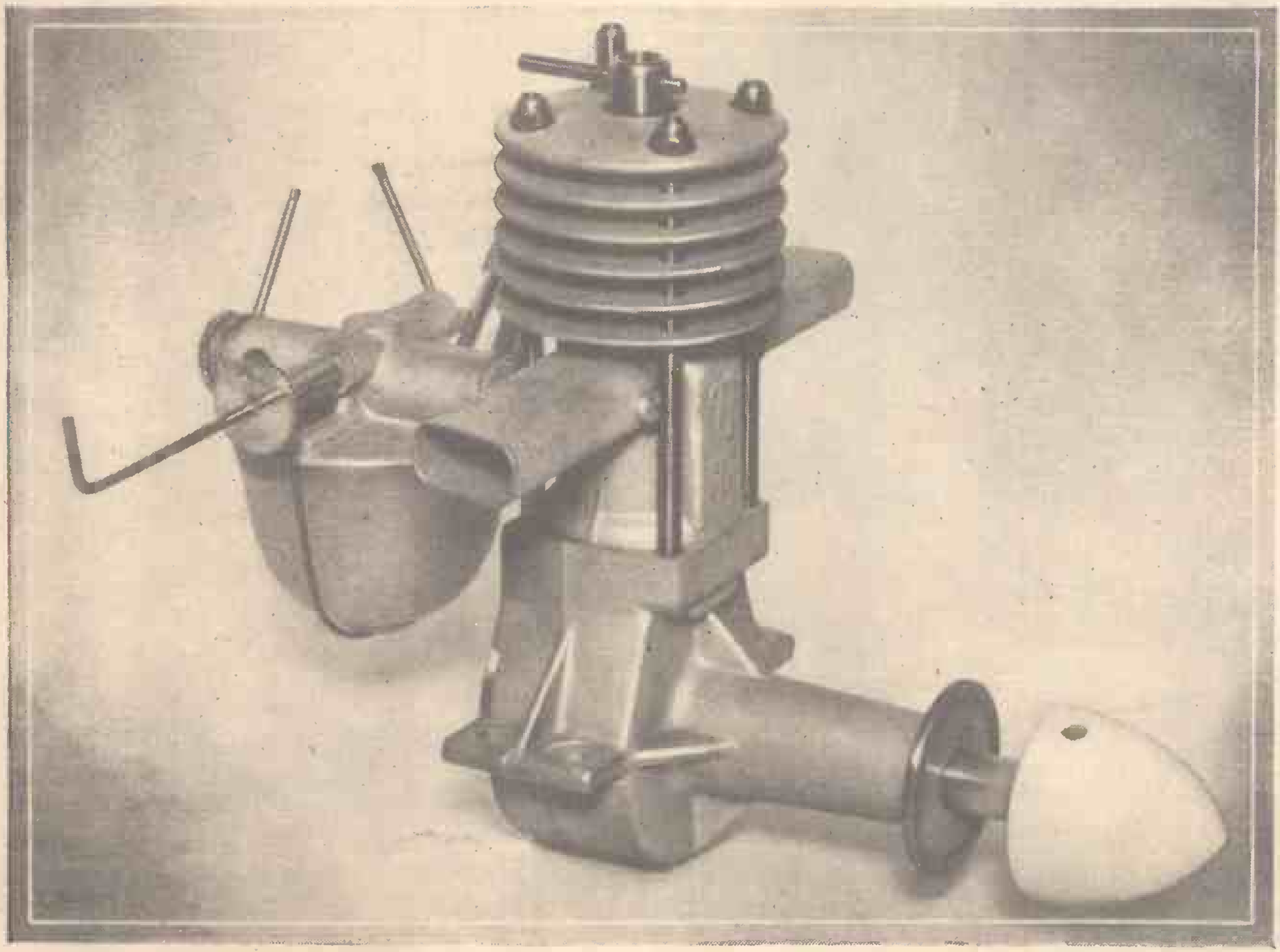


THE NEW 5 C.C. BRITISH-BUILT "ETA" MODEL DIESEL ENGINE (See page 332)

PRINCIPAL CONTENTS

Rocket Propulsion

The Northrop "Rocket-wing"

By K. W. GATLAND

(*Continued from page 268, May-June issue*)

The Northrop MX-324 " Rocket-wing " was the forerunner of the XP-79 " aerial-rammer " and research machine for the B-35 and YB-49. It is seen here at speed during the first test-flight under power.

THE most outstanding contributions to aeronautical science since 1903—actual turning points in development—may be summarised as the following: the true cantilever monoplane, the helicopter, jet-propulsion, rocket-propulsion and the *flying-wing*.

It would be difficult, indeed impossible, to name a *single* person as being responsible for any one of the above achievements. As in all branches of technology, it is seldom that one man, or even one group, is responsible for perfecting an original scheme; rather is it in the work of many, each making some small contribution over a period of years, that an idea is eventually brought to practical fruition.

Some inventions that are generally considered to be the work of modern technicians have, in fact, been in the " melting-pot " for centuries. Take, for example, jet propulsion. This source of power began to appear in practical form during the late war, but its actual inception was in Hero's

A self-combusting mixture of monoethylaniline and red fuming nitric acid powered the Northrop " Rocket-wing " which first flew in 1944.

æopile at the commencement of the Christian era. Similarly, rockets were known to the Chinese of the thirteenth century; and, as any student of aeronautics knows, Sir George Caley proved the feasibility of vertical flight with his model steam-driven helicopter, which flew in 1893.

The Flying-wing

The flying-wing does not appear to have so long-established a history, although it is true that some of the earliest gliders were " all-wing." Such names as Professor Hugo Junkers, Col. J. W. Dunne, Capt. G. Hill (now Professor Hill), and Professor Lippisch are outstanding among those who pioneered the flying-wing aeroplane, but credit for its final perfection is due almost exclusively to the work of John K. Northrop and engineers of Northrop Aircraft Incorporated.

" Aviation Advanced Ten Years "

What this firm has achieved in recent years must have advanced aviation by at least a decade. Solution has been found to all control and stability problems related to the type, and progress has been so rapid as a result that already a jet-powered all-wing fighter and a giant all-wing bomber are flying and in service with the U.S.A.A.F. It is an acknowledged fact that by eliminating the fuselage and tail surfaces the overall drag is diminished by anything from $33\frac{1}{3}$ per cent. to 50 per cent., and this implies considerably less power expended in obtaining a given speed, and hence less fuel consumed, permitting greater range or increased payload. Just how effectively this has been done can be gauged from the accompanying pictures.

The Northrop experimental programme could not have reached its climax at a more convenient time. It was apparent from the first that the new era of turbo-jets and rocket units meant power in excess of what the normal airframe and its cantilever arrangement of wing and tail could withstand, but now the flying-wing is established, power and structure are much more evenly matched. This, no doubt, will be seen when

The prototype YB-49 takes shape in one of the big workshop hangers at Northrop Field, Hawthorne, California. When completed, it will have a span of 172 feet, 31 feet greater than that of the B-29 " Super-Fortress."

the Northrop XS-3 transonic research aircraft is rolled out on the tarmac at Murac Flight Test Base, California.

The Northrop "Rocket-Wing" MX-324

It is perhaps not generally known that it was a rocket-powered flying-wing, less than 30ft. in span and weighing 4,480lb., that gave Northrop some of his initial data. It was built during 1943, and successful flight trials were made under the control of test-pilots John Myers (who is now the firm's vice-president in charge of sales) and Harry Crosby, the former flying the 'plane in glide tests and the latter demonstrating it under power.

This "Rocket-Wing" followed the same general layout as the earlier "Baby-Northrop" N1M (which was actually the first of the "all-wing" series and flew in 1940), though it did not embody down-turned tips and the composite rudder/elevator controls which these permitted, as did its predecessor. In the rocket 'plane, a reversion was made to the vertical type fin and rudder and normal wing-tips.

The pilot was accommodated *prone*—an achievement of merit in itself—in a trim cockpit which projected slightly beyond the wing leading-edge. In one of the photographs, Crosby is seen lying in the cabin, his head rested in a sling to permit easy forward vision through the large moulded Plexiglas nosing. The prone cockpit was adopted for two good reasons: one, to allow the incorporation of a special thin aerofoil without spoiling the shape with a big cabin, and, two, to give the pilot a better chance of withstanding high "g" pressures in violent manœuvres. The arrangement worked out well, but not without some early difficulty in design. A completely different control system was required, with a short servo-assisted control column which worked elevons on the wings, and rear foot operated rudder pedals, in addition to the novel pilot's *couch*.

The tricycle undercarriage was non-retracting and large fairings shrouded the wheels, keeping resistance down to a minimum. Small streamlined skids protected the wing-tips in the event of an uneven landing.

Rocket Engine Designed by Aerojet

Power for the MX-324 was obtained from a small bi-fuel rocket engine, the XCAL-200, designed and built by the Aerojet Engineering Corporation of Azusa, California. It had a single combustion chamber operating on a self-combusting mixture of monoethylaniline and red fuming nitric acid—a full complement of 31 gallons.

The propellant system was gas charged from four pressure tanks which fitted neatly in the wings alongside the fuel and oxydiser tanks, hydraulic and electric control equipment. The combustion chamber took up a position in the centre of the wing, its nozzle protruding from the trailing edge.

Early Tests

Flown first as a glider in October, 1943, the machine was taken to Harper Dry Lake, near Batstow, California, for ground and flight trials on June 20 of the year following. A team made up from engineers of Northrop and Aerojet was responsible for the tests which followed: first, static trials of the power plant; then, taxying trials and, lastly, flight trials under power.

The motor was first fired separate from the airframe to ensure its correct function, particular attention being given to the "cut-out" gear. A few minor adjustments and it was ready for bolting down in the wing.

The unit was then operated for duration of run, while the machine strained at heavy stakes used to secure it to the ground.

This stage satisfactorily concluded, it was time for Crosby to start taxying trials. He climbed in the cockpit and having settled himself down on his couch, pressed the ignition trigger on the control column, turning the rocket on and off as he manœuvred about the desert. That was on June 23! Slight re-work was needed on the 'plane after this, and nearly two weeks elapsed before the tests could continue.

The first actual flight under power took place on the morning of July 5, a Lockheed "Lightning" having been flown out to act as tow 'plane, with Capt. J. Sherman as pilot. The two aircraft were linked by a long cable which splayed out into two just ahead of the MX-324, the ends attaching to lugs, one on either side of the cabin.

Everything ready, Capt. Sherman inched his twin throttles forward. The cable came taut and the two machines gathered speed, lifted gently and began to climb in a long curve.

They came back over the take-off point at about 8,000 feet, and when directly above the observers, Crosby tripped the release, dropping the tow-line. The "Lightning" drew away rapidly, and before the speed of the tiny "Rocket-wing" had time to fall off too sharply, its pilot pressed the ignition trigger and the 'plane shot forward under the impulse of its motor. It cut a swift streak across the sky, the jet billowing out in a long plume and lasting about five minutes.

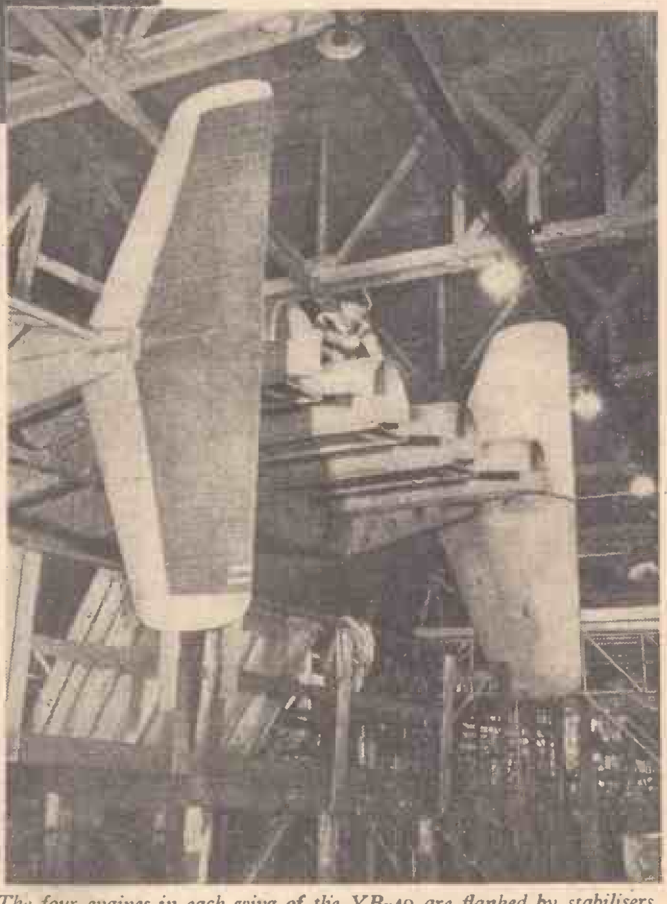
All fuel gone, Crosby glided down in front of his elated audience to a perfect landing.

A second test-flight was made six days later, in which the 'plane was dived under full throttle from several thousand feet. Crosby came down fast and low, skimming the lake bed, then pulled up almost vertical until he had levelled out again 6,000 feet high.

Following these tests at Harper Lake, the "Rocket-wing" was brought to Murac Base where, with Crosby again at the controls, it flew several times more. The Aerojet engine functioned perfectly at all times, though it lacked ample power for the MX-324.

As more powerful rocket-engines were not then available, Northrop carried out a redesign on the machine, and a development appeared later as the XP-79, a *twin-jet fighter* in the 500 m.p.h.-plus class. It was intended to operate as an aerial rammer for tearing the wings from enemy bombers, but came too late for use in the war. The all-wing leading edge was heavily armoured and

The completed YB-49, as shown by this model, will embody eight General Electric TG-180 turbo-jet engines rated at 4,000lb. thrust apiece. Features of interest are the grouped tail pipes leading from the submerged engines, the four stabilisers, and the central crew nacelle. Also apparent are the pilot's canopy and astrodome.



The four engines in each wing of the YB-49 are flanked by stabilisers. These supply the necessary stability and their absence in the earlier B-35 is accountable to the steadying influence of contra-rotating air-screws.

permitted the pilot to direct his machine straight into the wing of an opposing aircraft and fly away safely.

Big Brothers of the "Rocket-Wing"

Not only did the tiny "Rocket-Wing" supply invaluable data for building the XP-79, but it also contributed to the design of Northrop's latest masterpiece, the giant B-35 flying-wing bomber which, in general outline, is an enlargement of the tested wing pattern.

This 172ft. span "Wing" is powered by four 3,000 plus-horsepower engines with co-axial pusher airscrews and, being able to carry a load of 10,000lb. a distance of 10,000 miles, it must be classed as one of the world's longest ranging bombers. Although it is entirely all-wing in conception, normal fins and rudders are not fitted as stability arises from the contra-rotating airscrews. There are eleven controls operating as elevons (aerofoils which work either as elevators or ailerons), with rudder assemblies at the tips.

The recent disclosure that two *jet-drive* versions of this design are under construction and will be flying by mid-summer marks yet another triumph for Northrop. They are under contract to the Army Air Forces and have been given the designation YB-49.

"The Most Efficient Aircraft"

This latest development represents the most efficient combination of structure and power-plant that has yet appeared, and the design is so advanced aerodynamically that Northrop is likely to retain his lead for some time to come. Power hitherto undreamed of will be supplied by *eight* General Electric TG-180 turbo-jets. The engines are rated at 4,000lb. thrust apiece, and flying at sea-level and at most efficient speed (which is not yet revealed), each pound of thrust will equal one horsepower, making the total output of the YB-49's power-plant 32,000 h.p., *nearly three times that of the B.35.*

In addition to its engines, the B.49 differs from the B-35 in having four vertical stabilising surfaces, though these do not mount rudders. They are fitted to make up for the loss of stability originally obtained from contra-rotating airscrews in the B-35 and, as will be seen from the photographs, two are rooted in each wing on either side of the engine groups. Long, slit-like intakes are placed in the leading edge between each pair of stabilisers.

Identical in Size

The YB-49 is being built to the same specification as the earlier propeller driven bomber, both types having the same dimensions: a span of 172 feet, a root chord of 37½ feet, a root thickness of 7 feet, and a tip chord of 9ft. 4in. The length of each elevon is 34ft. 6in.

Landing flaps occupy the centre section of the span, and slots in the wing-tips are aids to control at low speeds. The landing gear is tricycle and, of course, fully retracting, with 5ft. 6in. diameter double-wheels on the main legs and a smaller wheel assembly at the nose.

In order that all excessive control forces should be prevented, the flying-controls are worked through a full-boost hydraulic system co-ordinated with special Northrop-designed pneumatic loading devices. This arrangement gives artificial "feel" to the controls, similar to that obtained naturally in smaller aircraft.

A special electrically-driven throttle, also designed by Northrop, ensures that the pilot does not "over-ride" his engines. The throttle opens slowly and is designed to extend engine life by holding down tail-pipe temperatures.

Performance Not Revealed

Speed, ceiling, range and bomb-load are not yet revealed, but it can be said that the ratio of load to weight is far greater than would be possible with a conventional aircraft of comparative size, and again this mirrors better economy and efficiency of operation.

The machine will house a crew of 13 within the 37½ft.-long pressurised centre portion, the pilot enclosed beneath a clear-view canopy in the extreme nose, with the co-pilot seated below him and to the right and having his view through a "glass" panel in the leading-edge. Just outboard to starboard and slightly behind the pilot is an astrodome, and immediately to his rear —within the same canopy—is seating for one of two gun-controllers, who faces aft.

Remotely Controlled Barbettes

Multiple guns (presumably 0.5in.) are mounted in five barbettes, two above the wing and two below with the other behind the pilot's enclosure; and these will be operated remotely by the controllers, the second "gunner" having his position in the central nacelle over the trailing edge. Also aboard will be a navigator, radio-operator and bomb-aimer, with space for six men "off-duty."

This all too brief resumé of Northrop research must serve for the present writing, but it is hoped to be able to return after the "security veil" has been lifted from the XS-3.

(To be continued)

Notes and News

Johnson's Photographic Competition

MESSRS. JOHNSON & SONS, of Hendon, have recently issued a list of prizewinners in their December Photographic Competition, which closed on December 31st, 1946.

Two first prizes of £5 each are awarded to: Mr. Vernon Shaw, 29, Park Road, Timperley, Cheshire, and Mr. A. Ruddle, 1, Westbourne Avenue, Worthing, Sussex.

Three second prizes of £2 each are awarded to: Mr. H. S. Bower, 113, South End Close, Hampstead, N.W.3; Miss B. Wagstaff, 1-21, Northwood Hall, Hornsey Lane, N.6; and Mr. I. W. Lightbody, 20, Allanshaw Street, Hamilton, Lanarkshire.

In addition, there are awards of 10 third prizes of £1 each, 20 fourth prizes of 10s. each, and 25 consolation prizes.

New Folding Canoe

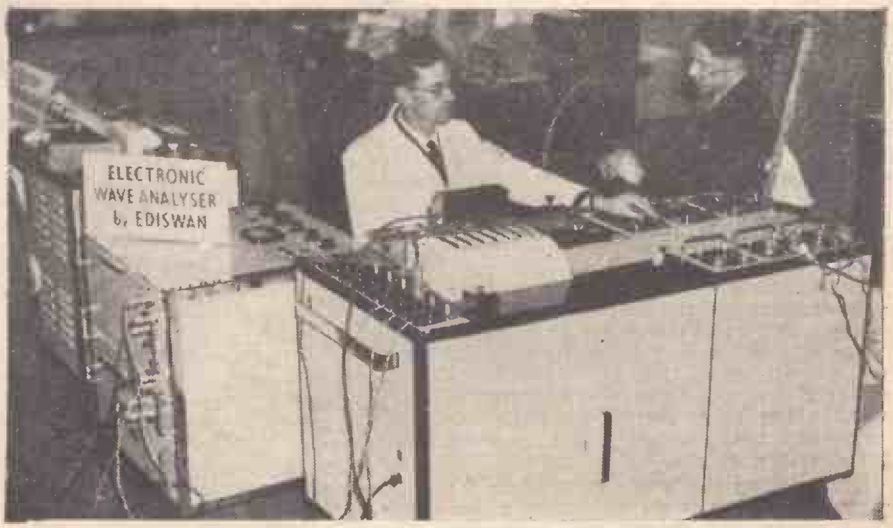
IDEAL for export to all countries, including the tropics, and already shipped to Denmark, Sweden, Turkey, Middle East, India, Canada and Latin America, the first light alloy folding canoe ever marketed in Britain was given all-day-long demonstrations at the British Industries Fair held last May.

It was shown at the London (Sports Goods) Section, and visitors were able to study for themselves the method of assembling from the "flat."

Devised by an R.A.F. squadron leader who was responsible for designing and producing the folding dinghy supplied to the British Admiralty and Ministry of Aircraft Production during the war, this peacetime version, suitable for two people and their camping equipment, weighs only 38lb. (17 kilos), and can be carried on the roof of a small car, yet it is 12ft. (3½ metres) long when assembled. Assembly takes only about two and a half minutes. The method of construction combines a light alloy skin with silver spruce gunwales and keels. The whole of the shell or skin is in one piece, folded to half its open length. When open, sliding tubes link the gunwales into a rigid frame. Telescopic struts lock the shell in the arched canoe-shaped position, and stainless steel catches bring the ends together. Soft rubber in compression seals the centre hinge joint and two ends, and the canoe is ready for use. All the fitments are built into the canoe, and nothing is carried loose to get lost.

Each canoe is tested to hold at least 400lb. before leaving the factory, and the corrosion resistant light alloy skin not only gives a stiff shell, but one which is impervious to fungus and insect attack. It is shipped in lots of 10 in specially built wooden crates.

The makers are Grimston Astor, Ltd., Bideford, N. Devon.



The Ediswan direct recording Electro-encephalograph (which has become known as the "Lie-detector"), in use at the Imperial College of Science Exhibition, South Kensington.