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GAS–TURBINE DEVELOPMENT

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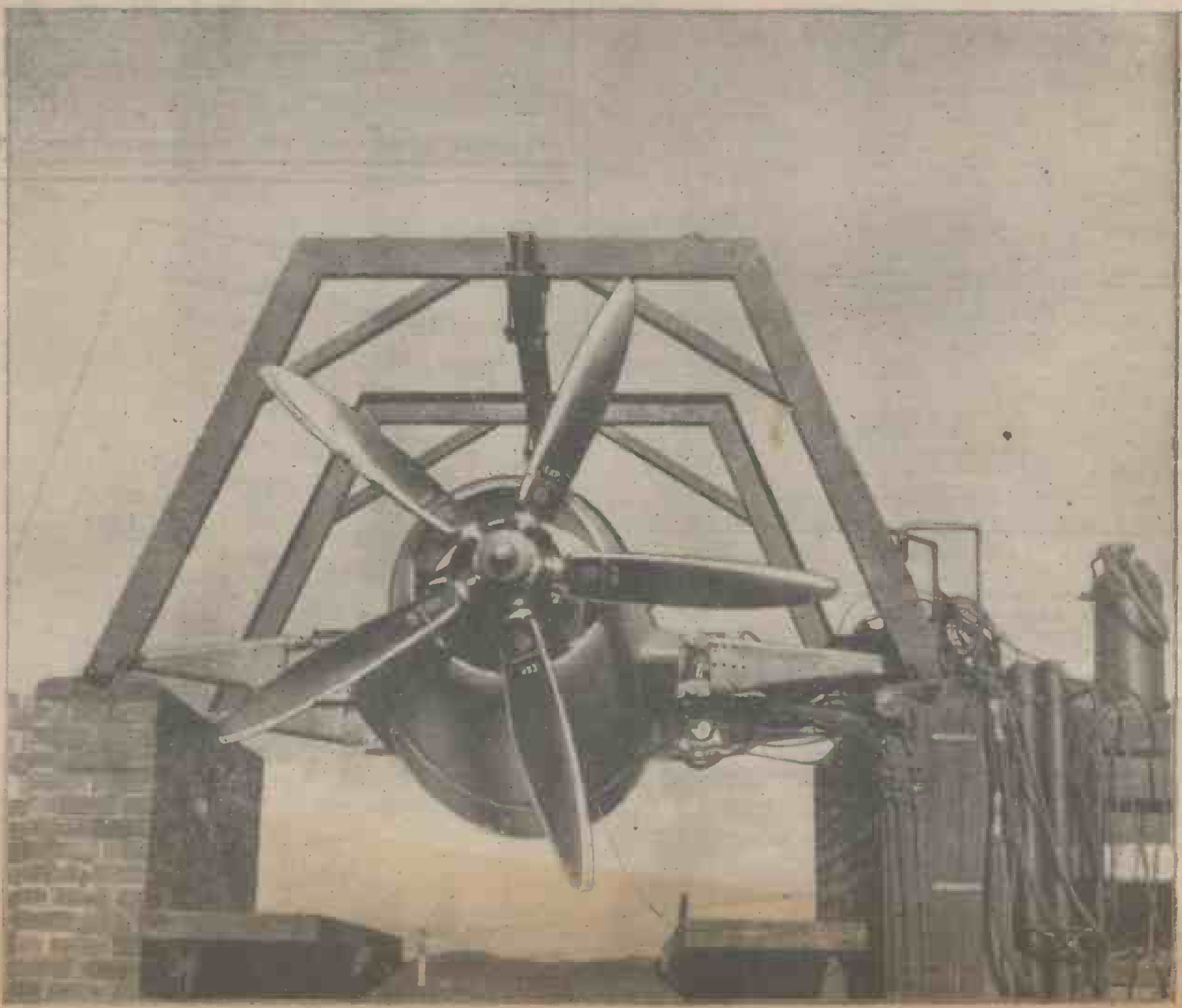


Rocket Propulsion

Japanese War Rockets : Rocket-firing Tanks : Airborne Rockets

By K. W. GATLAND

(Continued from Page 256, April issue).

Display of weapons showing how the "Bazooka" compares in size with the rifle-grenade launcher next to it. The Verey pistol and flare launcher are also in the exhibit.

ALTHOUGH the Japanese appear to have been in the process of developing jet-assisted take-off units, and at least one turbine-compressor jet fighter—the "Kikka"—there is little evidence of any similar work with rockets. The "Baka" suicide 'plane, some experimental copies of the German Me. 163, and a small variety of field weapons were the only rocket devices they produced.

In the years before the war very little of scientific affairs was allowed to leak out of Japan, and although it is known that some research with rockets had been conducted, it is not clear on what scale.

It is reasonably safe to say, however, that no liquid-fueled rockets were experimented with, either before or during the war, and although some of the larger pre-war powder rockets were controlled by radio, their means of propulsion was invariably little improvement on the pyrotechnic rocket.

The Japanese were slow in producing rocket weapons, and it was not until the closing months of the war that they came to be used on anything like a large scale.

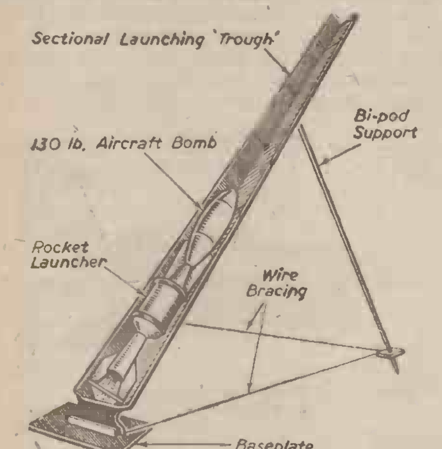


Fig. 63.—The "model 10 rocket launcher" captured on Saipan.

Rocket Launcher Model 10

One of the first Japanese rocket weapons was captured at Saipan, and, oddly enough, it appears to have been the only specimen of its type ever used in action.

This was the "Model 10 Rocket Launcher," shown in Fig. 63. It comprised simply an elevated wooden trough of right-angle section, supported at three points—by two tubular legs at the front and a small steel base-plate at the rear.

This crude structure was intended for launching an ordinary 130lb. aircraft bomb, which was propelled from the trough by a specially designed launching rocket placed behind it.

The launching rocket had a "canister" nosing, which housed three sticks of smokeless propellant weighing 13lb. A long divergent exhaust nozzle emerged from the rocket chamber, and attached outside the mouth were three steel fins. A flat cap, fitted at the nose, was slotted to hold the fins of the bomb.

The rocket was fired by a percussion striker screwed into the base of the trough, which the launching crew operated remotely by means of a lanyard.

Although no degree of accuracy could be claimed for the Model 10 launcher, it was said to have been capable of projecting the 130lb. bomb for distances ranging from 770 yards at a minimum angle of 30 degrees to 1,300 yards at 50 degrees.

A 20 cm. Rocket Projector

It appears that the Japanese favoured the "trough" to the tubular launcher, and this is borne out by the discovery of several light rocket projectors at Leyte. (Fig. 64.)

These resembled "production" equipment far more closely than the Model 10, although they were still remarkably crude when compared with similar Allied weapons.

The launching trough, which was in three sections, was formed of 3/16in. iron. It was supported by four tubular legs, two at the front and two at the rear, and could be adjusted to permit ranges from 450 metres at 60 degrees, the elevation being checked on a simple scale fixed to the side of the trough.

The projector fired a 20 cm. rocket that resembled a long shell, having an almost constant section. Its explosive was contained conventionally within a ballistic-shaped head, and seven sticks of smokeless propellant were housed at the rear in a motor body which screwed on to the back of the explosive compartment. As with the German rocket shells, stability was achieved through axial rotation, caused by the offset thrust of six nozzles set at 25 degrees to the rocket axis. The percussion cap, which initiated combustion, was screwed into the centre of the baseplate and, as in the previous rocket, was detonated by a lanyard.

There appears to have been no protection from blast, and it is assumed that the launching crew were well clear when firing took place.

A 44.7 cm. Explosive Rocket

Large rocket shells were later discovered during the American drive on Manilla, and these were found to be to the same design as the 20 cm. projectile, though of 44.7 cm. calibre. The large rocket measured 5ft. 9in., of which over half comprised the explosive head. The propellant container was charged with 40 sticks of smokeless powder, and the complete projectile weighed approximately 1,800lb.

It was spin-stabilised, six offset holes again being responsible for the rotation.

Improved "Jap" Rocket Equipment

There appears little doubt that, towards the close of the war, the Japanese were producing highly effective rocket shells, in many ways superior to contemporary German and Allied missiles. They, nevertheless, failed hopelessly in the manufacture of a satisfactory launcher.

The light and compact "Bazooka" was by far the most decisive rocket weapon of the Far Eastern conflict, despite its small size. This was very largely due to the conditions of the fighting, which demanded little more in the way of field ordnance than the mortar and the close-range rocket.

A tube-launcher was found later by

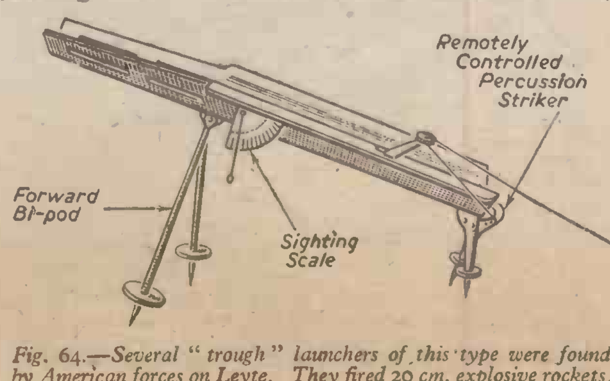


Fig. 64.—Several "trough" launchers of this type were found by American forces on Leyte. They fired 20 cm. explosive rockets.

American forces on Iwo Jima, and although somewhat cumbersome, it was an improvement.

The barrel, which had an overall length of 8ft., was assembled in two halves with a connecting collar, and was supported by two front legs and a rear base-plate. A simple catch was fitted at the rear of the open tube to prevent the projectile from slipping out of position once it had been inserted by the loader. The assembly was completed by a standard mortar sight.

The elevation scale indicated a minimum launching angle of 18 degrees, with a maximum of 65 degrees, and at full elevation the 20 cm. rocket had a range of 2,000 yards.

When stripped down into main components the tube-launcher—which, completely assembled, weighed 550lb.—could be transported by three mules.

Rocket-firing Tanks

When D-Day eventually arrived in Europe rockets were used in their thousands, and there is no doubt that in the development of field rockets the Allies had far surpassed the Germans.

Soon after the initial landings had been established the first rocket-firing vehicles began to make their appearance; lorries and cars had multiple projectors, and similar apparatus was mounted on light gun-carriages.

Last, and most formidable of all, were undoubtedly the rocket-firing tanks. These were used in the final assault upon the Reich fortress, firing explosive rockets in quick succession from multiple launching tubes.

Another launching arrangement, employed on Sherman tanks, was the aircraft rail-type projector. Two launchers were fitted, one either side of the tank, which fired the same 60lb. explosive rockets that were used on the Typhoon and Beaufighter.

Rocket-firing Aircraft

The first aircraft to fire rockets was the Russian Stormovik 1L2. Later, the two-seat Stormovik 1L3 and the Lagg 3, Mig-3 and Yak-1 single-seat fighters were similarly fitted.

It was these machines that figured prominently in the defeat of the Nazis at Stalingrad by their unremitting assaults upon tank columns. The rockets were housed under the wings on rail-type projectors and were fired electrically. They sped away at about 800 feet per second, and were proven capable of penetrating seven inches of armour plate.

A double-base propellant similar to cordite was used in airborne rockets, and this was generally in the form of several sticks inserted lengthwise into the propellant chamber. It was thus assured that a fairly constant area was exposed to combustion, with the result that initial velocities were high. The burning time was, at maximum, two seconds.

A German anti-tank projector resembling the "Bazooka" captured south of Caumont, July, 1944.

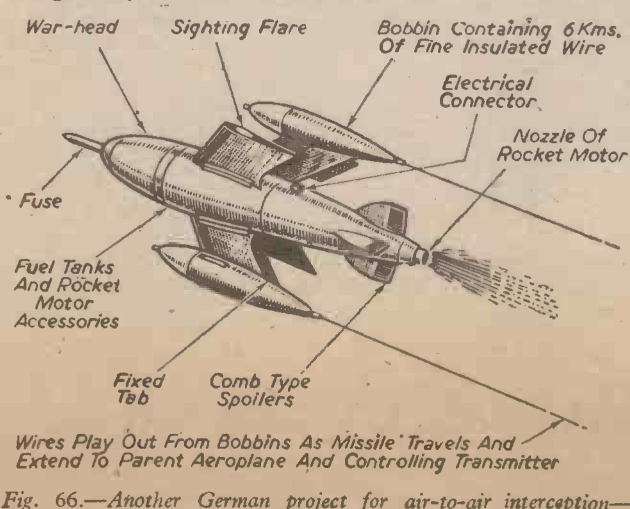


Fig. 66.—Another German project for air-to-air interception—the X-4

Air-to-air Rockets

Although the Germans did not place great importance in the rocket-firing aircraft for attacks upon land and sea targets they, nevertheless, produced several unique airborne launchers for firing explosive rockets into Allied bomber formations.

In May and June, 1943, the first fighters to be so equipped made their début. They included such established types as the Focke-Wulf 190, JU 88, Me. 109 and Me. 110, all of which had been specially modified for the purpose.

As the Allied formations swept closer to the Reich during the summer months the rocket attacks grew ever more vigorous and a situation developed which must have caused the air strategists no little concern.

The new Luftwaffe tactics enabled the launching aircraft to attack from beyond the 1,000 yards range of the .50in. machine-guns which were the bombers' main defence against normal fighter interception. The close-knit formations, which provided each machine with an effective coverage of fire under normal circumstances, were easy prey for well-aimed rockets.

The Luftwaffe achieved its greatest success during the Schweinfurt raid of October 14th, when 60 heavy bombers of the 8th U.S. Air Force failed to return to base. The Nazi fighters circled around the formations at high speed, laying their aim without interference whilst well out of range of the bombers' protective fire.

Whatever their method of evasion, the bombers were equally prone to destruction. Breaking formation or spreading widely were no solutions because lone bombers fell easy victims to fast-flying machine-gun and cannon firing fighters. Their pilots had no alternative but to maintain formation, hoping all the time that the range was too great for accuracy.

The days of the rocket launching fighter, however, were numbered. In both Britain and America fighters were being produced which were capable of escorting bombers all the way to and from their targets. In a large number of cases existing machines were modified, and high performance fighters began to appear which embodied streamlined "overload" fuel tanks suspended from beneath their wings. This naturally added considerably to their endurance.

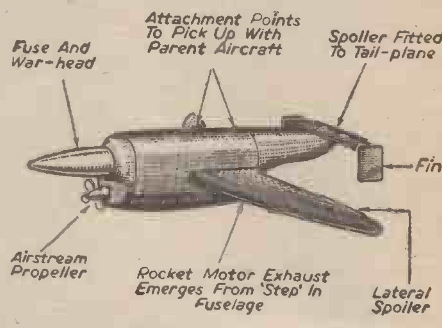


Fig. 65.—The Henschel 298—an experimental air-to-air weapon produced towards the close of hostilities.

The "overload" tanks were used before the internal tanks so that they were expended of fuel at as early a period in the flight as possible, whereupon they were jettisoned. Thus, as the formations approached the target area the escorts became fully combatant.

In later raids, it was the German fighters that took the greatest toll, and Allied bombers, ringed by numbers of protecting interceptors, returned to base almost unscathed.

Further Details of the Rocket-firing Aircraft

The single engine fighters, such as the Focke-Wulf 190 and the Messerschmidt 109, had single projector tubes, one beneath each wing. They fired 2.5in. rocket shells. Four to six wing launchers were fitted to the twin engine aircraft, and these fired the larger 6in. and 8in. shells. In a few instances, it was noted that some bi-motor 'planes had launchers mounted under the fuselage.

A number of the projectiles used on aircraft were the same or slightly modified versions of the explosive rockets used by the Wehrmacht. An example was the 6in. rocket shell used in the Nebelwerfer 41, (*Practical Mechanics*, April 1946, p. 255). This, it will be recalled, embodied the propellant in the rocket head, exhaust being made through a number of tangential nozzles in a conical centre-section. The after part of the projectile contained the explosive charge. The rocket had a length of 3ft. 6in., and weighed approximately 75lb. Its maximum range was in the region of 7,000 yards.

These rockets used a double base powder, similar to cordite, and in every case stability was caused by axial rotation.

The larger 8in. projectile was a development of the 21 cm. cannon shell, having a

A striking contrast in cleanness of design is the "zero-length" launching installation which is now a Service fitment on the latest Hawker Tempests. In this system there is no "rail": the rockets simply shoot off from the hook-retainers on which they are loaded.

Among the first British aircraft to be fitted for R.P. was this Hurricane Mk. II. C. Note the heavy "blast-plate" on the wing undersurface, and the two-rail launchers which were a feature of all early installations.

propellant container added behind the explosive charge. It had a range of approximately 9,000 yards, and weighed 200lb.

At the close of hostilities in Europe at least two new air-to-air weapons were in course of production. These were large missiles, entirely different from the earlier "rocket shells."

One type, the He. 298, resembled a small aeroplane, and the other, the X-4, was a finned rocket projectile. Both were to have been controlled remotely from parent aircraft.

The Henschel 298 (Fig. 65), stable companion to the He. 293 anti-shipping rocket glider, had a liquid fueled motor, and was guided to its target by radio. Its development was commenced early in 1944.

In order for it to be aimed easily, the missile was released from its parent aircraft at a height slightly more or slightly less than the target formation. It had an effective range of 1½ miles, and was exploded by a proximity fuse.

The He. 298 appeared as a mid-wing monoplane. Its fuselage was narrow and deep, and there was a "step" approximately two-thirds from the nose, from which the exhaust emerged clear of the tail. The wings were tapered towards the tips and had slight sweepback. A wooden tail-plane was attached high at the rear of the fuselage, at the ends of which were fitted square-cut fins of non-aerofoil section, projecting downwards. Control spoilers were provided on the wing tips and tail-plane.

A thin, conical warhead protruded forward from the top of the fuselage nosing, and a small air-stream propeller was fitted below as power for the electrical services. Two lugs were disposed about the centre of gravity for attachment to the parent aeroplane.

The missile had a wing span of 4ft. 2¾in, and a tail span of 21in. Its length was 6ft. 7in., and the fuselage had a width of 7½in. and a maximum depth of 16in. The all-up weight was 210lb.

The He. 298, along with a selection of other aerial weapons, was included in a display of German aeronautical developments on view to technicians at the R.A.E., Farnborough, last autumn. A large part of the exhibition was, earlier this year, removed to the Science Museum, South Kensington, to form the "Exhibition of German Aeronautical Developments."

The missile, shown in Fig. 65, was sketched at Farnborough, and observant readers who visited the Kensington exhibition will have noted that the tail-plane of the same exhibit appeared inverted, the horizontal stabiliser *below* the fuselage and the fins projecting *upwards* This was somewhat perplexing, and inquiries made at the exhibition brought no solution. As there is an obvious need for the tail to be high to clear the rocket exhaust, however, it is suggested that the missile shown there had been wrongly assembled.

Another air weapon in quantitive production at the time of the defeat was the X-4 (Fig. 66), perhaps the best example of an "aerial torpedo" that the war produced.

It embodied a well streamlined metal body, upon which were mounted four "wings" equally spaced around the circumference, about half-way along its length. A small cruciform tail-plane was attached at the rear. The nose of the missile contained a 110lb. warhead, which was detonated by a fuse in an 11in. extension, and the centre section housed a bi-fuel liquid propellant, which was fed to a single rocket motor at the extreme rear.

Perhaps the most unique point about the X-4 was that right up to the moment of detonation it was linked to the parent aircraft by two 0.22 mm. wires, which trailed out as the missile sped towards its target. The pilot of the controlling fighter was thus able to transmit electrical impulses direct to the missile: his signals worked electro-magnetic spoilers attached to each of the tail fins, permitting full longitudinal and lateral control.

Two bobbins, each capable of paying out fully six kms. of wire, were fitted to the tip of the lower port and upper starboard wings, and flares were attached to each of the remaining wings for sighting purposes.

The missile was carried by Focke-Wulf

Demonstrating the "Bazooka." The loader inserts a rocket into the rear of the projector tube held by the kneeling sergeant.

fighters on a modified version of the 70 kg. bomb rack. It had a top speed of 620 miles per hour.

Allied Rocket-firing Aircraft

In the summer of 1944 it was disclosed that four types of British aircraft had been modified to fire rockets. The Typhoon, Beaufighter, Hurricane and Swordfish were each fitted with eight launching rails, four beneath each wing, from which the same number of rockets were fired, either in pairs or as a complete salvo of eight. The launching aircraft experienced no recoil.

The projectile itself consisted of a heavy-gauge steel case, containing a charge of cordite sticks—it was stabilised by four small fins attached at the rear, and the warhead, which could be either high explosive or armour-piercing, was screwed on at the nose.

A number of American aircraft were later fitted for "R.P." (the Service abbreviation for "rocket-projectile"), among which the Thunderbolt, Lightning, Mustang, Tomahawk, Airocobra and Dauntless achieved outstanding success in the Far Eastern war theatre, notably in attacks upon Japanese shipping and troop concentrations.

The development of rocket launchers was carried out in Britain by the Projectile Department of the Ministry of Supply, and first tests were made with Hurricanes at the Aberdeen Proving Grounds, Scotland, during 1942.

In America the initial experiments were conducted at Wright Field, where, early in 1942, firing tests were made with a Curtis P.40, which had been fitted with two heavy-gauge steel projector tubes, one beneath each wing.

As might be expected, the early work was extremely hazardous, because of the ever-present danger of fire resulting from the rearward blast. This risk was minimised in early installations by the provision of a heavy steel "blast-plate" on the under-surface of the wing, local to the projectors. The precaution was dispensed with when improved, low-drag, launching rails and mountings were developed, which projected slightly deeper below the wing skin than previously. This was the British way.

The Americans overcame the difficulty by using tubular launchers extending to the trailing edge of the wing, which enclosed the blast and ejected it rearwards, clear of the structure.

The tubes, of which three were usually carried beneath each wing, were constructed of a special light-weight plastic, developed by technicians of the General Electric Company. They were 10ft. in length, having a bore of 4½in., with a wall thickness of ⅛in. Each unit of three weighed 450lb.

Weighing 40lb. apiece, the rockets employed with this launching system had an overall length of 3ft., and were a sliding fit in the launching tubes. They were spin stabilised by the reaction of the airstream on six small offset fins attached at the rear, which were collapsed when the rockets were inside the launcher. This calibre rocket shell, known as the M8, was credited with an effective range of 4,000 yards.

More recently American aircraft have begun to appear which embody "zero length" launchers, similar to those fitted to recent Hawker Tempests.

The principal advantage of the rocket projectile over the conventional light bomb for terrain and marine attack is the greatly increased *impact velocity*. Whereas a normal bomb will strike the objective at approximately the same speed as the attacking aircraft, the rocket-accelerated "bomb," because of its inherent power, will arrive at the target at a considerably improved velocity, and thereby obtain a greater penetration.

Another point of significance is the reduced liability to error in sighting. The combined action of gravity and forward motion result in the normal type bomb falling with a curved trajectory, while the rocket-driven projectile is able to maintain a highly accurate flight path, coinciding very nearly with the line of sight. The pilot dives his aircraft directly at the target with the aid of a normal type gunsight, looses his missiles, pulls up and over the objective and is quickly out of range of local defence. Meanwhile the rockets have struck, and, if aimed true, have dealt destruction out of all proportion to the explosive weight. The war-head of the British projectile, for instance, was only 60lb.

The effectiveness of the R.P. has been demonstrated over a wide range of uses during the war, but its possibilities have by no means been exhausted. The complete absence of recoil means that the sole limiting factor to projectile size is the aircraft carrying load, and, in consequence, it is not unreasonable to assume that, if need be, rocket-projectiles bearing explosive charges rated in several hundreds, perhaps thousands, of pounds could be developed.

(*To be continued*)

DEVELOPMENT OF THE GAS TURBINE

(*Continued from page* 271.)

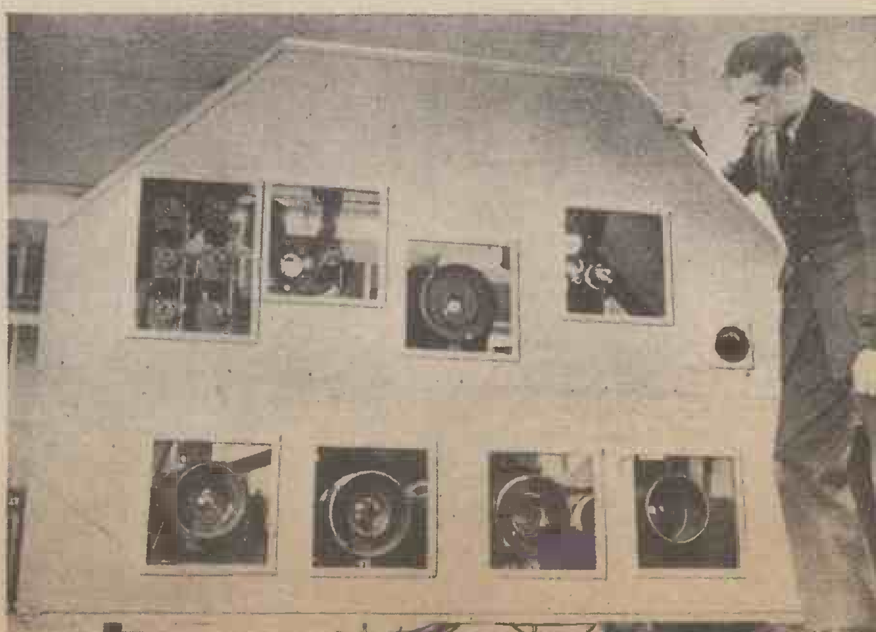
this type. As far back as May, 1944, the "Derwent" engine, subsequently known as the "Trent," was equipped with a spur reduction gear and tested for shaft horsepower. In March, 1945, it was hangar tested complete with airscrew, and in September, 1945, it was undergoing flight trials installed in the Gloster "Meteor."

The "Trent" was thus the first gas turbine engine with airscrew to be manufactured in the world, and the first to fly in any aeroplane. It may even at the present time be the only gas turbine-airscrew engine to have flown.

The Rolls-Royce "Trent" engine follows the general design of the "Derwent," with of course, the addition of the reduction gear through which the airscrew is driven. It is purely an experimental engine developed to gain experience with the jet/airscrew combination. The five-blade airscrew of small diameter will be noticed in the accompanying illustration, five blades being necessary to absorb the power. A smaller number of larger diameter blades could not be fitted on account of the low undercarriage of the Gloster "Meteor."

Cameras for Recording Atomic Bomb Blast

The accompanying illustration shows one of the camera units that will be used to photograph the blasts when atomic bombs are dropped on a "guinea-pig" fleet of warships at Bikini Atoll in the Pacific next month. The unit is made up of a number of cameras, all of which will be operated by remote control. The units will be set up on steel 100-foot towers ringing the warships, and controlled from a "magic box" by radio on a warship outside the danger zone. Cameras are left to right : (top), nest of six gun cameras ; 35 mm. motion picture camera ; F-56 8¼ inch Aerial camera ; Mitchell 35 mm. motion picture camera. Bottom (left to right) row of cameras : F-56, 40-1 inch ; F-56, 20-1 inch ; F-56 20-1 inch and F-56 40-1 inch. The small circular opening at right is the "Magic Eye," which will operate all the cameras by the flash of the bomb itself should the radio remote control fail to work. The size of the unit can be gauged by comparison with the U.S. Lieutenant seen in the illustration.



Front view of one of the camera units.