Contributors

No. 1823
Vol. XLIV

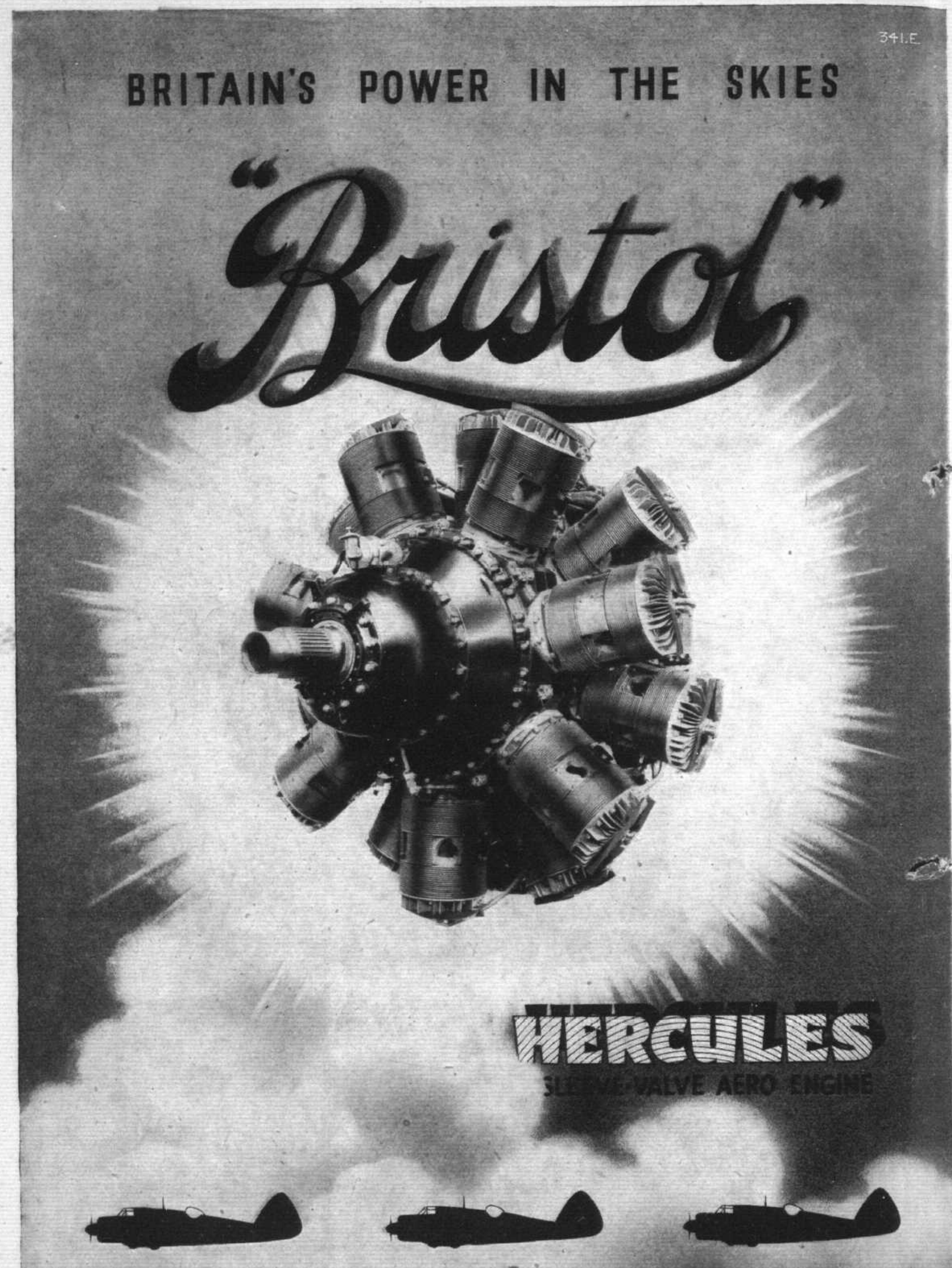
1/-

FLIGHT

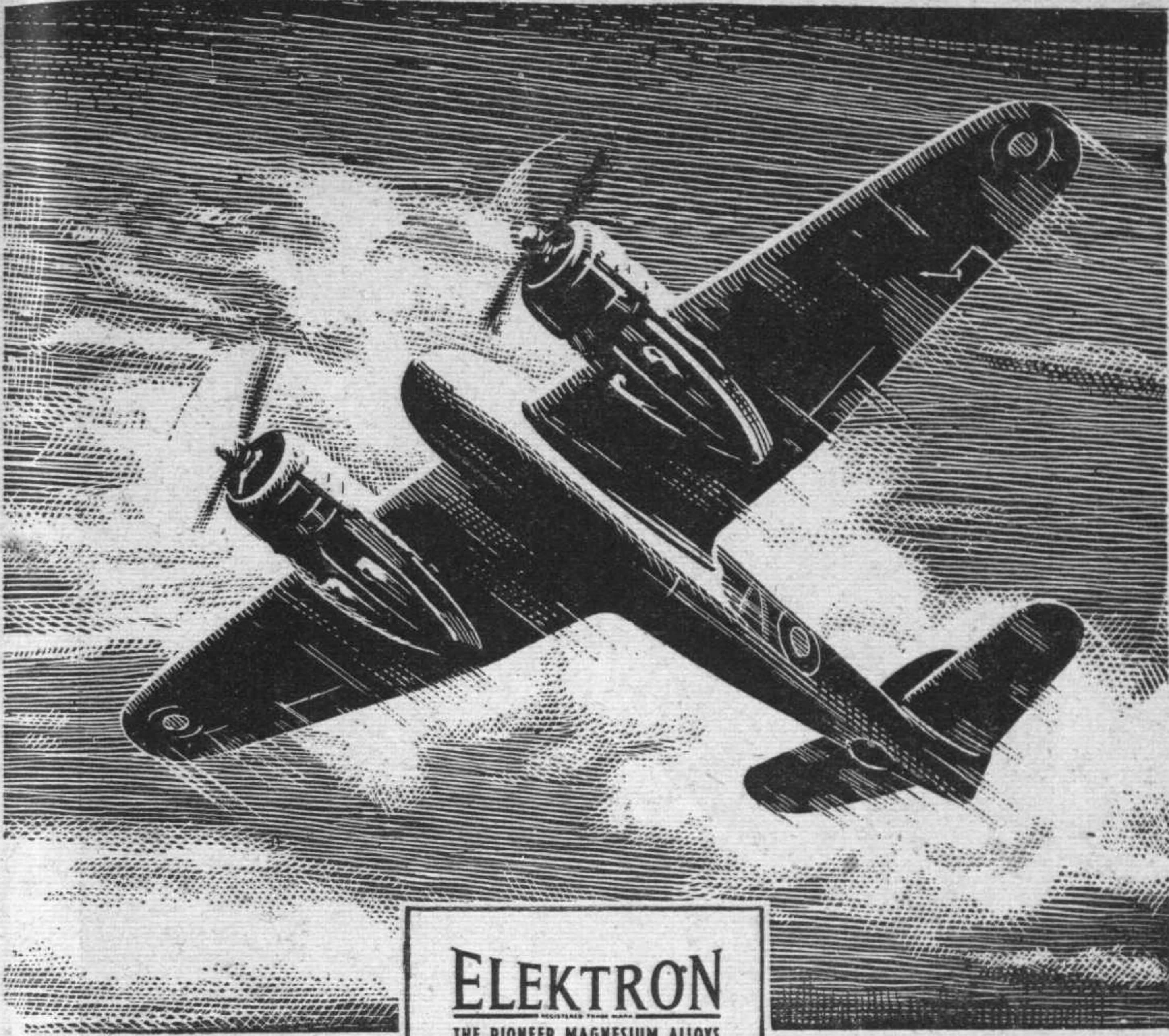
and The AIRCRAFT ENGINEER

OFFICIAL ORGAN OF THE ROYAL AERO CLUB

DECEMBER 2nd, 1943


BRITAIN'S POWER IN THE SKIES
"Bristol"
HERCULES
SLEEVE-VALVE AERO ENGINE
THE BRISTOL AEROPLANE CO., LTD. BRISTOL


Blackburn
AIRCRAFT
'SKUA' DIVE BOMBERS ATTACKING
ENEMY SUPPLY SHIPS, NORWAY, 1940



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FLIGHT

and The AIRCRAFT ENGINEER

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The Outlook

Lifting the Curtain

ALTHOUGH the end of the war is not yet in sight, and although there must be no let-up of our war effort, it is a healthy sign of the times that in many quarters the question of post-war aviation is being pondered and discussed.

Mr. Roy Chadwick, Avro's chief designer, told members of the Design and Industries Association in Manchester last week his views on post-war flying. Of orthodox aircraft he said he thought that up to a loaded weight of 100 tons the landplane would win, but that above this weight the flying boat would score. It is interesting to have this statement from a designer who has produced landplanes almost exclusively (except for a few types fitted with floats).

Improvements likely to be included in post-war aircraft were pressurised cabins for long-range trans-oceanic flights, and thermal anti-icing equipment on nearly all types. In this week's issue we describe and illustrate the American thermal anti-icing equipment produced as a result of collaboration between the American National Advisory Committee for Aeronautics and the Consolidated Vultee Corporation. This, of course, goes a good deal further than the exhaust-heated leading-edges of certain German military types.

We have for many years held the view that pressure cabins will have to be used on nearly all classes of commercial passenger aircraft. It will not suffice to confine this "luxury" to long-distance transoceanic types. It is not necessary to go to very great heights in order to experience the discomfort that can be caused by rapid changes of height. We believe that passengers will *demand* pressure cabins, and that of two competing airlines with similar equipment except for the pressure cabin, that which has the pressure cabins will scoop all the traffic. It is no use saying that the weight cannot be afforded. It will have to be afforded.

On the subject of ranges and speeds, few will disagree with Mr. Chadwick. With present-day aircraft, and any orthodox types likely to follow, stages of about 1,000 miles are not only economic from the operator's point of view but they give passengers a chance to get out and stretch their legs. This type of aircraft is not likely to cruise economically at more than 200 m.p.h. The faster-cruising types will be crack liners and mailplanes.

Flying Wings

ALTHOUGH he expressed the belief that there will be a great deal of experimental development work done on jet propulsion and flying wing or all-wing aircraft, we think Mr. Chadwick was unduly pessimistic in thinking that it will be ten years before such types come into use. Sir Frederick Handley Page rather took Mr. Chadwick to task for this view. He was speaking as Master of the Worshipful Company of Coach Makers and Coach Harness Makers of London, in London, the next day, and pleaded for a realisation of the futility of thinking we could build a better world with wartime equipment. We had to realise that new and better machines, whatever their class and type, would be needed to enable us to face the competition. Of Mr. Chadwick he said that it might be true that we should go on building existing types for ten years, but he very much doubted that anyone would buy them!

The flying wing may or may not be the ultimate solution—ultimate in the sense only that so long as we depend upon indirect lift we shall need wings. Mr. Chadwick knows what he is talking about when he says that the problems are many and have not yet been fully studied. Even if they are solved, it does not appear entirely certain that the all-wing type will necessarily be very much more efficient than one with a fuselage or with tail booms. The all-wing ideal is closely linked with size, and if the size increases to such an extent that passengers can be mainly or entirely housed inside the wing, it seems to us to matter little that there are a pair of relatively slender booms carrying a tail. That may well be a better solution than the tailless, with its many peculiarities.

Jet Propulsion

HAVING said that cruising speeds in excess of 200 m.p.h. would only be employed by the crack air liners, Mr. Chadwick made the very sensible remark that the really high speeds would only come with the introduction of the jet-propelled high-altitude type of aircraft. In his classic Wilbur Wright lecture Dr. Edward P. Warner showed that the net advantage to be derived from flying high might easily be overrated. He was referring to the orthodox type of aircraft with supercharged reciprocating engine and variable-pitch airscrews.

The picture is very different when we come to jet propulsion. Not until very great speeds are attained does the direct reaction form of propulsion become really efficient. Although compressors will have to deal with the rarefied air at great heights, much as does the blower of the present reciprocating engine, the jet efficiency itself increases with speed. In this connection readers will find much of interest in the article published in this issue which deals with research on rocket propulsion. The work extended over a period of years before the war and the experimenters were amateurs who received no official encouragement. All the more credit to them for carrying on. It is true that they dealt with powder fuel only, but the efficiency of problems of jets and ejectors or thrust augmenters are much the same whether the fuel is powder or liquid. An additional field for research and experiment is in connection with the compressors needed for jets using liquid fuels, but the efficiency of the jets themselves plays a big part in the final results, and if the jet-propelled aircraft is to become a practical vehicle for high-altitude, long-range flights, the field in which, for peaceful purposes, it is most likely to show to advantage, the fuel consumption problem will have to be tackled and solved. Otherwise the potential advantages of jet propulsion will be negatived by inferior pay load.

Even granting that the compressor problem is likely to be solved, it must not be overlooked that altitude with its rarefied air is not an unmixed blessing. Up to a point the "thin" air enables the aircraft to travel faster for a given thrust, but it is somewhat unfortunate that the speed of sound in air is related to air density, so that it is reached at lower speeds the higher one flies. That may mean shock waves set up locally at relatively moderate speeds.

Mr. Chadwick may possibly be a little too pessimistic about the time which this research will take, but nobody is likely to challenge his statement that "A great deal of experimental work will be done with the jet and combination of jet and airscrew propulsion during this next ten years."

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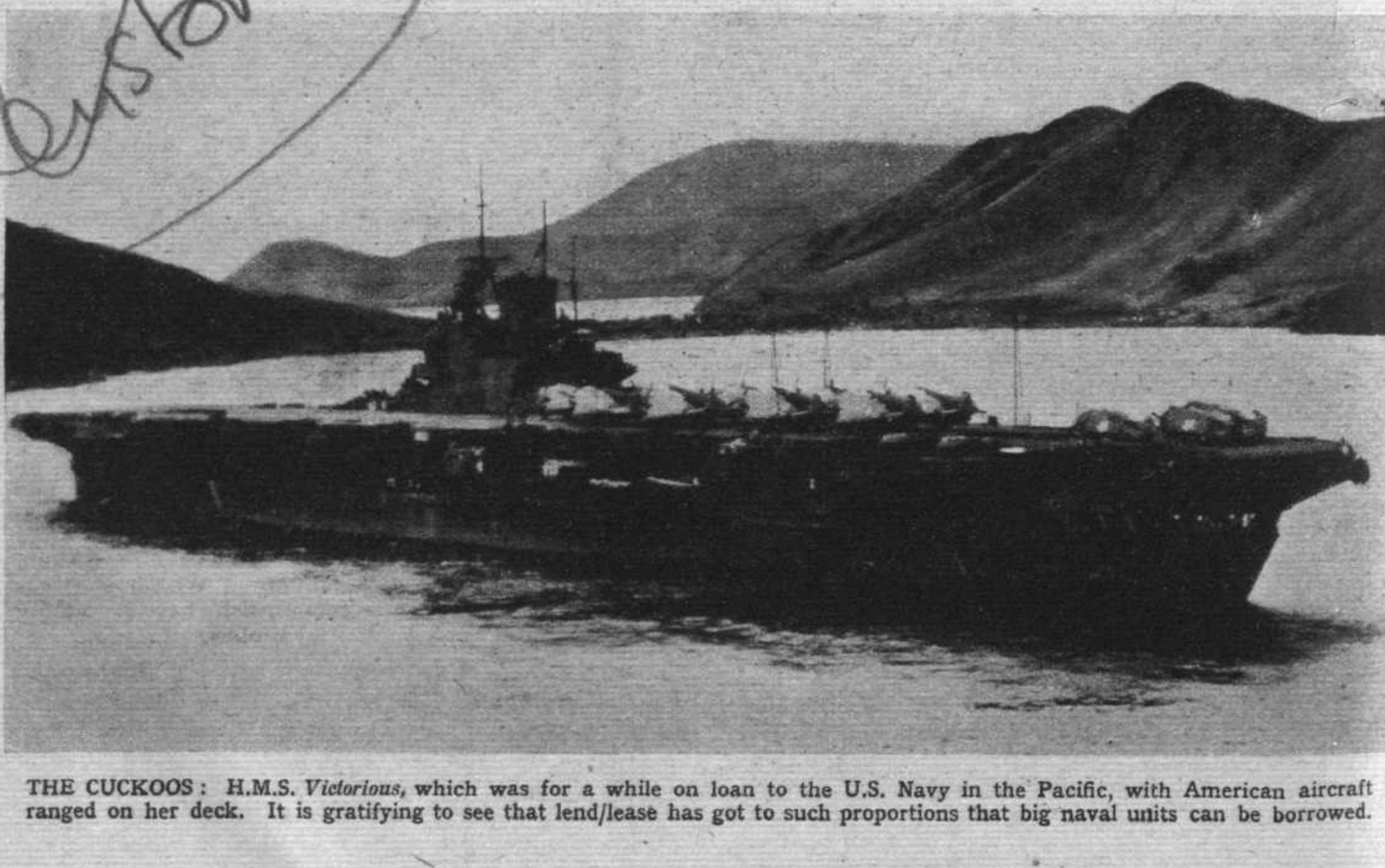

THE CUCKOOS: H.M.S. *Victorious*, which was for a while on loan to the U.S. Navy in the Pacific, with American aircraft ranged on her deck. It is gratifying to see that lend/lease has got to such proportions that big naval units can be borrowed.

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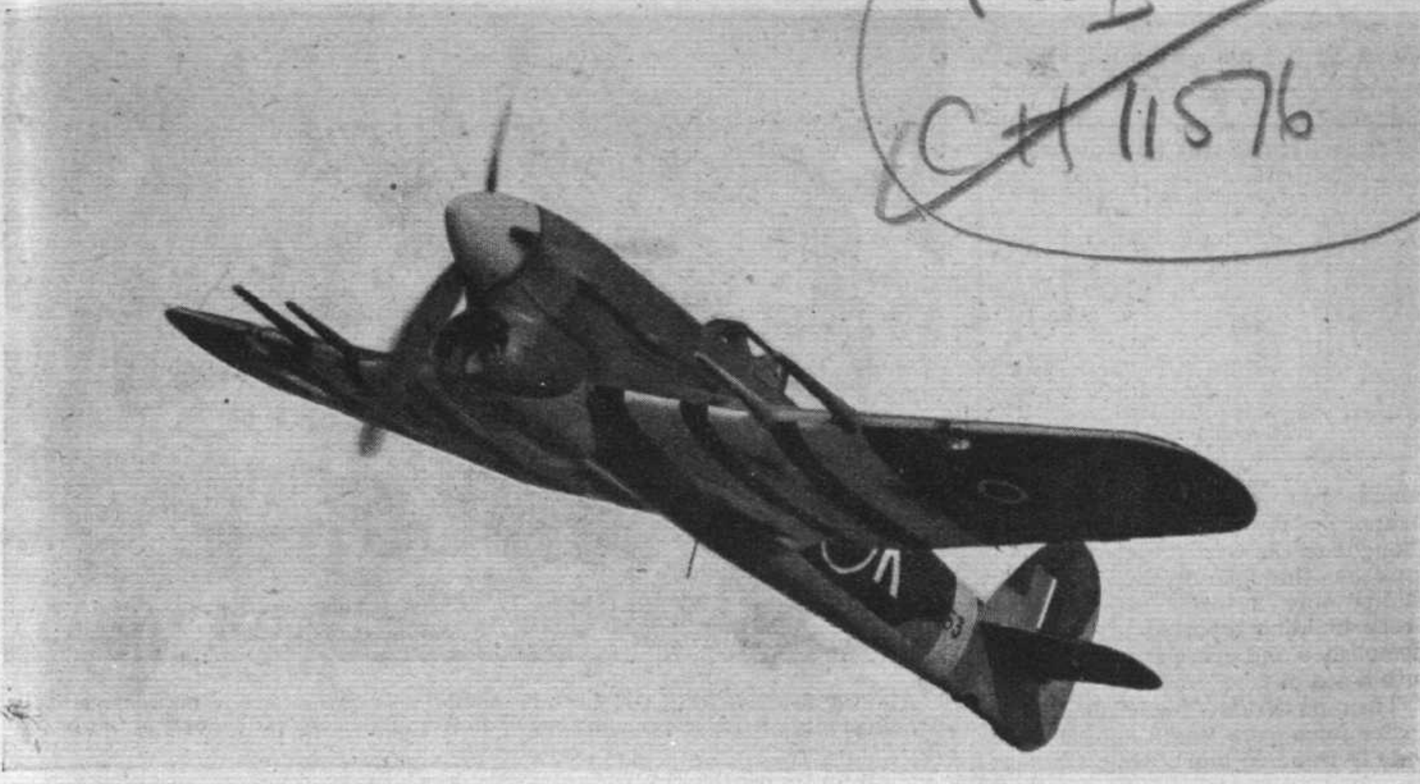


Interceptor fighter, ground strafer and fighter bomber. The Napier Sabre-engined Hawker Typhoon.

WAR in the AIR

R.A.F. Attacks Paralyse Berlin : "A Great Sea of Fire and Smoke" : U.S. Fighter-Bombers in Daylight Offensives over France

Keystone

THE series of heavy and concentrated raids on Berlin have easily topped all other news subjects recently, and according to at least one report from Stockholm, the heart of the enemy capital is paralysed.

The two smashing attacks launched by the R.A.F. on the nights of November 22nd and 23rd brought the total of bombs dropped on the Nazi stronghold during the present year to close on 12,000 tons, and by the time this issue of *Flight* reaches the hands of its readers that staggering figure may well have been exceeded, for Sir Arthur Harris has said that the onslaught will continue "until the heart of Nazi Germany ceases to beat."

Scenes of desolation have been described by refugees arriving in Sweden from Berlin which must have made even the bitterest enemies of Germany shudder, despite their grim satisfaction at the knowledge that the nation which sought to enslave the rest of the world by aggressive brutality was now having some of its own medicine rammed down its throat in enormous doses. For not only has the centre of the city been blasted into what has been described as a "great sea of fire and smoke," but some of its suburbs have suffered almost as severely. The defences were "saturated," communications almost completely severed for several days, and most of its social services brought to a standstill.

MODERN NORSEMEN: Norwegian paratroops making concerted training drops in Britain.

All this could not be done, of course, without inflicting very great loss of life which even Goelitzer, Berlin's vice-gaulieter, admitted to be approaching 8,000 to 10,000 killed, and which has been estimated by non-German sources at more than twice as many. Those who have suffered at German hands will, quite understandably, shed no tears over this; others must at least regard it as a regrettable necessity in the ultimate interests of humanity in general.

One significant factor which should not be overlooked is that the R.A.F. bombers, mostly Lancaster, in the Tuesday night attack, found their target accurately lit by the flares of the Pathfinders in spite of bad visibility. The *New York Herald Tribune*, commenting upon this, was quoted by Reuters as saying: "What this means is that the British have not only beaten the fog problem, they have perfected some system which enables their pathfinder planes to drop the guiding flares accurately over the objective under weather conditions that give the maximum aid to the attackers.

"It has actually been the R.A.F.

WAR IN THE AIR

ENEMY AIR LOSSES TO NOV. 27th

	Over G.B.	Con-tinent	Middle East	N.W. Africa
Nov. 21	0	0	0	1
„ 22	0	2	0	0
„ 23	0	2	0	0
„ 24	0	0	0	5
„ 25	0	3	0	0
„ 26	0	6	0	12
„ 27	0	0	0	8
	0	13	0	26

Totals: West, 7,738; Middle East, over 5,751; North-West Africa, 3,670.

which has produced the 'secret weapon.' It must be an awesome thought to the Germans that so many millions throughout the world are taking only a bitter satisfaction in every building reported to have been demolished and every street converted into a sea of fire."

Then on Friday night an all-Lancaster force gave Berlin another 1,000 tons in some 20 min., while Halifaxes plastered Stüttgart's railway centre.

Germany, however, now threatens more loudly than ever of a "secret weapon" which, when the right time comes, will be used to obliterate Britain from the map of Europe. But without in any way wishing to gloat over the present situation, one may be forgiven for wondering if even the Berliners do not think (very secretly, of course) that the time has probably come and gone, and wonder uneasily if their leaders' promises of terrible reprisal will prove any less empty than Goering's promise that no enemy bomb should ever fall on the Reich.

AT CONSIGNEES RISK: A 4,000 lb. bomb looks comparatively harmless as it is hoisted into the capacious bomb bay of an Avro Lancaster for delivery in Germany.

U.S. Fighter-bombers

IN the meantime the unceasing attacks on enemy shipping and power stations, airfields and land communications in occupied territory are kept up by our Typhoons, Mosquitoes, Bostons, Mitchells and other light aircraft, last week being notable for the addition of an American fighter-bomber to their ranks. At the time of writing it has not been stated what type of aircraft it is which our American Allies have now put into action as a fighter-bomber in the daylight offensives across the Channel, but the indications suggest that it may be the Lightning.

BRITISH & U.S. AIR LOSSES TO NOV. 27th

	Over G.B. A'crft.	Continent B'brs.	Continent F'trs.	Middle East A'crft.	N.W. Africa A'crft.
Nov. 21	0	0	0	0	1
22	0	26	0	0	1
23	0	6	0	0	0
24	0	21	1	0	4
25	0	0	7	0	1
26	0	74	11	0	6
27	0	0	0	0	5
	0	127	19	0	18

Totals: West, 8,540; Middle East, 2,335; North-West Africa, 1,368.

At any rate, they made their bow by attacking airfields in the Calais-St. Omer area with Thunderbolt escorts, and the party disposed of a few enemy aircraft (destroyed, probably destroyed and damaged) at the cost of two Thunderbolts. Whirlwinds, escorted by Spitfires, also went for targets in Holland and Northern France.

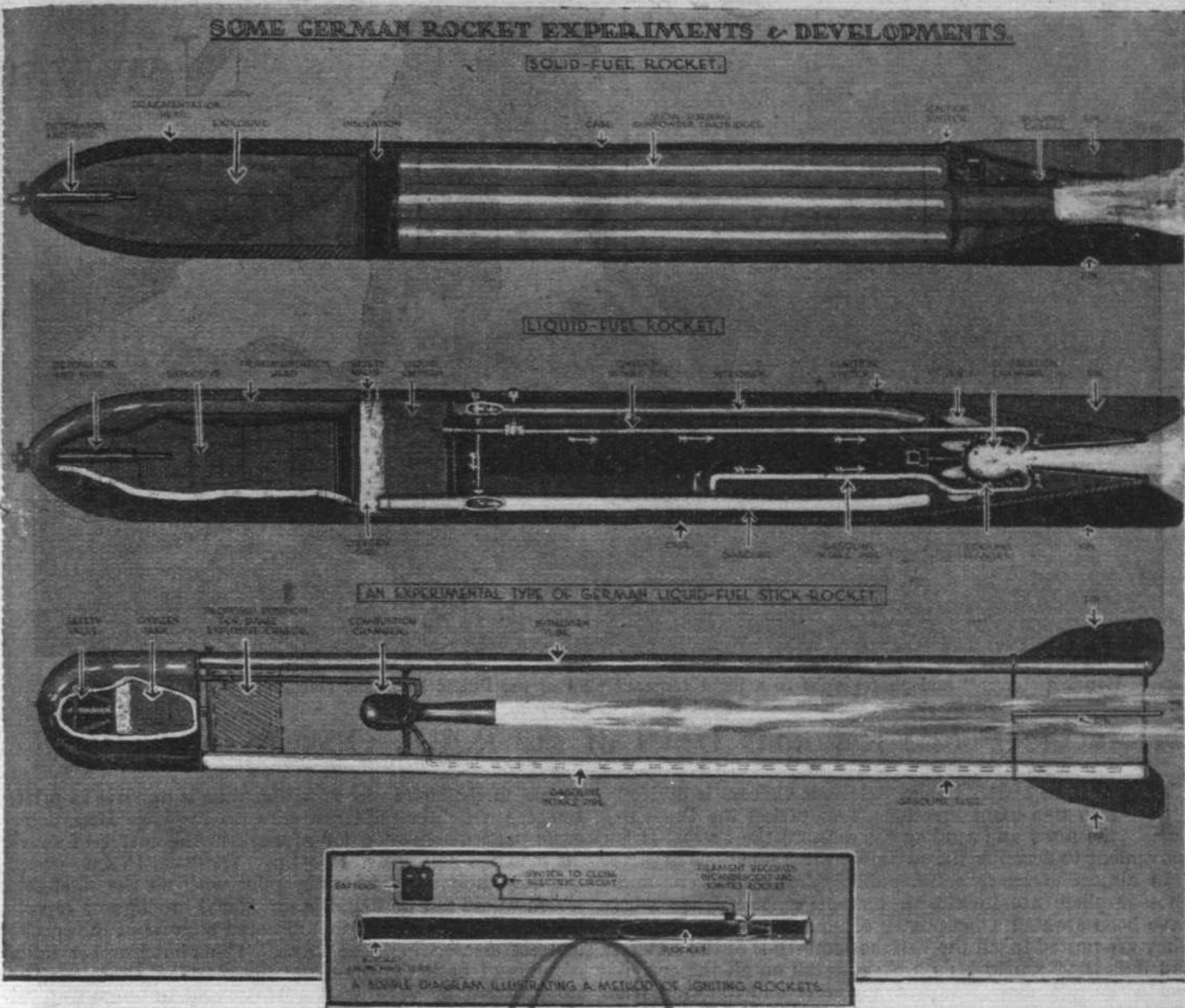
Last week, also, Flying Fortresses and Liberators of the Mediterranean Command attacked Toulon and Sofia, respectively. The raid on the French Mediterranean port was directed against docks, submarine pens and repair works and, according to Vichy radio, some 30 buildings were destroyed. At Sofia the Liberators went for railway yards, and, shortly after these two attacks, R.A.F. Wellingtons hammered communication targets at Turin, the three attacks all taking place within the space of 24hr.

In the Pacific, heavy losses were inflicted on the Japs by the Carrier Task force which covered the Gilbert landings. At the expense of three fighters and one torpedo-bomber, the U.S. Navy fliers destroyed 34 enemy fighters, nine bombers and three four-engined flying boats—a total of 46 aircraft.

And to crown the week, the Russians recaptured Gomel.

PACIFIC PLUNDER: Japanese aircraft found on the airfield at Munda after its capture.

Rockets as Secret Weapons



IF the war is prolonged for any length of time it is now more than probable that its character may entirely change by reason of new weapons now in process of development on both sides. On several occasions the Germans have issued threats of a new secret weapon which is said to take the form of a rocket projectile capable of being propelled for long distances, "and to countries almost on Hitler's doorstep." Germany made prolonged experiments with rocket-assisted cars in pre-war days, Fritz Opel being prominent, and also with aircraft at a special rocket flying field in a Berlin suburb.

In recent months the Germans have employed small rockets on fighters to attack formations of Fortresses on their daylight raids, and it is said that they can outdistance the 0.5 in guns. One rocket is carried under each wing and the dimensions are roughly six inches diameter and some thirty inches long. Long-range fighters accompanying the bombers are ably countering the new menace.

In the current issue of the *Illustrated London News,* drawings by G. H. Davis, which are reproduced herewith, show some German rocket experiments. From the sections it will be seen that solid fuel and liquid fuel rockets have been developed. One experimental type is a liquid fuel stick rocket. The more generally used type is the solid fuel rocket using slow-burning powder as the propulsive force, but experiments proceed with the liquid fuel type, which offers greater possibilities.

An Me 10 firing rocket shells to break up a Fortress formation.

Spreading Air News

Handing "copy" and photographs to a flight sergeant pilot of the Public Relations courier flight of Hurricanes.

How the Public Relations Units of the R.A.F. Operate in the Field

THE work of the Public Relations Officers is divided into two main functions, i.e., taking the Press to the news and sending the news to the Press. It is convenient to describe the second of these functions first.

In almost every case the public relations officers and photographers are men with newspaper experience who have been granted a temporary commission in the R.A.F. They are posted to all the various commands of the service and it is their job to keep a close watch on all the activities of the command in which they serve and to send back stories and photographs of incidents suitable for publication. A glance at the diagrammatic layout on page 608 of the P.R.O. units in the Mediterranean Air Command will give an idea of a typical arrangement.

Let us follow a hypothetical incident from the time it occurs on the Italian front to the time it appears in print. Imagine a fighter pilot returning to his base after doing some particularly good job of work in the course of which his machine had lost a wing-tip. The local P.R.O. would get the whole story from the pilot with all the sidelights which would not be found in an official intelligence report. His home town and school are noted because of the special interest created in those areas. The photographer takes pictures of both the pilot and his disabled aircraft. The story is sent by W/T to A.F.H.G., and the photographic plates flown back by long-range Hurricane if there is no other air transport available.

Here the air authorities consider whether it is suitable for publication; if so, it is passed on for the attention of base censor. If the story is for local publication in one of the service news sheets it will be handed over direct, but if it is selected for universal distribution the story and pictures go by radio or air to the Air Ministry in London. Here they are reconsidered and issued to the Ministry of Information, who, in turn, issue the story to the newspapers as printed sheets and distribute the photographs via the ordinary Fleet Street photographic agencies.

Essential Speed

This seems to be a cumbersome arrangement by which a lot of time must be lost. Actually this is not so. If a story is of sufficient importance it can be in the daily papers in this country in a matter of hours after its occurrence thousands of miles away.

Obviously public relations officers spend most of their time travelling from one unit to another, but they have their own local head-

Public Relations Officers at work in a classroom of a requisitioned Italian school at Porte Cognano, near Salerno.

all MoI
CNA 1852
1853
1856
1854

(Top, left) An official photographer typing his titles outside a farmhouse mess in Sicily. (Top, right) Operators of a P.R.O.U. on the steps of their transmitter trailer. (Bottom, left) A wrecked Fw 190 makes a useful desk. (Bottom, right) Overhauling a commandeered Fiat car for use with the Unit.

quarters, which have to be freshly established at every move forward by the forces. Since the battle of El Alamein, just a year ago, they have moved forward some 2,500 miles. In the desert they were under canvas, but now they are in civilisation it is usual for them to find a small empty villa on the outskirts of a town where they can work in reasonable comfort.

Taking the Press to War

Turning now to the P.R.O.'s other main task (the accompanying of Press representatives or war correspondents when they visit R.A.F. units in the field), this is a vast organisation covering all the commands at home and abroad. To recount a single visit to a bomber squadron in Britain would show how the whole system works but, because of its unusualness, it will be more interesting to describe the recent trip by fourteen air correspondents to the Mediterranean Theatre of Air Operations.

Before a single mile of their 7,500-mile trip could be covered, the Public Relations Department of the Air Ministry had to make sure that everyone had a war correspondent's licence; a passport valid for Portugal and French North Africa; a military permit to enter the war zone, and a permit to take sufficient cash out of the country. While this was being arranged—it only took a matter of a few days—signals were sent to Wing Cdr. George Houghton, who commands the P.R.O. units in the Mediterranean area, to start up his end of the organisation. Tickets for the first part of the journey had to be obtained from B.O.A.C. and because the aircraft landed in Lisbon on neutral territory the whole party had to travel in civilian clothes. At Rabat Sale, in North West Africa, B.O.A.C. said good-bye to the party and Wing Cdr. F. Gillman, the accompanying P.R.O., got in touch with Air Transport Command to find an aircraft to take them on to Algiers.

At Allied Headquarters

On arrival at Algiers, the Allied Forces Headquarters, the party were met by Wing Cdr. Houghton and whisked off to the P.R.O. villa, where they were met by Air Vice-Marshal Wigglesworth, Deputy Air Commander-in Chief, and Air Vice-Marshal H. P. Lloyd, Air

SPREADING THE AIR NEWS

ALLIED FORCES HEADQUARTERS
BASE CENSOR
CABLE HEAD
DAILY CONFERENCE TO 50-60 WAR CORRESPONDENTS
AIR COMMUNIQUÉ ISSUED
PHOTOGRAPHIC DARKROOMS
PHOTOGRAPHS RADIOED

AIR COMMAND POST
AIR C.-IN-C's. H.Q.
CHIEF PUBLIC RELATIONS OFFICER
AIR COMMUNIQUÉ PREPARED
W/T TO ALLIED FORCES H.Q.

COASTAL AIR FORCE H.Q.
P.R.Os. AND A PHOTOGRAPHER
TELEPHONE

TACTICAL AIR FORCE H.Q.
P.R.Os. AND A PHOTOGRAPHER
W/T TO A.F.H.Q.
PRESS HURRICANE FOR PHOTOGRAPHS

STRATEGIC AIR FORCE H.Q.
P.R.O.
TELEPHONE

12th AIR SUPPORT COMMAND
P.R.Os. AND 2 PHOTOGRAPHERS
BROADCASTING UNIT
W/T TO A.F.H.Q.

P.R.O. ASSAULT POST
P.R.Os. AND A PHOTOGRAPHER
COMMUNICATION BY D.R.

DESERT AIR FORCE
P.R.Os. AND A PHOTOGRAPHER
W/T TO A.F.H.Q.

Officer Commanding Coastal Air Force.

After spending the night in accommodation provided for them at British Officers' Transit Camps—another name for hotels in wartime—the party moved off the next morning in an aircraft allotted to them for the tour. On board the machine there was a camp bed and blankets for everyone, and rations for twenty days.

The organisation was so good that after a series of conferences, at the rate of nearly two a day, the correspondents had to beg for a day off to set their brains and notebooks in order. All the arrangements were excellent and reflected great credit on the public relations departments both at home and abroad. It is no small task to take 14 correspondents for a 7,500-mile trip, arrange 14 conferences with senior officers (including General Eisenhower and Air Chief Marshal Tedder), and also fit in visits to typical squadrons of the Strategic, Tactical and Coastal Air Forces in North Africa, Sicily and Italy.

Routine at Base

On return to A.F.H.Q. with bulging notebooks, the correspondents were able, during a few days' wait for an aircraft, to see the daily routine of war correspondents at headquarters. The official communiqués are issued in the morning and at about 11 a.m., in the news room, the naval, military and air spokesmen add some colour to the bare official statement.

This news room is interesting to watch. The floor is covered by a number of small tables, each with a typewriter on it. Some of the spokesmen speak fast and there is silence while the correspondents take shorthand notes. Others speak a deliberate sentence at a time, leaving sufficient time for the correspondents to type it out. The sudden clatter as fifty typewriters stammer out a few words, to lapse into absolute silence while the next sentence is delivered, is amusing to the onlooker. Later on in the day, when the story is written, it is put on the wire to their journals after having passed through censorship. This is on the opposite side of the corridor to the news room. These accredited correspondents, in the same manner as the 14 visitors, are entitled to make application to visit any special commander or squadron in order to keep their background knowledge up to date. If a request is granted it is a public relations officer's duty to make the necessary arrangements and accompany him on his journey.

We have come to expect efficiency from every branch of the R.A.F., and certainly the Public Relations Department is not letting the side down. It is, in fact, the envy of the other services.

J. Y.

A P.R.O.U. radio operator establishes his gear on a flat Italian roof with a tarpaulin for cover.

BRITAIN'S AIRCRAFT PRODUCTION AIM

SIR STAFFORD CRIPPS, Minister of Aircraft Production, thanking members of the N.F.S. a few days ago for their part-time work on aircraft production, said: "We are going to try with your help and with the help of the large body of people now engaged in the aircraft industry to build up an ever-growing bomber force so that we shall be able to swamp completely the defences of Germany.

"The whole effectiveness of our bombing effort really depends upon the numbers we can send over on any given occasion.

"The Germans are concentrating everything on defence today, and the more we can saturate their defences the more we can protect the lives of our pilots and their crews who go over to bomb Germany."

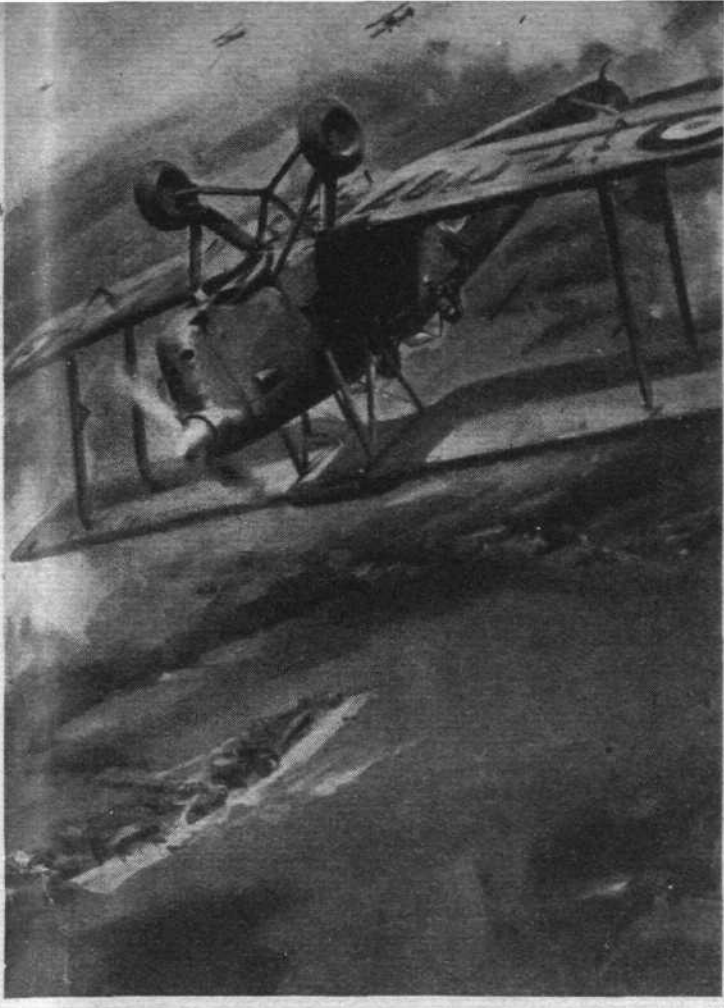
Sir Stafford, who was speaking at an N.F.S. training college, said that his department was still trying to increase the total volume of effective offensive aircraft and did not admit that they had reached the ceiling, but they had no further supplies of labour with which to reach the ceiling.

Britain's man-power situation was becoming very critical.

"There is a great deal more that we should like to do," he said, "but which we cannot do because we have not the labour.

"As we approach final victory the position will become more and more difficult, because we shall have to make a greater effort to clinch that victory in the soonest possible time.

"In this situation every bit of extra labour that we can get is of the most vital importance."



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Area of coloured print 17 ins. x 12 ins. on 25 ins. x 20 ins. plate-sunk sheet. Other subjects will shortly be added.

These prints will be eagerly sought for the decoration of R.A.F. messes ; they make ideal gifts to members of the flying forces and will be much appreciated by all concerned with aviation.

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★ The first series of Frank Wootton prints, of which a few only of some of the subjects are still available, has already been responsible for raising over £2,500 for the Royal Air Force Benevolent Fund.

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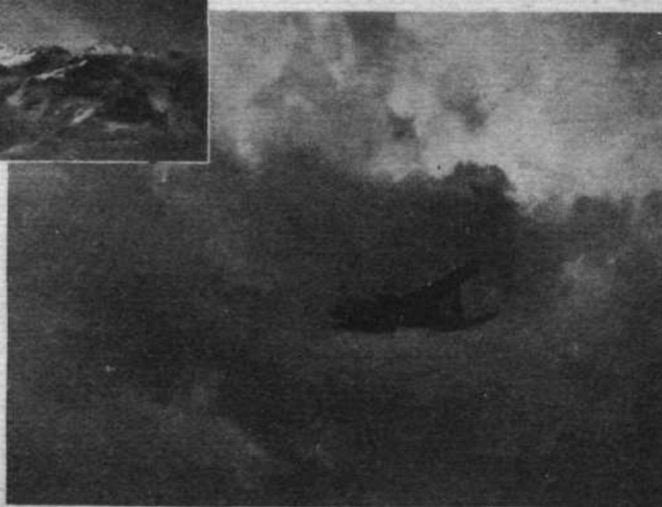

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HERE AND THERE

New Westland Appointment

WESTLAND AIRCRAFT, LTD., announces that Mr. John Fearn has been appointed deputy managing director. Doubtless this appointment has been rendered desirable by the fact that the managing director, Mr. Eric Mensforth, is devoting a good deal of time to his advisory duties at M.A.P. Mr. Fearn has been works director of Westlands for some considerable time.

Brig. Critchley's Air Tour

BRIG.-GEN. A. C. CRITCHLEY, Director-General of British Overseas Airways Corporation, after a six weeks' tour of the corporation's routes to India, Ceylon, North Africa and the Near East, has now returned to this country.

During his tour Brig. Gen Critchley covered more than 30,000 miles by air and inspected establishments in Arabia, Iraq, Persia and Palestine, in addition to those in India, Ceylon and North Africa.

P.R. Changes

AIR COMDRE. LORD STANSGATE'S appointment as Vice-President of the Economic and Administrative Section of the Control Commission for Italy has necessitated the appointment of a new Director of Public Relations at the Air Ministry in London.

Until such appointment has been made, Group Capt. Lord Willoughby de Broke and Mr. C. P. Robertson, the joint Deputy Directors of Public Relations, will undertake the duties.

Back to 1914-18

ITALIAN aircraft operating with the Allies, Cairo radio recently announced, now have the same markings as those used by them when they were fighting the Germans in the last war.

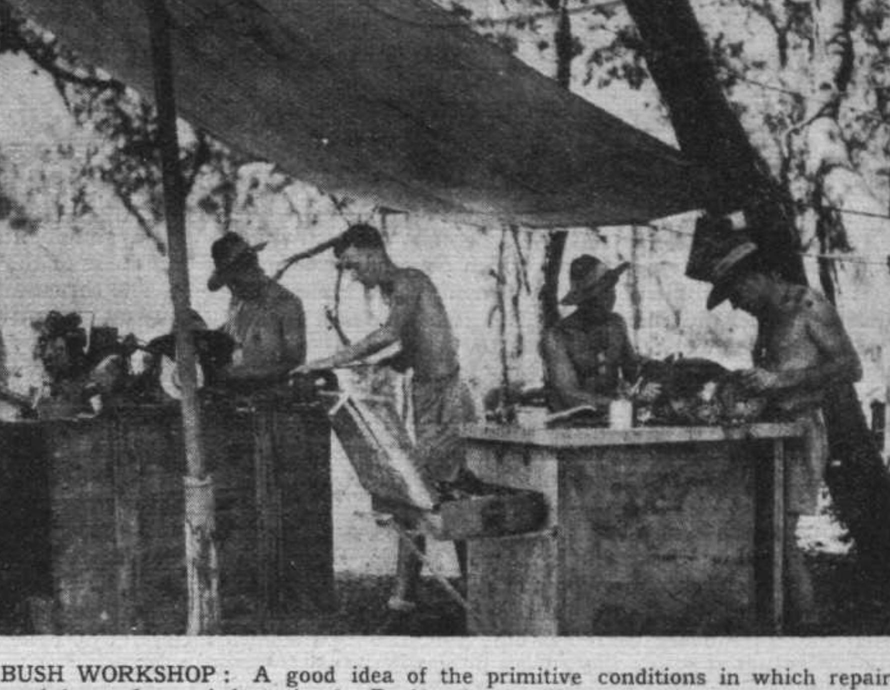
Three rings in the national colours, red, white and green, are painted on fuselage and wings, the green being in the centre, but there are no markings on the fins or rudders.

No Italian aircraft bears either R.A.F. or American markings.

R.Ae.S. Meetings

A WINTER programme of four meetings to be held by the Graduate and Student Section of the R.Ae.S. begins on December 8th, and all of them will be held in the society's library at 4, Hamilton Place, London, W.1, at 7.30 p.m.

Mr. K. G. Wilkinson will speak on "Gliders and Gliding" at the opening meeting, and this will be followed by a discussion, on December 15th, on the training of the automobile engineer, under the chairmanship of Dr. H. Roxbee Cox, an address on January 6th by Commodore G. d'Erlanger on "Technical Problems in the Conversion of Military Aircraft to Civil Use," and the final meeting of the season on January 12th, when Capt. J. Laurence Pritchard will speak on "The History of the R.Ae.S.," the occasion being the society's 78th birthday.



BUSH WORKSHOP: A good idea of the primitive conditions in which repair work has to be carried out in the Pacific theatre of war is given by this picture of a bush workshop belonging to a signals unit of the R.A.A.F. in North West Australia. That their aircraft equipment is efficiently maintained speaks volumes for the improvising skill of the technical ground staffs.

Still They Come—

WHEN the Blue Star Line recently applied before Mr. Justice Bennett in the Chancery Division for confirmation of alterations to its articles giving it power to operate airlines, Mr. J. M. Bower, for the company, said that it had no intention of carrying on air transport as a separate business, but only in conjunction with its existing shipping business.

Mr. Justice Bennett, confirming the alteration, told him that the memorandum must be altered to make that point clear.

Blue Star Line, Ltd., it will be remembered, was one of the five leading shipping lines trading between this country and South America which announced on November 1st that they were forming separate companies to operate air services.

"And stop making that blasted *chewing* noise!"

—And Yet Again!

REFERENCES to the steady spread of shipping interests into the world of aviation are getting almost monotonous, in fact.

Even the companies trading around our coast, determined not to be left out of what looks like being a good thing, are following the example set by their bigger maritime brothers and are preparing the way accordingly.

With capital subscribed by shipping and other transport interests, they are forming a separate company to operate passenger and cargo air services as soon as consents and aircraft can be obtained, and, it is reported, they do not necessarily intend to wait till the war is over.

"H.P."—Coach Maker

AVIATION was well represented at the luncheon which, as Master of the Worshipful Company of Coach Makers and Coach Harness Makers of London, Sir Frederick Handley Page gave last week. The luncheon was held in the Vintners' Hall as the Coach Makers' own hall was damaged in the great air raids.

Speeches were made by Sir William Letts, by the Lord Mayor of London, by Lord Brabazon of Tara and by Sir Frederick Handley Page. The guests also included representatives of the R.A.F., the R.C.A.F., the U.S. Eighth Army Air Force and the U.S. Navy. Representing the two last-named were General Eaker and John Jay Ide, now a Commander in the U.S. Navy.

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Rocket Research

An Account of Experiments Carried Out in Scotland from 1934 to 1939 : Some Startling Results Obtained : Fresh Field for Amateurs

By J. J. SMITH, assisted by J. DENNIS

WHEN, in 1920, a Glasgow schoolboy made a flying model of 4ft. wing span which covered three miles in one minute the achievement went almost unnoticed, and so did the power plant, which was a rocket. Several people working in Glasgow argued about the phenomenal performance, and Mr. John Algar suggested that the four-inch diameter cardboard tube used as a fuselage and for controlling the direction of the propulsive force must have added considerably to the thrust available at low speeds, for 180 miles per hour *is* a low speed for a rocket.

Nothing much was done until the writers and Naomi Roberts joined in the work in 1936. Mr. P. Blair, who had done some work on rockets for military purposes, came along later. These newcomers provided means and tools which had previously been lacking, and also two sets of buildings situated so far away from human habitation that dangerous experiments could be made in Cumberland and Sutherlandshire without danger to anyone not taking part in the work.

This was very necessary, since models had grown from the crude original shown in the photograph to more advanced models which could fly more than five miles. The original, with a float arrangement, could be tested on Loch Lomond. The early models had been carried out of Glasgow by lads on bicycles and used on Loch Lomond with the help of rowing boats and other paraphernalia, the cost of which was pretty well negligible.

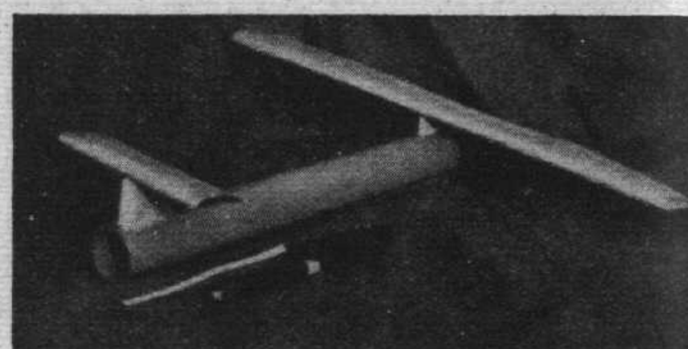
Simple Equipment

Even when we became better organised, our methods had to be conditioned by the means at our disposal. We had a cheap lathe and a deal of other bulky equipment of no great value, but unlike many experimenters we had ample space. It was, for instance, easy for us to lay a concrete track 20 yards in diameter. This track had a massive boss and was used for "captive" trials.

We always questioned the value of this dangerous piece of apparatus, but used it in spite of our dislike because it did have certain great advantages. For instance, the rockets were fired from a tube, much as a shell is fired from a gun, but at much lower velocities, of course; otherwise the acceleration would have wrecked the starter tube (which had to be light so that it could be pulled out of the way of the rocket on its circular path), the cardboard thrust-augmenters, or the three segment-shaped gas retainers of the model shown in experiment 4.

The thrust-augmenters, we found, were most easily tried out on a captive rocket travelling around a circular path. By using a 9.5 mm. cine camera as a crude form of stroboscope with eye or film we were able to measure speed, and the ejectors shed by stages could be retrieved and examined.

When the starter tube was used, the gas retainers were blown off as soon as the rocket left the muzzle. Then the three-stage ejector or thrust-augmenter came into operation and rapidly accelerated the contrivance to about 350 ft./sec. At this speed the air forces had changed so that the third stage was torn off, leaving two stages in use. They dropped off at about 800 and 1,800 ft./sec. respectively, and the rocket would still accelerate before burning



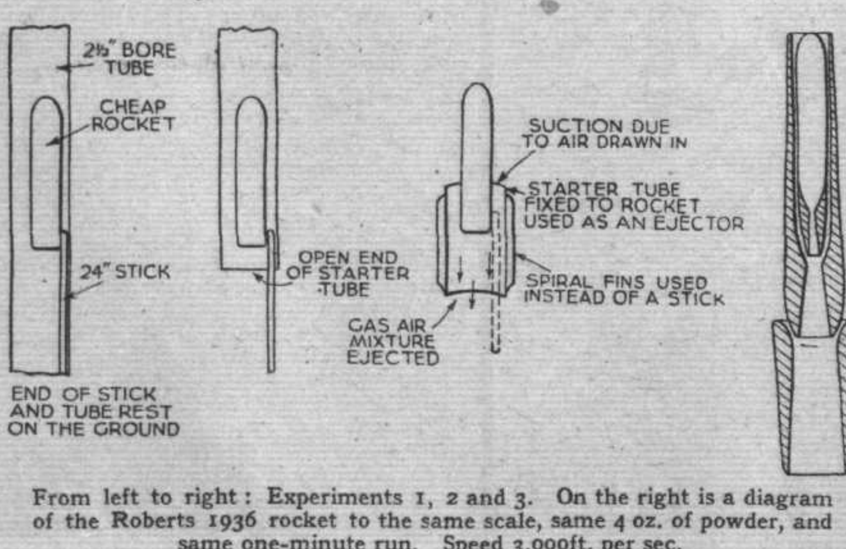
CRUDE BUT EFFECTIVE: Main parts of an early model, one of the first to cover more than two miles in one minute, recovered from Loch Lomond in 1920. It had a steel-cased rocket and flame-baffle tube. The tape measure is just over 16in. long.

out. Speeds of something like 3,000 ft./sec (2,000 m.p.h.) can be attained with these cheap rockets. The materials cost about 2s. for each launch.

And now for the model experiments and some of the results obtained. But first it may be useful to recall briefly the forms of jet propulsion. First there is the rocket, in which an explosive resembling "gun powder" is used. Then there is liquid fuel, such as petrol or paraffin, burnt in compressed air or oxygen. Now that liquid oxygen is regularly manufactured for other purposes, this most concentrated source of all is ideal for those who can obtain it. Its advantages over cylinders of *compressed* gas are obvious.

The rocket type of propulsion is ideal for short durations, say, from 25 seconds to three minutes. For longer duration the liquid fuel comes into its own. For a flight of more than an hour's duration the air compressor begins to show its advantages.

There are a good many things in common in these three aspects of jet propulsion. It has been found that pressures of approximately 300 lb./sq. in. have so many advantages that it is not advisable to use much more nor much less. The jets should be designed in accordance with the calculations usual in de Laval turbine practice. In theory, velocities of 7,000 to 8,000 ft./sec. will be attained by the gas stream. In



From left to right: Experiments 1, 2 and 3. On the right is a diagram of the Roberts 1936 rocket to the same scale, same 4 oz. of powder, and same one-minute run. Speed 3,000ft. per sec.

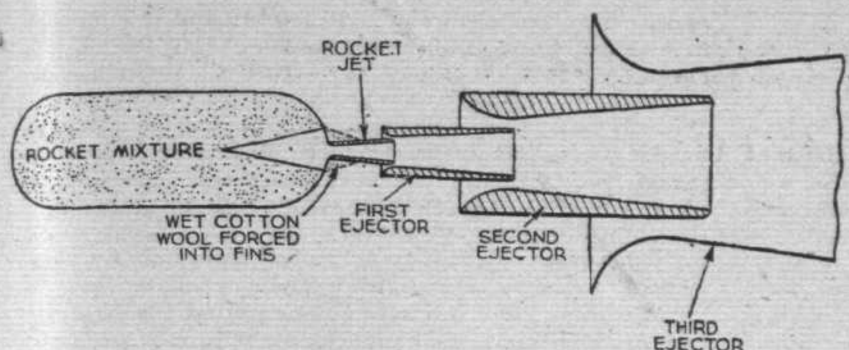


Diagram 4 shows an Aldred rocket. The metal body was strong enough to withstand a pressure of 300 lb./sq. in. in the 4 oz. per sec. size; the rocket body itself is approximately 13in. long.

practice these may not be produced, but the various re-heat effects seem to have the result that the theoretical dimensions work as well as any we have tried. It is difficult to air-cool the jets of gunpowder rockets, so no one should expect more than about one minute's run before the jet burns out. With compressed air or liquid oxygen this cooling is equally necessary; it is, however, very easily achieved since the expanding gas absorbs huge quantities of heat from any point where its effect is applied. When long runs are planned, the multiple-jet scheme employed by Mr. Williams in his internal combustion turbine marine engine will probably have to be used. Although this is likely to be out of reach of amateurs, it is worth mentioning that the writers used nine jets, set like the cartridges in a revolver, in experiment No. 43. Runs of more than 30 minutes were obtained with complete success.

The Faster the Better

Rocket propulsion has a number of advantages and one serious fault. The fault is that at speeds of less than 2,000 ft./sec. most of the power is wasted, and reaction alone is only efficient when the aircraft is moving at between 1,500 and 3,500 ft./sec. (say, 1,000 to 2,200 m.p.h.). The rocket has been well developed up to a certain point and then left alone. Thus all the essential basic details can be looked up in a reference library. For many years work on rocket research was stopped until, some years before the present war, it was resumed by Herr von Opel in Germany, by Mr. P. Blair in Spain, and Mr. G. Aldred in Scotland.

For the amateur experimenter rocket research has the advantage that the apparatus is simple to make. Schoolboys of 16 have made really good rockets, and the best possible will not cost many shillings unless huge sizes are involved. As a means of propulsion the "gun powder" variety is unique in that it will work in the stratosphere where there is no air for the combustion of liquid fuel, but this aspect is not likely to interest the amateur experimenter. What does interest him in connection with aircraft is that a model reaction-propulsion unit is very nearly as efficient as the full-size machine, so that experiments on a small scale are especially valuable. It is actually possible to make power units of lower weight per horse-power than their full-size counterparts, due to the fact that the shorter run and consequently smaller fuel store reduce the main weight so greatly.

It is, for example, quite within the range of a skilled amateur's ability to make a power unit weighing under 2 lb. which will develop 50 h.p. for one minute. Only explosives will give such tremendous power in such tiny and light devices. Readers will doubtless recall the starter cartridge used in high-power aircraft engines. On a large scale we have the cordite charge used in aircraft catapults. In the case of the rocket the power appears in the velocity of the gas ejected, and so the ideal speed for a rocket-propelled device is about one-half of the gas velocity, which is about 7,000 ft./sec.

Although this article is not intended to treat the rocket as a means of speeding-up a bomb or projectile, it is obvious that the addition of the sort of jet described will be needed if rockets are to be of any appreciable assistance. The normal type of rocket is useless for this purpose. Without a proper jet a rocket which burns 4 oz. of powder per second will give less than 20 lb. thrust. It will probably weigh more than 12 lb. and will give its power for less than 30 secs. The same rocket with a jet and first ejector, or thrust-augmenter, will weigh more (15 lb.) but will give a thrust of more than one cwt. at any speed up to 1,400 ft./sec., and a thrust of one-half of that up to nearly 4,000 ft.-sec.; it will give really useful acceleration to an object weighing as much as one cwt.

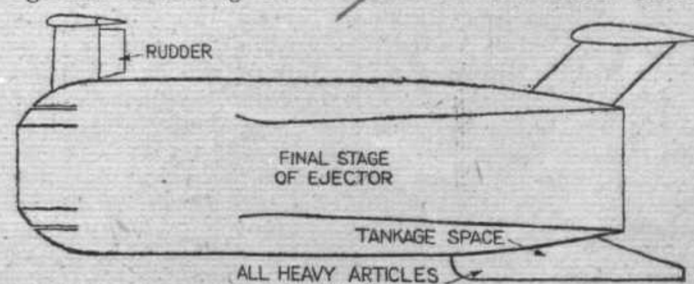
Without jets based on de Laval practice a rocket is a mere toy; a gun is so much better. The principle of the rocket is simplicity itself. There is a closed container with a source of high-pressure gas and a jet. The reaction to the force ejecting the gas through the jet propels the rocket in the opposite direction.

The inner part of a "gun powder" rocket and ejector made by the writer may be regarded as a large example. A specially formed mass of a "composition resembling gun powder" is burnt. The hot, high-pressure gas produced by the combustion of the powder escapes through a jet so shaped that the gas leaves the jet at the maximum velocity; if it succeeds in doing that it gives maximum thrust.

All those who worked with the writer in our experiments used metal jets. It may have been lack of skill which prevented us from making clay or pottery jets which did not need cooling and gave proper thrust. The metal jets need cooling, about one oz. of water for every pound of "gun powder," and a forced draught which carries on the cooling after the water has been turned to steam and the rocket is travelling fast enough to make the draught useful. We found that water soaked up in cotton wool effects the cooling very simply. The heat and draught burn up the cotton wool and remove it.

Jet Accuracy Essential

The jet is the heart of every aircraft and every rocket, and unless it is good enough all the other work will be wasted. The choice of material is wide, and pottery *should* be ideal in spite of our failure to make satisfactory jets from it. We found that pure copper, machined from the solid, made the best jets; cast aluminium was nearly as good. The jets were finned, externally, of course, except in the tiny sizes (40 grains per sec.), which had a thin, spun, Monel-metal jet. These jets must be accurate in size and shape; a lot of trouble taken over them is worth while. A really well-made jet will give four or five times the thrust obtained with the crude type described in the fireworks text books; and then this force can be multiplied many times by properly made ejectors or thrust-augmenters. The size of the throat of the jet needs to be perfect. It is worth while plotting the area change of the throat and to see to it that the coefficient changes steadily and evenly. The exact angle of the divergent portion, and its length, are debatable points; there are so many unknown factors. The writers used a 10-deg. angle. The jet expands one inch in every six inches of length. Our figures and drawings are the result of several years' careful



Rough diagram of tail-first layout. Proportions are: front tailplane and elevator chord 2 units, span 10 units; main plane chord 4 units, span 22 units. Controllable air intake in nose.

ROCKET RESEARCH

work and should be accepted as probably the best for the first few trials, but not as perfect results. Even the tiny rocket model shown in the photograph would not give, in our hands, anything like its proper thrust (nearly one pound) unless fitted with a metal jet of a type similar to that used in the more advanced models.

We used three sizes of jet, 40 grains per second, on a steel-cased rocket 10in. long and 1½in. in diameter, containing just over half a pound of mixture, which burned out in about a minute and a half. This did the early work not too badly, but it was unreliable and not to be recommended. The same can be said of the one we used in most of our early work. This was used on a rocket 3in. inside dia. and 5in. long, which held just over 1 lb. of mixture. It discharged at ¼ oz. per sec. This will do, but the one shown in the drawing is really big enough to be reliable and its cost is not great; however, its power demands large aircraft models.

The effect of ejectors on these rockets, when they work properly, can be tried quite simply. If you can make a smooth accurate hole 1/12in. dia., the 40 grains per sec. jet gives a thrust of about 1 lb. With ejectors fitted, a thrust of 10 lb can be obtained, but you cannot expect more than 6 lb. thrust *every* time.

Shown in the drawing of diag. 4 is the ¼ oz. per second jet. That size gives a force of from 3 to 3⅜ lb., and with the biggest ejector system we used on it it would give a force of 150 lb. at 50 m.p.h. The 50 h.p. in the gas stream at 7,000 ft./sec. is reduced to 20 h.p. by these ejectors, and although this is very bad efficiency compared with what Mr. Williams had already done, unknown to us, its success was pretty striking.

Rocket-assisted Tiger Moth

There are before me now full particulars of the ejector used to help a Tiger Moth into the air. These figures speak for themselves. *One pound of explosive only was used.* The device was 11ft. long, and 22in. in diameter. It scaled just over 33 lb. in weight. It developed a force of 150 lb. up to some 50 m.p.h.; this only fell to 100 lb. at 100 m.p.h. The cost of fuel at present prices would be about 1s. 8d. per launch. The value of a device like this may be as low as the Ministry of Aircraft Production told us in 1939, but some engineers have different views. So did the pilot of the aircraft it assisted.

Although it is known that rockets can attain speeds of over 2,000 m.p.h., and the manufacture of them is well within the ability of the skilled amateur, this article is about fully controlled aircraft, and so speeds above 800 m.p.h. cannot be considered interesting.

The first experiment with rockets is easy to try. The writer used a rocket 1½in. dia. and 6in. long in a 20ft. long rain-water pipe of 2¼in. bore. This was set down tight over the rocket while the slow fuse was burning. The effect was remarkable (see diag. 1). You may find your rocket covering twice the distance, due to its better start. Anyone can do this with the sort of rocket we used to buy in November in memory of Mr. Fawkes. The tendency is to say that in this way the jet of escaping gas pushes against the gas held stationary by the tube, and so the rocket is ejected as if fired from an ill-fitting gun.

If my reader thinks for a minute or two he will begin to wonder, as we did, if this explanation is adequate, and he can try the experiment which our doubts suggested. This is illustrated as experiment 2. The rocket is put in the tube, with its active part in and the end of the tube wide open. He will find that the rocket will fly almost as well as it did with the end of the tube resting on the ground. The remarkable thing is that the tube is jerked upwards while the rocket is inside and *after* the rocket has left the tube.

The simplest ejector consists of a plain tube of steel or cardboard. If the rocket is of 1½in. dia., the tube should be about 2in. or a little more, and 4in. long. The effect of this is greater than the starter tube, and it is difficult to imagine how it works. Our guess was that the escaping flame drew in a lot of air and so created a vacuum above (see diag. 3), and that the rocket pushed against more air. Without any theory, by sheer test and experiment we perfected tubes that increased more than three times the pull given by ordinary rockets at low speeds. The specially made jets of Aldred rockets, in addition to giving three times the thrust by themselves, gave a good gas stream the force of which could be multiplied more than ten times instead of a mere three times in the case of the thrust of crude rockets. We can say it is clear that the stream of escaping gas sets up a high-velocity stream of air which drives the whole system along, but just how is a matter for aerodynamic experts to decide; their training differs from that of the writer, whose work was limited to steam turbine design. The point is that the group of us, G. Aldred, P. Blair, N. Roberts and the writers, proved that the use of ejectors is an easy way to propel model aircraft at high speeds; Mr. Williams proved that ejectors were more efficient than airscrews. His ejectors appear to have been more accurately made than ours. The principle and general design are the same.

Obedient Models

Rocket-propelled self-launching models are interesting because they will obey pre-set instructions laid out on a basis of clockwork or time-fused mechanism. Reasonably skilled amateurs can make and use them without incurrring any expenditure that is unreasonable for people whose weekly wages are under £5. The machines are limited to about 200 m.p.h. if circumstances and facilities are normal.

Radio control, which may be within the range of some amateurs, imposes the same limits and needs larger and better made models to carry the greater weight (two metres wing span or more).

Readers of *Flight* should know more than we do about the models themselves. The tail-first arrangement was chosen for obvious reasons. It lends itself to jet propulsion. Readers can work out for themselves the speed which they consider desirable, and also the means for launching. The small weight per horse power of a reaction-ejection power unit gives greater freedom. Vertical launching is possible since a model that will lift directly upwards is easy to make if small sizes are used. The size/load ratio is just the same problem with models as with full-size aircraft, and wing loading and power loading of this type of model compares with modern fighter practice; but the designer's scope is widened by the huge power of the small, light propelling units.

In the photograph is shown our first crude model. The rocket used was the smallest of those described, viz., with a 40 grains per second jet. With the ¼ oz. per second jet we used a streamline fuselage, 5ft. long, instead of a cardboard tube. One model had a 5ft. 6in. wing span, covered with 1 mm. plywood.

Made in Concrete Moulds

For more advanced models the writers made aircraft parts by building up layers of wood, cloth and casein glue, and let them set under clamp pressure between concrete moulds covered with tinfoil or waxed paper. If the moulds, which cost only a few pence, are carefully made and finished with a coarse file, very strong and accurate parts can be made. The result is cheaper, lighter and stronger than any of the older methods, even for "one off." If several parts are wanted alike, the advantage is tremendous since making the moulds takes most of the time and labour. Later we found that other substances, based on the Aldol Condensation Process, could be used to replace the casein glue, and we were able to make boats and car bodies. One of the latter is still in use after five years' hard work and ill-use which would have utterly destroyed the usual enamelled iron car body. We were helped tremendously by Casein Industries, Ltd., and by I. G. Farbenindustrie Aktiengesellschaft of Leverkusen.

Finally, to conclude by reverting to the design of ejectors, we have given enough facts for an amateur to start work,


HAWKER TYPHOON
This formidable fighter is fitted with a
NAPIER
'SABRE'
"FLIGHT" PHOTO

ROCKET RESEARCH

but there is no science of ejectors and different workers have obtained different results in spite of the most careful checking. Small modifications and inaccuracies make huge differences to performance, so we must ask other workers to use their own initiative.

Using my 4 oz. per second jet, the reader can follow the drawing for the first ejector, but an adjustable air inlet is vitally necessary. The second ejector can also be taken to be well drawn, but the rest depends on other factors. The 4 oz. per second jet gives a thrust of 55 lb., which is quite reliable, and so is its 700 h.p. gas stream. With Williams's ejectors one can get 600 h.p. of this, usable at 400 m.p.h. with ease.

With Williams's multiple-jet gear, and Williams's ejectors imitated in Cumberland, a reliable 450 lb. thrust at up to 900 ft./sec. (700 m.p.h.) can be maintained; this makes large models quite practicable. This power unit, complete with fuel for 30 minutes, weighs less than one-third of a ton, or a little under one lb./h.p. More than half of this is fuel and oxygen, so the amazing figure of 1 lb./h.p. for the equivalent of engine, airscrew, tanks, fuselage, etc., would not be quite so striking if power for some hours were needed. Because of this we can see the next step, for indeed the advantage of drawing air from an engine and compressor is obvious.

One other figure might be mentioned. It concerns the size of ejectors. One experimental device of ours was based on a jet ejecting two pounds of gas per second, at 7,000 ft./sec., with a horse power of 6,500 in the jet. With our crude ejectors this gave a force of six tons at any speed up to 80 m.p.h., but its size rules it out. It was 20ft. in diameter and 40ft. long, though it weighed only two tons.

It is unfortunate that, although more than one Williams engine is in use to-day, and its success depends upon the efficiency of its ejectors, the device is all but unknown. It is a pity that we had so few weeks between our first examination of Mr. Williams's ejectors and the outbreak of war; aircraft were not ready for ejectors in 1939; they were too slow. Because of this we could not expect much notice to be taken of our work in the Misty North. With one exception all the original workers are in the Army now.

Atlantic Charter

Historical Inaccuracies Being Perpetuated : Real Facts About North Atlantic Air Services

IT is a very old saying that if only a statement is repeated often enough it comes to be accepted as fact. Recent utterances and publications concerning the inauguration of air services across the North Atlantic indicate that there is risk of a distorted picture coming to be regarded as genuine. Since air services across the Atlantic will be of primary importance after the war, it appears desirable to place the correct history of the beginnings on record now.

The picture which is being conveyed is that the British Government and Imperial Airways deliberately prevented Pan American Airways from inaugurating trans-Atlantic air services because this country was not ready and the American competition was feared. Such was not the case, and the facts are, briefly, as follows:—

So far from Imperial Airways wishing to hold up the start of the service across the Atlantic, as early as 1931 Pan American Airways and Imperial Airways reached an understanding. This was, quite frankly, to protect their respective interests in view of the fact that the French air company had been granted a concession by Portugal to use the Azores on the southern route to North America. In June, 1937, the British Government issued to "Pan Am." a permit which clearly indicated the close co-operation between the American and the British company by providing for simultaneous inauguration by the two companies.

On July 5th, 1937, flights were made by both companies, Imperials sending the Empire boat *Caledonia* to New York via Montreal, and Pan Am. the *Clipper III* (Sikorsky S42B) to Southampton. *Caledonia* and her sister ship *Cambria* made four more round trips during that summer; the *Clipper III* completed two more.

After the completion of the experimental flights, both companies began preparations in real earnest. Pan Am were relying on the new Boeing 314, of which great things were expected. The first of these was not, however, launched until June, 1938, and was then found to require considerable modifications. In actual fact, it did not get its certificate of airworthiness until December, 1938. Pan Am. appear to have been uneasy about the situation, for as early as January, 1938, the U.S. Embassy enquired when Imperials would start, and asked whether the British Government intended to invoke the restrictive condition about simultaneous inauguration. In the reply, sent in January, 1938, it was pointed out that the managing director of Imperials would be discussing the starting date with Mr. Juan Trippe, head of Pan Am., and that there seemed little point in meeting the hypothetical question about the simultaneous start, which might never arise.

In spite of statements about a probable start by Pan Am., no start was actually made, for the reason given above, since by the time the Boeing 314 got its C. of A. in December, 1938, it was too late in the season. In the meantime, in July, 1938, Imperials carried out a return flight across the North Atlantic with *Mercury*, the upper component of the Short-Mayo Composite. *This was definitely the first North Atlantic flight by a heavier-than-air aircraft to carry a pay load.*

Further tests had been planned for the summer of 1938 with De Havilland Albatross landplanes, but the first of these developed a structural defect under overload taxying trials so that had to be put right first. Tests were also to be made with Empire flying boats adapted for flight refuelling, but the international crisis led to delays.

On December 23rd, 1938, the American Embassy in London asked when it would be possible for regular flights to start; whether Imperials were ready and, if not, whether there would be any objection to Pan Am. making a start during the coming spring. The reply of the British Government (dated January 28th, 1939) was to the effect that it was hoped that Imperials would be ready to start scheduled services on June 1st, but that in any event the British Government did not wish to raise any objection to Pan Am. starting before then if they were ready to do so. It was assumed that if the positions were reversed, the U.S. Government would adopt a similar attitude.

The final chapter in the story is that Pan Am. were unable to start their service with Boeing 314s until the end of June, 1939. Imperials followed on August 5th, using the Empire S.30 flying boats *Cabot* and *Caribou*, with refuelling in flight at Shannon airport, Eire, and Botwood, Newfoundland. Then war broke out and the British flying boats had to be diverted to military work, while Pan Am. were able to continue.

Truly there are no traces of an obstructionist policy to be found in the historical facts of the case, so let us hope that, for the sake of the friendship between the two nations, there will be no further perpetuation of these unfair allegations.

MODEL WARTIME ACTIVITIES

AT a dinner held by the Northern Heights Model Flying Club in London last week, the new London League Cup was presented by Mrs. D. A. Russell, the wife of the donor, to the Blackheath Club, who are the first to have their name inscribed on the shields surrounding the plinth.

Mr. C. A. Rippon, who was in the chair, told of how this new London District Inter-club League had been formed and how, despite wartime handicaps in the way of material shortages and the fact that no fewer than 6,000 active aero modellers were serving with the Forces, twelve club teams had entered the competition.

Several aero modellers on leave from the R.A.F. turned up to meet old friends, and the organisers, both of the competition and of the function, are to be congratulated on the excellent show put up under very difficult conditions.

2

Seventy-seventh of the Current Recognition Series

Aircraft Types and

LOCKHEED LODESTAR (C-56 AND C-57)

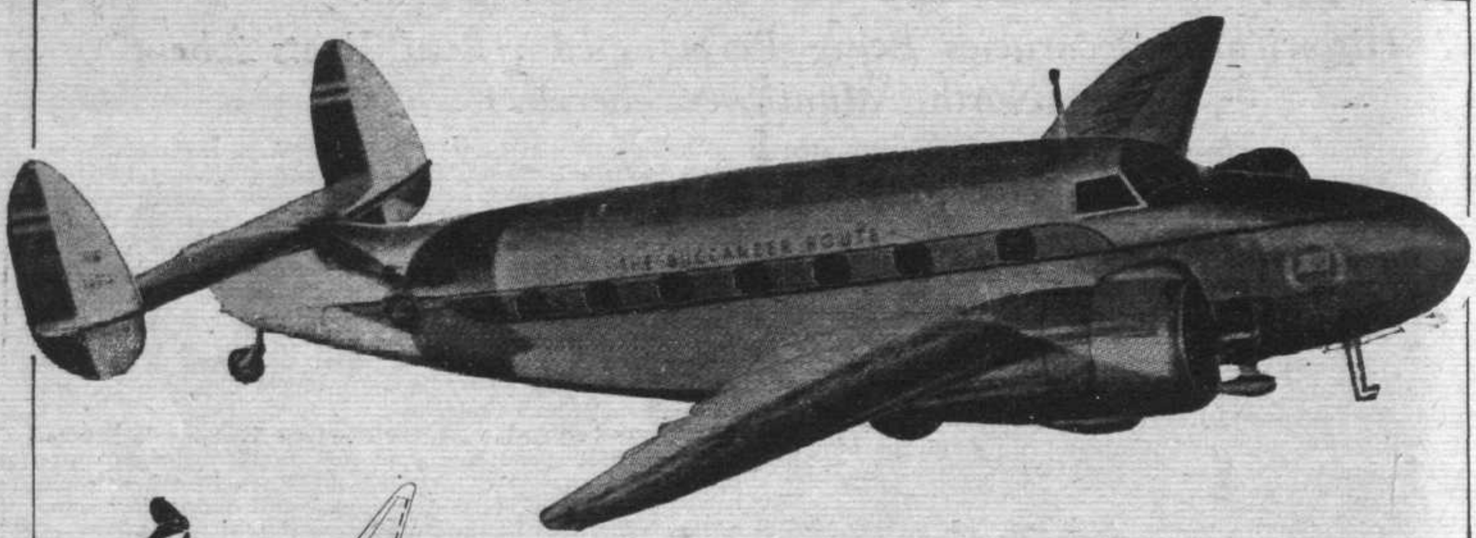
THE increasing importance of air transport in the efficient prosecution of the war has resulted in a wide variety of aircraft, as well as growing numbers of them, being put into service for the rapid movement of mail, freight, military equipment and personnel.

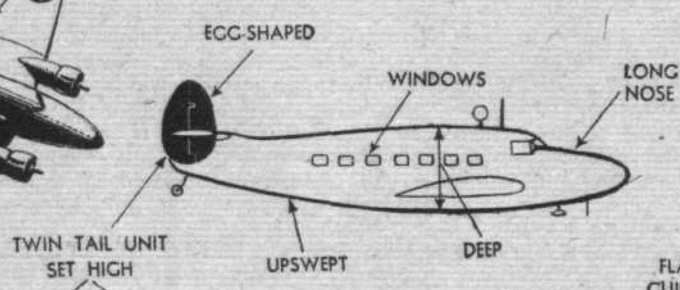
Aircraft employed on these duties can be roughly divided into two classes, civil types (mostly of pre-war design), and military types which, either because of operational obsolescence or special suitability, have been modified into transport aircraft.

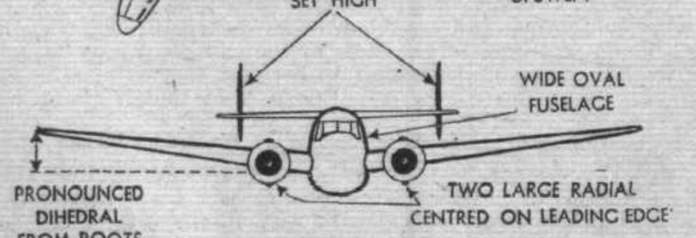
Two versions of the Lodestar, which is in the first-named category, are in service with the U.S.A.A.F., the C-56, which is equipped with interior fittings of the executive kind, such as tables and facilities for administrative use, and the C-57, which has seating for the transport of personnel. The former is powered by two 1,100 h.p. Wright Cyclone engines, and the latter by a pair of 1,200 h.p. Pratt and Whitney Twin Wasp engines, and of the two is perhaps nearer to the original civil version except that this only had 750 h.p. Pratt and Whitney nine-cylinder Hornet engines. Actually a number of "civil" Lodestars with various types of lower-powered Wright and Pratt and Whitney units were taken over by the U.S.A.A.F., but those now being supplied all have the larger engines already mentioned. The U.S. Navy also uses the Cyclone-engined model, which it designates the R50-1.

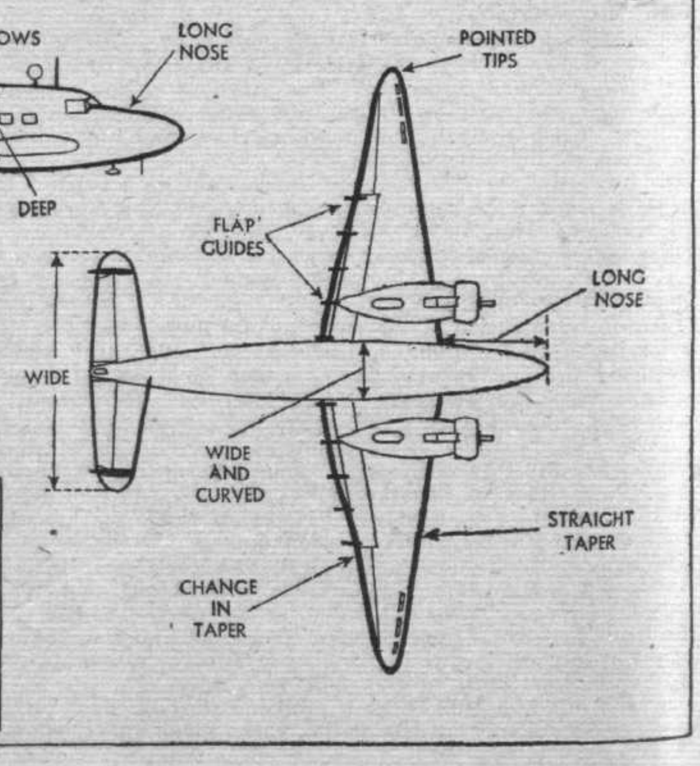
The Lodestar, like the Ventura, is of all-metal construction with a deep, oval-sectioned monocoque fuselage and single-spar mid-wings which have pronounced taper on both edges and small rounded tips. Fowler flaps are employed, and their six guides project from the trailing edge of each wing. The wide-span tailplane tapers on the leading edge and carries twin, egg-shaped fins and rudders set slightly inboard from the rounded tips.

Top speed of the C-56 is 259 m.p.h., and of the C-57, 277 m.p.h.







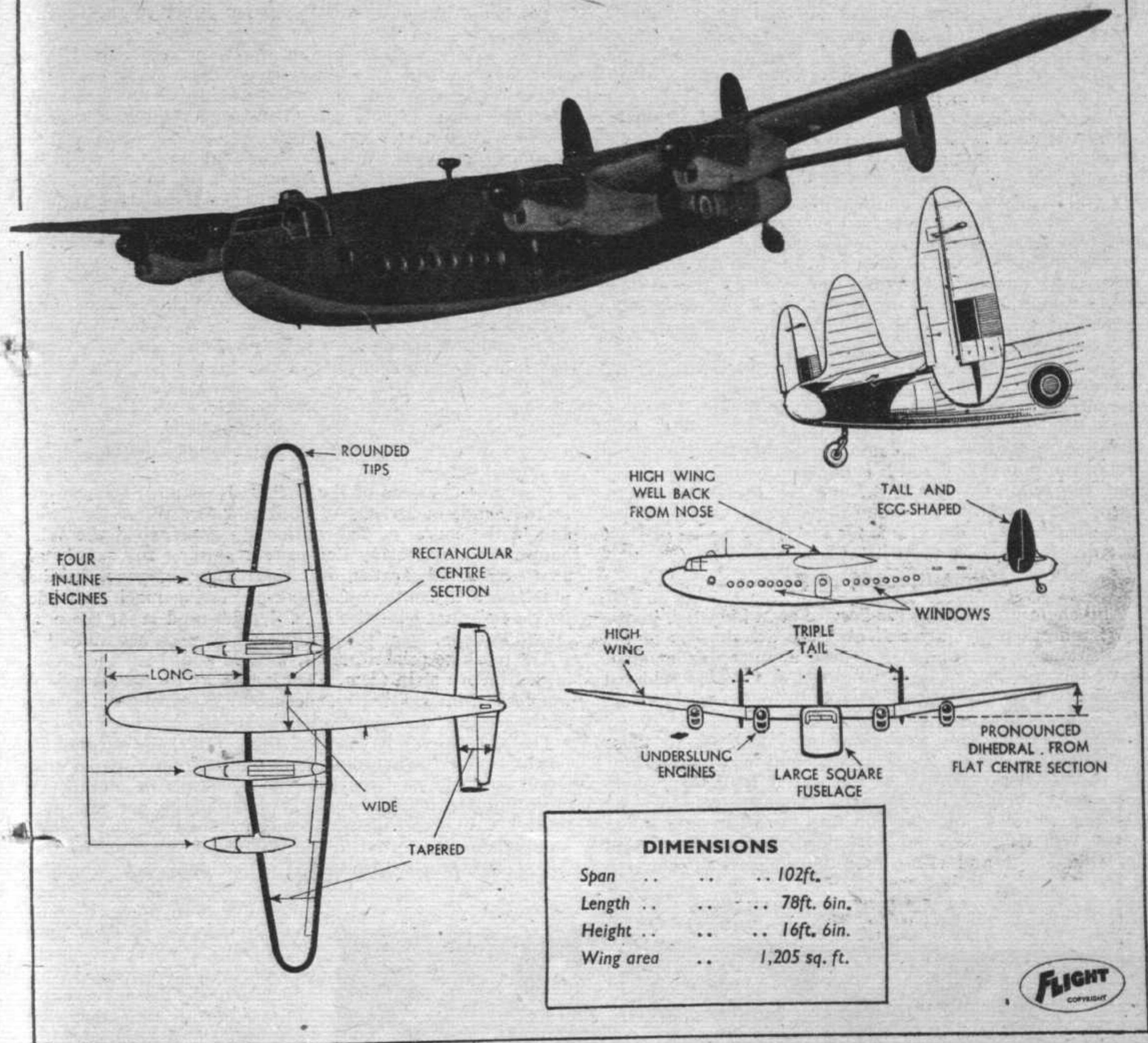


DIMENSIONS

Span	*65ft. 6in.*
Length	*49ft. 10in.*
Height	*11ft. 10½in.*
Wing area	*551 sq. f*ᵗ*.*

Their Characteristics

AVRO YORK



DIMENSIONS

Span	.. *102ft.*
Length	.. *78ft. 6in.*
Height	.. *16ft. 6in.*
Wing area ..	*1,205 sq. ft.*

GREAT BRITAIN'S shortage of really useful transport aircraft, due to her chronic neglect of civil aviation between the two wars, was the subject of a great deal of argument a short time ago. It was debated in the House of Commons and the Lords, public speakers held forth at considerable length and emphasis, and others "wrote to the papers about it."

For a time our efforts to mitigate the situation, so far as war needs were concerned, were confined to the modification of certain bomber types into transports. The transport version of the obsolescent Whitley was an example, and more recently a civil version of the Lancaster appeared.

But the first up-to-date transport aircraft, designed as such, to go into production in Britain since the outbreak of the present war was the Avro York, and, despite our neglect in the development of airliners from 1918 to 1939, it can be compared favourably with the best of the American types in the same category.

The design of the wings and four underslung Merlin engine mountings of the York are the same as those of the highly successful Lancaster, but in order to provide maximum space within the fuselage a high-wing layout has been adopted. The fuselage, wide and deep, is square in section and well streamlined longitudinally, its long line of portholes giving it a truly liner-like appearance. In addition to its tall, oval "endplate" fins and rudders it also has a fixed central fin to counteract the greater keel surface forward of the wings.

Suitable for either short- or long-distance work (one has already crossed the Atlantic), the York's interior equipment may be either for freight or for a mixed load of freight and passengers. On short journeys it can accommodate more than 50 passengers in comfort.

Microgram Service

How Airgraph Letters are Handled : Details of the Williamson Microprinter

CONSIDERABLE publicity has been given in recent months to the transmission of mail by photograph, i.e., by making a 35 mm. or 16 mm. cinematograph record in miniature of the original text, transporting this by air, and then enlarging the original negative at the reception end on to bromide paper.

The advantages of such a system are manifold. Valuable aircraft space is saved, since many thousands of letters can be easily recorded on a small spool of film, and should by the chances of war the negative be lost, the original letters are still available for re-photographing.

The value of this process for the transmission of civilian and Service correspondence, and its contribution in maintaining the morale of the country, is no doubt fully recognised, but possibly the public, and indeed the average photographer, is not aware of the wider and even more important implications of the process in contributing to the war effort.

The development of the Microgram Service for the expeditious transmission of official documents has been the subject of investigation of the G.P.O. Research Station, extending back to several months before the war, and resulting to-day in a complete organisation under the control of the War Office, and it is now permissible to mention that the R.A.S.C., R.A.O.C., and the Royal Army Pay Corps, for example, are among the many units of the Service who employ micrograms for the transmission of their records.

Requisitioning of Spares

Any engineer, either in the Service or in industry, knows the importance of clear and accurate descriptions of the requisitions for spares and for speed in their transmission, for it is very easy to have hundreds of vehicles rendered absolutely useless by a breakdown in the paper-work system for replacing damaged parts.

While perhaps this work sometimes appears to those who are engaged in it unspectacular and even routine, for the successful prosecution of the war it is of the utmost importance. This is convincingly demonstrated when one sees a small roll of film brought into the Microgram Room of the War Office, having been flown, for example, from the Middle East, and within a few minutes sees an enlarged, dried bromide print calling for the supply of some very large quantities of particular spares direct to the theatre of war.

The historic background of the transmission of letters and documents by air is interesting. In the year 1918, Mr. Colin Williamson met Major-General Sir Percy Girouard, the Managing Director of Armstrong-Whitworths. Sir Percy was then engaged in trying to create a payload for airships, and one of his ideas was that messages could be sent on film. Sir Percy's inspiration in this connection appears to have been the fact that in those days the old silent film had long titles. Mr. Colin Williamson suggested a method of copying letters, which Sir Percy sponsored.

Began in 1918

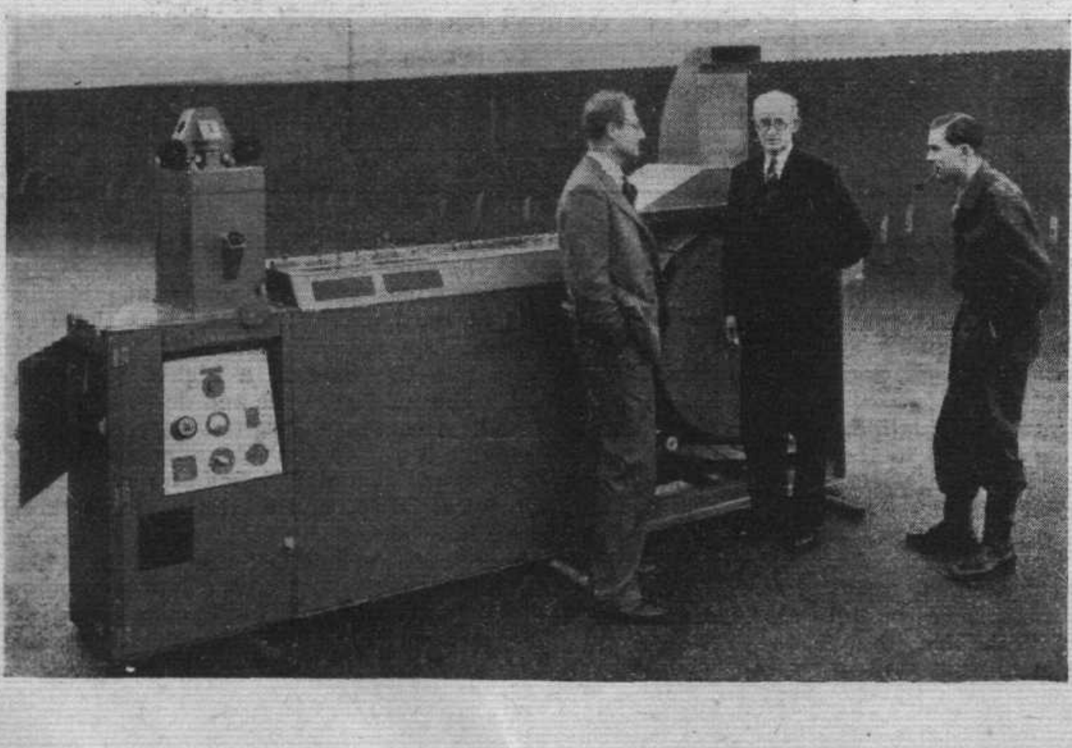
Demonstrations were given by the Williamson firm of an apparatus which copied a letter on to 35 mm. film, and then enlarged these again on to bromide paper. These were seen by high officials of the Post Office and Royal Air Force, and there was a certain amount of publicity in 1918-1919 for the idea. The ambitious schemes of those days, however, were abandoned through the death of Sir Percy Girouard, who was the prime mover of the scheme in official circles.

The investigations of the G.P.O. Research Station were in the hands of Mr. O. W. Gill and Mr. W. A. J. Paul, and in the course of this work they approached the Williamson Manufacturing Company regarding the supply of any existing apparatus, resulting, early in 1939, in the purchase of a continuous paper-processing machine made by that company for the R.A.F., who used it for the production of 5in.×5in. prints from air camera negatives.

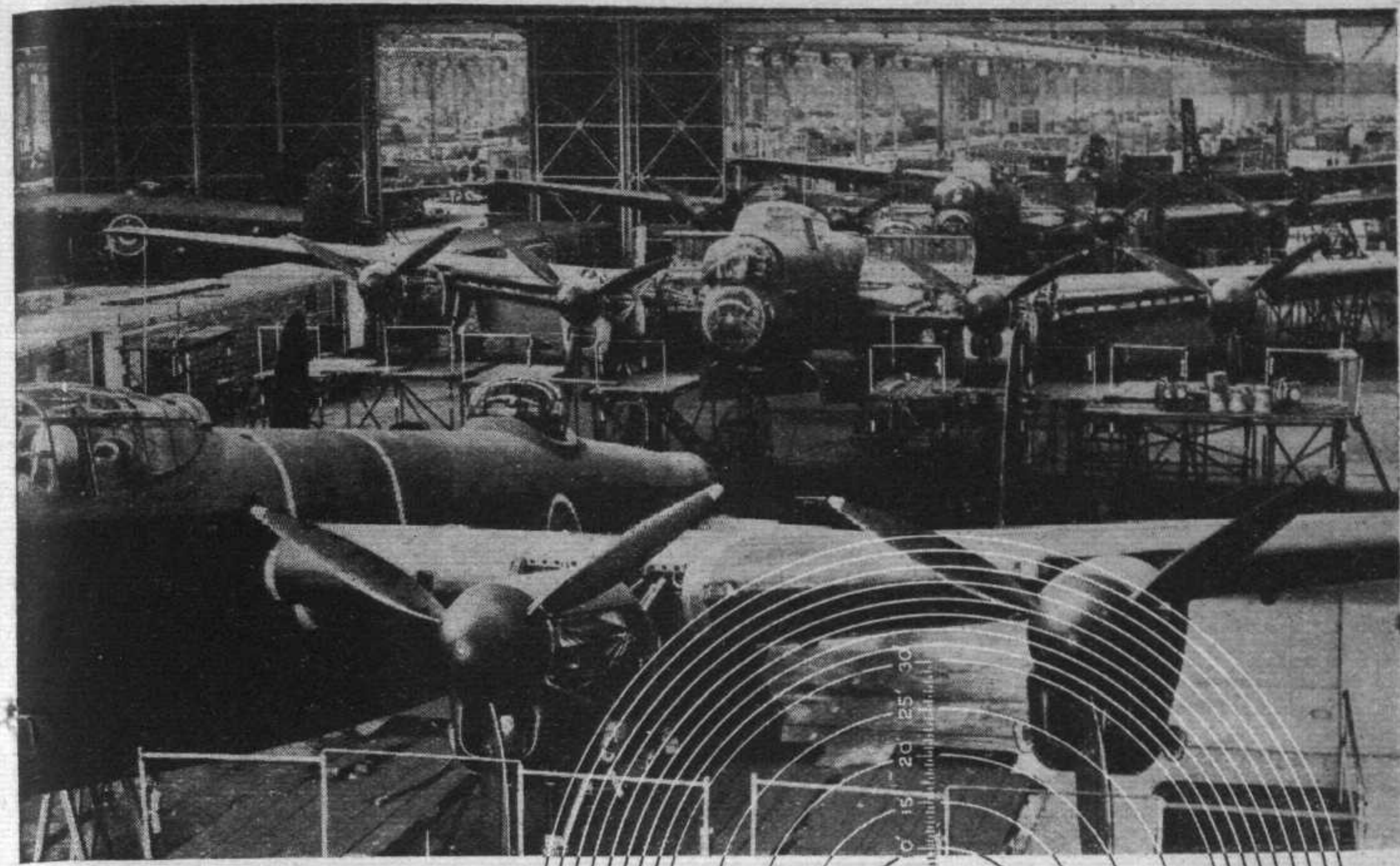
The machine printed, fixed, washed and dried the prints in continuous strip form. The paper at the printing box was moved intermittently, picture by picture, but the rest of the process was continuous.

The G.P.O. wisely decided that, for their purpose, a continuous and synchronised movement of the paper and negative would be best, using the well-known method of projecting the image through a slit, variable for exposure control. An experimental projector head on these lines was built up and fitted to the Williamson machine by the G.P.O. Research workshops. The machine was a complete success, and for some years now has been doing sterling service for the G.P.O. and War Office. Others have been added, and have formed the nucleus of the present service. It was at this time that the definitions of microprinter for the machine and microgram for the product were officially adopted.

In the course of time the question arose of further expanding the service, and discussions took place between the Williamson Manufacturing Company, the Post Office Research Station and the War Office, as a result of which a specification was laid down, based on the past experience

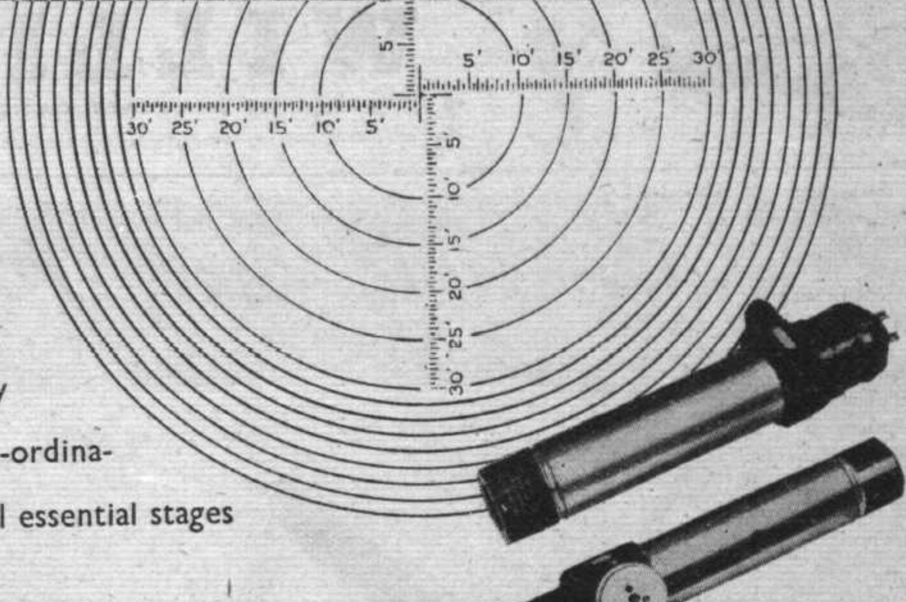


Microprinter accepted by War Office. Left to right: Mr. Paul, of the G.P.O. Research Station, Mr. Colin Williamson and Mr. J. E. Odle.



Lancasters on assembly—Photograph courtesy A. V. Roe & Co. Ltd.

PRODUCTION ON A "PLANNED" SCALE



Any large scale production to-day calls for Planned-Precision . . . a co-ordinated plan for securing accuracy at all essential stages in production.

A co-ordinated plan to ensure that the "man-on-the-bench" at each stage of production is granted facilities for attaining the accuracy expected of him.

Jig assembly facilitated by the "Taylor-Hobson" Alignment Telescope—a typical instance of the application of Planned-Precision

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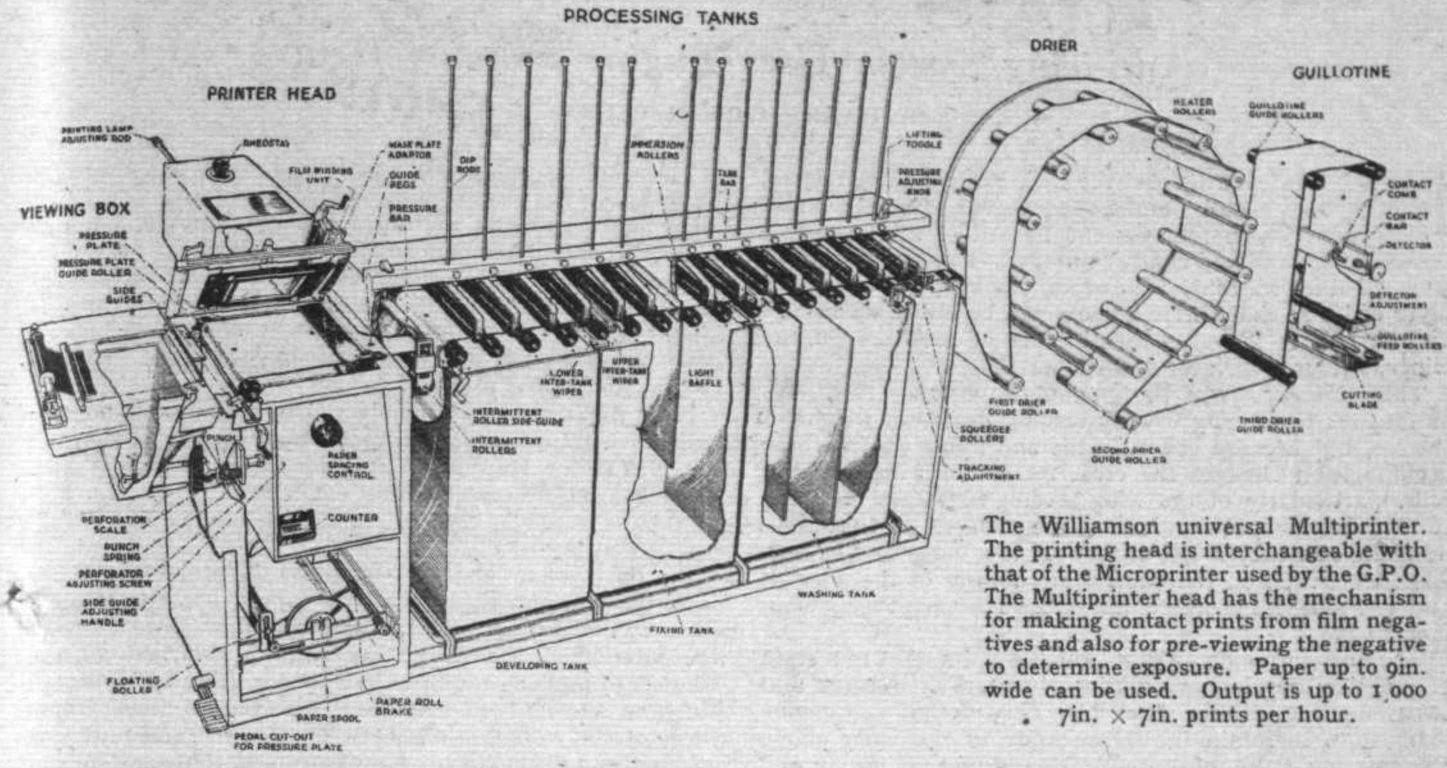
MICROGRAM SERVICE



The Williamson universal Multiprinter. The printing head is interchangeable with that of the Microprinter used by the G.P.O. The Multiprinter head has the mechanism for making contact prints from film negatives and also for pre-viewing the negative to determine exposure. Paper up to 9in. wide can be used. Output is up to 1,000 7in. × 7in. prints per hour.

gained and providing for the production of a larger and faster Microprinter, specially designed for the purpose in view. Williamsons' design to this specification was approved early in 1941 and work was commenced immediately on a sample model.

Coincident with this action, the Air Ministry decided that the Service requirements called for a machine with a larger capacity than the 5in. × 5in. capacity of the earlier machine. Since the processing and drying requirements of the two Services were identical, Williamsons proposed that a universal machine should be produced with interchangeable printing heads suitable to the individual requirements of each Service. It was agreed that this should be done, and the two complete machines are now in full production, the one used by the R.A.F. being known as the Multiprinter, and that used by the G.P.O. as the Microprinter.

These machines are the result not only of Williamsons' many years' experience combined with that of the G.P.O. and the R.A.F., but also incorporate Mr. Ellis Graber's 30 years' experience with this type of apparatus.

In the consideration of the design of a machine suitable for the two Services, many points had to be considered, not the least being the fact that many of the Multiprinters are installed in vehicles, to form mobile photographic units for the R.A.F., compelling every detail to be studied to withstand vibration in transit.

1,000 Prints per Hour

Paper up to 9½in. wide can be used, and the output ranges from 450 to 800 feet per hour, according to requirements. A steady output of 1,000 7in. × 7in. prints can be maintained per hour.

In the Multiprinter the printing head incorporates the necessary mechanism to perform repeatedly the functions required to make contact prints from film negatives, together with means for previewing the negative in order to assess the exposure required. Incidentally, the mechanism is totally enclosed in an "oil bath" gear box which would do justice to a small car, and is certainly more complicated. The paper is also perforated at each exposure for the purpose of operating a cutter after the drying operation, whereby cut prints are delivered from the machine.

In the Microprinter head the fact that the paper is travelling continuously means that the driving mechanism is extremely simple, and the main points of interest are concerned with the projector head.

The first series of Microprinters followed the lines of development initiated by Messrs. Gill and Paul, wherein the film projector was mounted above the paper, projecting vertically downwards. The magnification required of 8—1 naturally resulted in the projector head being mounted some distance above the paper feed rollers, and solution of the inherent problem of producing an accurate and lasting transmission system, free from any minute irregularity between paper and film, is an essential requirement if definition is not to suffer.

Ensuring Good Definition

Experimental work on this question persisted, and many methods were tried before the present patented method was designed. In this the paper feed roller and the film sprocket are mounted on one shaft, the diameter of the former being eight times the latter, and the projected image of the film is diverted by two surface-silvered mirrors so as to return on to the paper roller. The projector follows orthodox lines, with a 250-watt projector lamp condenser system and projection lens. The film passes over a curved track at the gate, a condition which is permissible without affecting flatness of field owing to the small amount of film (less than one-tenth) which is projected. A Dallmeyer 2in. focus f/3.5 enlarging lens is used for projection. In the Post Office experiments a Goertz-Elmar had been used, and some doubts were expressed as to whether the optical perfection of this lens could be repeated, but Dallmeyers' confidence in their products has been substantiated by the results obtained.*

It is hoped that this important application of the photographic process to the requirements of war will have peacetime uses. Much credit for the development of the system and the equipment must go to Mr. Paul and Mr. Gill, of the G.P.O. Research Station, who have worked on the transmission of mail by photographic means, without publicity, and who have given great help in the production of the Williamson Microprinters now coming into active service.

* Due credit must be given to Chance Brothers who supplied the high-class optical glass required by Dallmeyer.

Keeping Them Warm

Anti-icing System Uses Engine Exhaust Heat

By HARRY WILKIN PERRY

FOR several months past the U.S. Navy has been flying Catalina patrol bombers equipped with a heating system which removes the hazard of ice formation on the wings, tail and control surfaces. This system differs from de-icers in that, instead of cracking up a formed layer of ice so that the fragments will be blown off by the air current, it prevents the freezing of moisture on the wings, ailerons, elevator and rudder.

This difference is of the greatest importance to safety, as disaster from icing usually results, not from weight of the ice, but because of loss of lift and flying control. Ice accumulation changes the cross section of wing and tail foils, particularly of the wing leading-edge, and destroys the uniform, smooth contour of the surfaces, so that aerodynamic efficiency is lost or reduced to a dangerous extent. Also, ice frozen on the control mechanism of the ailerons and tail surfaces increases the hazard by rendering them inoperative.

The new anti-icing system, which was brought to a state of practical development during six years of research and experimenting, utilises waste heat from the aircraft engine exhaust to maintain the temperature of the parts above the freezing point of water. In addition to use of the system in some of the Catalinas, it is being installed in the new Consolidated Vultee two-engined flying boat P4Y-1, which is in production for the Navy at New Orleans, and before next winter is to be provided in the Coronado PB2Y-3 four-engined bombers now building for the Navy at San Diego, California.

In theory, the use of engine heat to keep leading-edges and surfaces warm was logical and apparently simple, but working out a practical method of applying the principle proved far otherwise. The result represents the combined efforts of the National Advisory Committee for Aeronautics, which conceived and partly developed the idea, and of engineers of the Consolidated Vultee Aircraft Corp.

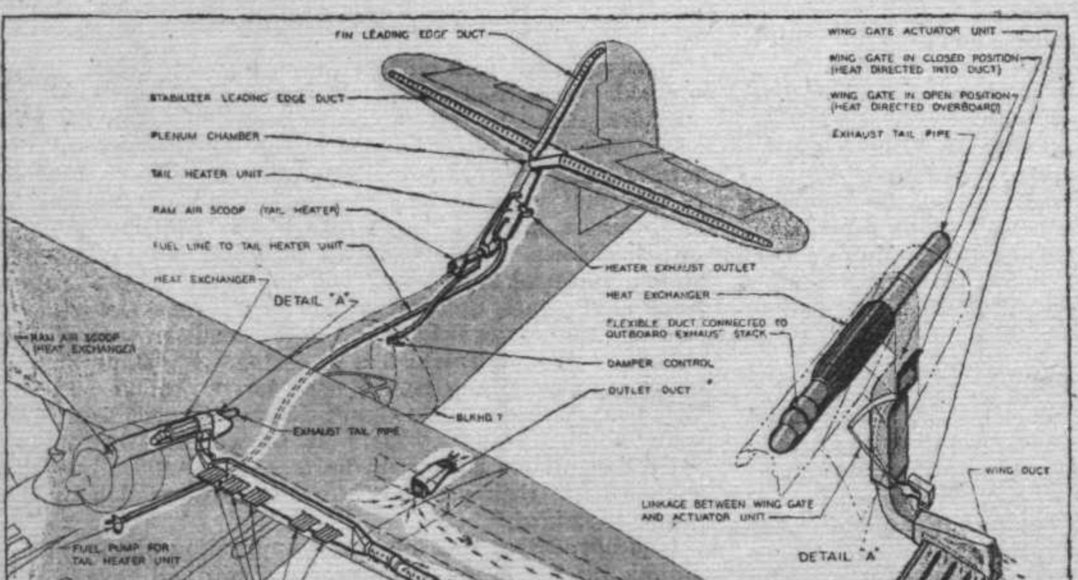
The method consists essentially of heating air indirectly by means of heat exchangers located in the engine exhaust pipes and circulating the hot air in the wings and tail at controlled initial temperatures ranging up to a maximum of 350 deg. F. This hot air keeps the metal of leading-edges at 60 deg. F. even in atmospheric temperatures as low as −40 deg. F., and tests recently completed in high northern latitudes are stated to have shown that the system functioned perfectly.

Final flight tests were conducted in a Liberator bomber and other aircraft at Minneapolis by Engineer Rodert, of the N.A.C.A.; Harold F. Schmidt, Consolidated Vultee engineer; and a crew of Army engineers.

System in Liberator

By the system installed in the Liberator, heated air from the two outboard engines is supplied to the leading-edges of the two outer wing panels and flows back through the interior of the wing and over the surfaces of the ailerons to prevent icing of the controls. Similarly, heated air from the inboard engines is directed to the leading-edges of the wing sections between inboard and outboard engines, and ducts convey hot air from the inboard engines through the fuselage to the tail surfaces. Other ducts carry hot air to the cabin and flight deck to heat the former and prevent frosting of the pilots' windshield and the bombardier's window. An additional feature in the Catalina and the Coronado is the installation of an auxiliary heater in the tail to supply more heat for prevention of freezing of water sprayed on the surfaces during take-offs and landings.

Arrangement of the elements of the system as installed in the Catalina patrol bomber is shown in the accompanying drawing showing the port engine, port wing, fuselage and tail. Outside air enters ram air scoops on the engine nacelle and passes through a heat exchanger surrounding the exhaust tail pipe, where the air is heated by convection from the exhaust gas.



The heated air then travels chordwise of the wing panel through feeder ducts in the leading-edge, shown in enlarged detail "A" at the right. It also flows spanwise through a duct in front of the front spar and escapes through a series of vents in the duct to warm the metal of the leading-edge. The released air then circulates in the interior of the panel, heating the whole skin, and finally is vented to the atmosphere through an outlet back of the rear spar.

The amount of heating is regulated by a wing gate and actuator inserted between the heat exchanger and the wing leading-edge feeder ducts (detail "A"). A movable cover on the wing-gate duct is operated through linkage by a thermostat unit which opens and closes the duct. When

KEEPING THEM WARM

the gate is closed, the hot air is directed into the wing; when opened in warm weather, the air is discharged outboard through the leading-edge feeder ducts.

The drawing shows also the auxiliary heater installed forward of the tail surfaces on the Catalina and the Coronado. This is a petrol-burning unit having a ram air scoop and an exhaust gas outlet. Fuel is pumped from the fuel tank to the heater through a line passing through the fuselage. There is also a damper control in the fuselage for regulating the flow of air through the air scoop to the heater. Air from the heater is forced into a three-way plenum chamber, whence it passes into ducts in the leading-edges of the fin and stabiliser and is vented into the interior of the structures. The Liberator Express and P4Y flying boats will dispense with this auxiliary heater and, instead, draw heat for the tail surfaces directly from the engines.

This new thermal anti-icing system is said to add no weight to aircraft, as it replaces the rubber-boot pulsating type of de-icer. Ice or frost formed on the craft while stationary on the ground begins melting off as soon as the engines are started, making unnecessary the scraping off manually on wing and tail surfaces and on the controls.

A Case for Standardisation

Puzzle of the Boost Gauge : British Unit an Anachronism : "Centibar" Suggested

By JOSEPH LOWREY, B.Sc.(Eng.)

DURING the hectic days of the Battle of Britain, this country had one great need: aircraft. With the stream of American machines beginning to flow, it was no time to be critical of details, and such things as instruments calibrated in unfamiliar units were accepted as inevitable.

Three years have passed since those days, and many things have changed. Aircraft of transatlantic origin but with French instrumentation and data plate inscriptions are no longer commonplaces. But it seems that assorted boost pressure gauges, like the poor, are always with us.

There has been need for standardisation of boost gauges for a long time past, but this has become particularly urgent with the appearance of the American-built Rolls-Royce Merlin engines. These power units are employed in aircraft of British design, with boost gauges reading in pounds per square inch, but identical engines also appear in American machines with "manifold pressure gauges" registering inches of mercury. Pity the pilot or engineer who, quite unnecessarily, has to memorise two sets of limitations for the same engine!

These two systems of boost gauge calibration are the most common on Allied aircraft, but they are by no means the only ones. Machines taken over from French contracts may still have gauges reading "Piezes" or "centimetres of mercury," and captured German types use a unit called the "atu."

If standardisation is to be achieved, agreement on the best type of instrument must be reached. This can only be hoped for if the function of a boost gauge and the merits of various calibration systems are clearly appreciated.

British System

A boost pressure gauge, in spite of its name, differs fundamentally from the fuel pressure gauges, oil pressure gauges, and other pressure-measuring instruments used in an aircraft. Like an altimeter, it records absolute pressure, and not merely pressure above atmospheric. In fact, the American name of "manifold pressure gauge" is more correct, the gauge giving no indication of the extent to which the supercharger has boosted atmospheric pressure.

The orthodox British system of boost gauge calibration ignores this fundamental fact, pressures being given in pounds per square inch above or below an absolute pressure of 14.7 pounds per square inch. The latter pressure, which is the mean sea level atmospheric pressure, is arbitrarily known as "zero boost."

For engines operating at sea level, such a system is at least reasonably convenient, even though it overlooks day-to-day variations in barometric pressure. But for engines used at varying altitudes it is entirely illogical, and should at least be superseded by calibration in absolute pounds per square inch. The latter system would probably be acceptable in this country, except during a period of transition when there would be a risk of confusion, but it is a little doubtful whether we shall ever secure world-wide acceptance of our peculiar units of pounds and inches.

EQUIVALENT BOOST PRESSURES IN DIFFERENT UNITS.

Lb./sq. in. gauge	Lb./sq. in. absolute	Ins. of Mercury	Cms. of Mercury	atu	pieze or centibars
− 4	10.7	21.8	55.3	0.75	74
− 3	11.7	23.8	60.5	0.82	81
− 2	12.7	25.8	65.6	0.89	88
− 1	13.7	27.9	70.8	0.96	95
0	14.7	29.9	76.0	1.03	101
+ 1	15.7	31.9	81.2	1.10	108
+ 2	16.7	34.0	86.3	1.17	115
+ 3	17.7	36.0	91.5	1.24	122
+ 4	18.7	38.1	96.7	1.32	129
+ 5	19.7	40.1	101.9	1.39	136
+ 6	20.7	42.2	107.1	1.46	143
+ 7	21.7	44.2	112.3	1.53	150
+ 8	22.7	46.2	117.4	1.60	157
+ 9	23.7	48.3	122.5	1.67	164
+10	24.7	50.3	127.7	1.74	171
+11	25.7	52.3	132.9	1.81	177
+12	26.7	54.3	138.0	1.88	184
+13	27.7	56.4	143.2	1.95	191
+14	28.7	58.5	148.4	2.02	198
+15	29.7	60.5	153.6	2.09	205
+16	30.7	62.6	158.8	2.16	212
+17	31.7	64.6	164.0	2.23	219
+18	32.7	66.6	169.1	2.30	226
+19	33.7	68.7	174.2	2.37	233
+20	34 7	70.7	179 4	2.44	240

The American manifold pressure gauge calibration system is infinitely preferable to ours, this being the measurement of pressure in terms of the number of inches of mercury it will support. For international use, however, it would probably be better to standardise a scale of centimetres of mercury: the centimetre is an accepted unit in the English-speaking world, whereas the inch is almost unknown outside it.

From the scientific aspect, however, the measurement of pressure in terms of a mercury column has two weaknesses. It is necessary to specify a temperature for the mercury, and also the gravitational acceleration "g," to obtain a truly fundamental unit of mensuration.

German Unit

The method of manifold pressure measurement used by the Germans is based on a unit known conveniently as the "atu," actually one kilogram per square centimetre. This unit is really too large for convenience, pressures being necessarily quoted to two places of decimals, and once again it is a "gravitational" unit. It is convenient in that sea level atmospheric pressure is only slightly more than "1 atu," so that the extent to which an engine

A CASE FOR STANDARDISATION

is boosted at ground level is readily comprehended.

An ideal system for universal use, both in normal flying and in scientific work, should be based on fundamental units of convenient size. The most universally accepted fundamental unit of force being the dyne, and the corresponding unit of area the square centimetre, it would be rational to adopt "dynes per square centimetre."

It is perhaps fortunate that such an awkwardly named unit is also of inconvenient size, being far too small for the purpose in view. Opportunity thus exists to choose a suitable multiple of the "dyne per square centimetre" and to adopt a more reasonable name.

This step has, in fact, already been taken. In meteorology, units used are the "bar," one million dynes per square centimetre, and the "millibar," one thousand dynes per square centimetre. These measures are already in world-wide use, but for manifold pressure measurement the most useful sized unit would be a "centibar" of ten thousand dynes per square centimetre.

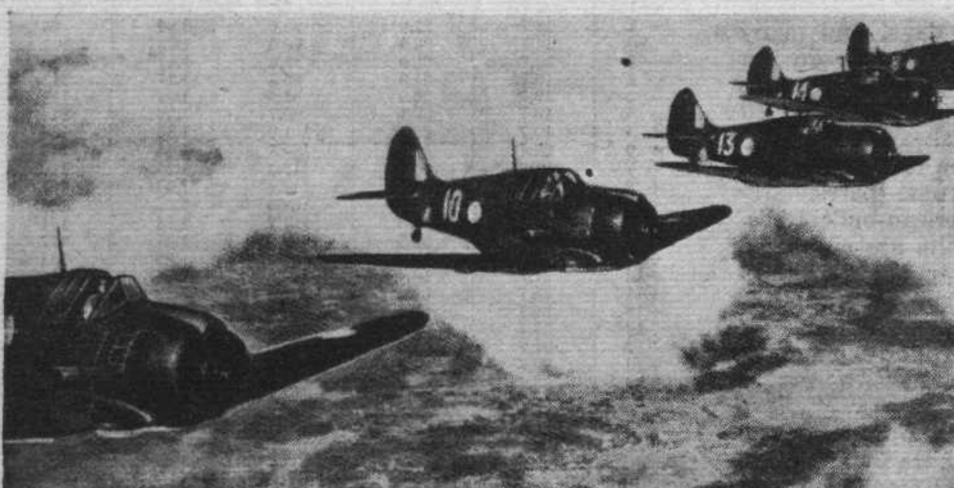
This is not actually a new unit, or even an old unit put to a new use, for manifold pressure gauges registering "centibars" are already in use. Unfortunately, however, this sound and useful unit has been inflicted with the name of "pieze."

There is no doubt that standardisation of the units of manifold pressure measurement throughout the world would offer real advantages to both pilots and aeronautical engineers. My personal opinion is that the "pieze" or "centibar" is the most suitable unit for universal use, although there are alternatives which might also be generally acceptable.

What is really required is action to standardise some reasonable system before the end of the war and enforcement of its use.

At the present time, the whole British aircraft industry is working for the Ministry of Aircraft Production, and the state of affairs in U.S.A. is very similar. Is it too much to hope that the Air Forces of our two nations can agree on a standard manifold pressure measuring system and adopt it for all their aircraft? After the war, most of the world's aircraft will have to be supplied by Britain or the United States, and any system standardised by both would inevitably spread to other countries.

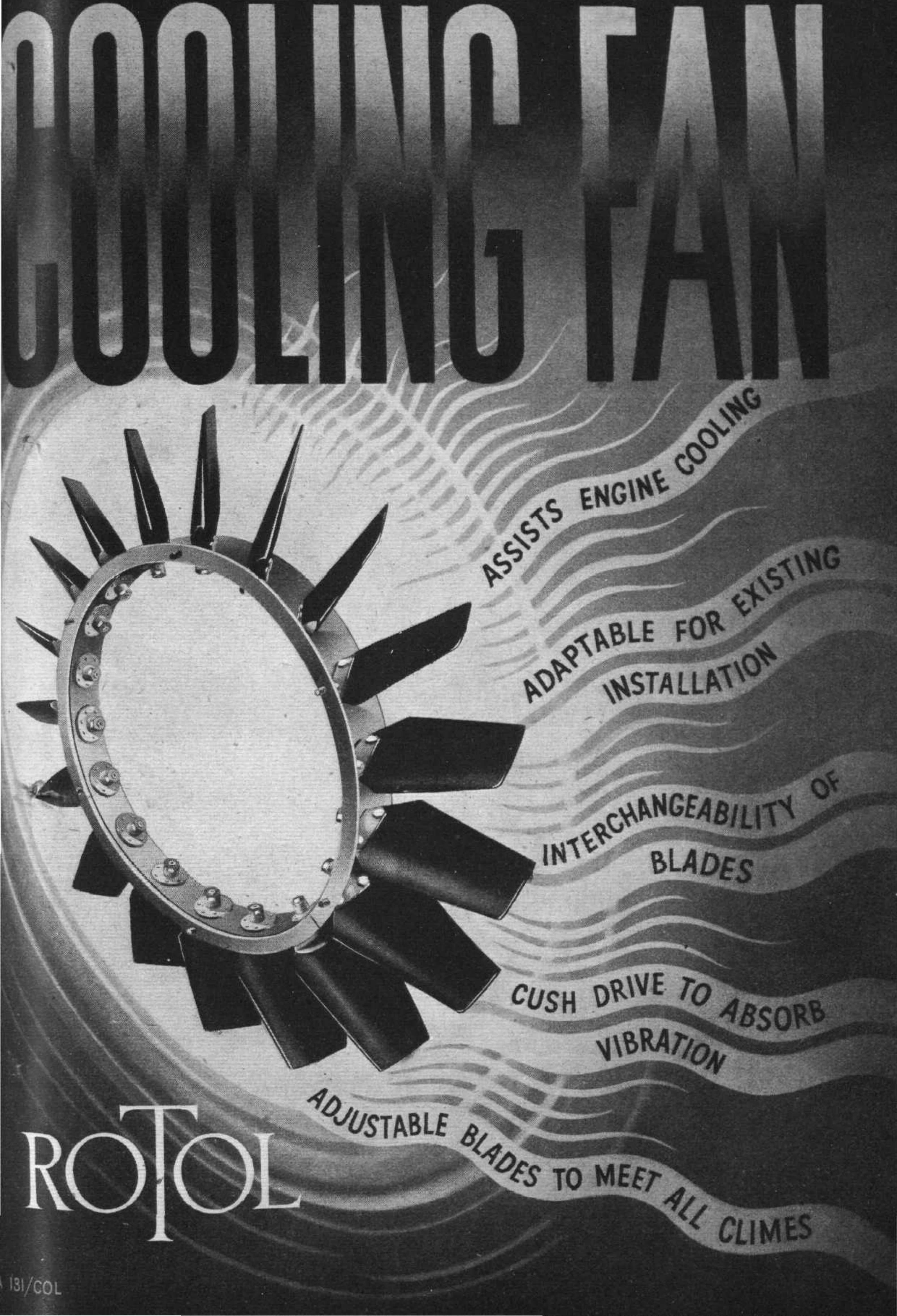
If the Americans are unwilling to change their present "inches of mercury" gauges, then let us fall into line with them. Their choice of units is not ideal, but at least they employ a scale of absolute pressures. The British boost gauge with its arbitrary "zero" of 14.7 pounds per square inch is an anachronism which should be thrown away and forgotten.



NATIVE WEAPON: Official secrecy still forbids anything like a useful description of the first single-seater fighter to be designed and produced in Australia, namely the Boomerang. But from the picture showing a line-abreast formation of them high above their native land, their resemblance to the Wirraway trainer (Australian version of the Harvard trainer) will be noticed about the wing design, while the fin and rudder resemble those of the NA-25.

Type of engine (beyond the obvious fact that it is an air-cooled radial), performance and armament are not disclosed, but it is said to be heavily armed and to possess good manœuvrability. Long-range drop tanks can be carried under the fuselage. Under threat of invasion early in 1942, the prototype took the air 14 weeks after design was started.

MILITARY AIR LINE: Two photographs of the new air service run by the French military authorities between Damascus and Moscow. Teheran, the capital of Iran, is the main stopping place. Lockheed Lodestars are employed on the route.


COOLING FAN
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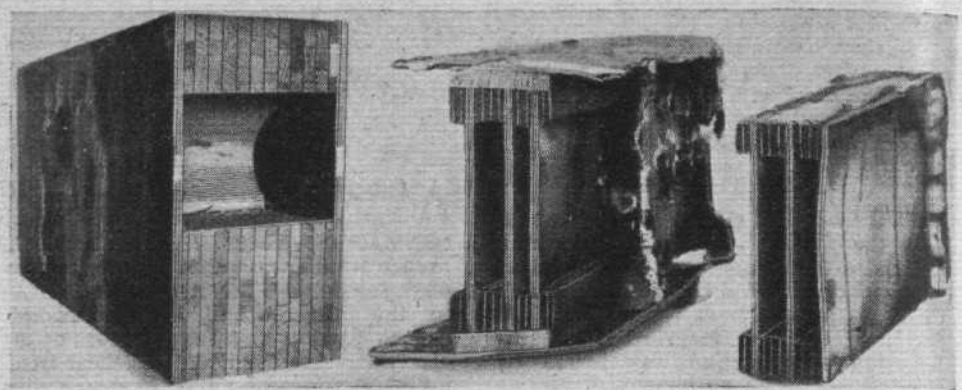
131/COL

Russian Aircraft Materials

Wide Use of Wood : A Complimentary German Report : Strength Characteristics Data

A TRADITIONAL feature of the Soviet aircraft industry is the preference for mixed construction displayed on a large number of types. Side by side with all-metal fuselage construction and metal skin covering, a prevalent practice is fabric or plywood covering on a metal or wood structure. Recently some all-wood aircraft have also come into the foreground.



Spar flanges of the YAK-1 (left), the LAGG-3 (centre) and of the MIG-3 (right). In the YAK, flanges are of multiple bonded pine veneer strips and webs in birch plywood ; in the MIG-3, flanges are of compacted birch, webs of birch plywood with fillers in laminated pine.

This predilection for the employment of wood as an aircraft material, more pronounced in Russia than in other countries, is, of course, natural if one remembers the extensive and readily available timber resources of that country. Traditional skill and a high standard of craftsmanship is yet another incentive, and the wood-processing and plywood manufacturing industry has for many years been a feature of Russia's economy. In fact, this development goes as far back as the Napoleonic wars, when a project was belatedly submitted to the Russian Government to construct military balloons out of thin wooden veneers—the beginning of the plywood industry.

There is no doubt that the attention paid by the Soviet Government to the application of wood to aircraft production, and to the development of this technique, has proved of particular value to the Soviet Air Force in the present war. A source of material was available which went a long way towards keeping up the production of aircraft at its present high level of output despite the losses sustained by the German occupation of industrial zones of the country. In fact, wood in one form or another is now being widely used in the aircraft industry irrespective of the tactical purpose for which the aircraft are designed.

Three Types Examined

As to the quality of material and workmanship employed, the three relatively recent fighter types, the YAK-1, the MIG-3 and the LAGG 3, are perhaps the most representative examples. The YAK-1, designed by Major Gen. A. Yakovlev, is a single-seater with an approximate span of 38ft., length 32ft. and height 10ft., and a wing loading of 30 to 32 lb./sq. ft. Powered with one M-105 liquid-cooled engine of 1,100 h.p., it has a speed from 270 m.p.h. to 370 m.p.h., according to altitude. The MIG-3 is a single-seater powered with a liquid-cooled 12-cylinder engine of about 1,200 h.p., with a span of 37ft. 6in., length 31ft. 2in., height 10ft. 6in., and a wing loading of about 36 lb./sq. ft. to 38 lb./sq. ft.

The LAGG-3, a single-seater fighter of more recent development, is powered with a 12-cylinder V-type liquid-cooled engine of 1,100 h.p. and has a top speed at 16,400ft. of 350 m.p.h. The aircraft is armed with one 20 mm. cannon and two 12.7 mm. machine guns, and has the following characteristics: flying weight 7,000 lb., wing loading 36 lb./sq. ft., and length 29ft. 5in.

While the YAK-1 and the MIG-3 are of mixed construction, the LAGG-3 is built entirely of wood. Birch is used for the plywood for the wing

TABLE I. STRENGTH CHARACTERISTICS OF RUSSIAN BIRCH PLYWOOD. PLYWOOD OF THE :—

	Wing Covering (Centre Section)			Fuselage Skin	Web of Spars		
Type of Aircraft	YAK-1	LAGG-3	MIG-3	LAGG-3	YAK-1	LAGG-3	MIG-3
Construction	3-ply	3-ply	5-ply	4-ply	7-ply[1] (5-ply)	1:1, 5:1:1, 5:1	1:1, 2:1:1, 2:1[1] (1:1:1)
Thickness (mm)... ...	3.5–3.7	2.8–2.9	2.4–2.6	2.4–2.5	8.0–8.4 (6.4–6.6)	3.7–4.0	3.9–4.0 (2.7–2.8)
Weight per volume g/cm³	0.68	0.68	0.72	0.93	0.74 (—)	0.73	0.78 (0.77)
Moisture content per cent.	8.7	8.1	7.1	7.5	8.2 (8.2)	8.3	7.5 (7.8)
Tensile strength—kg/cm² longitudinal							
limits	539–822	772–1040	678–780	319–833[2]	700–832 (840–990)	622–730	880–913 (657–792)
mean	698	912	703	604[2]	779 (937)	705	899 (719)
transverse							
limits	568–706	717–910	543–713	—	690–947 (—)	850–902	845–911 (557–580)
mean	646	801	631	—	804 (—)	870	882 (571)
diagonal							
limits	—	—	—	—	—	—	—
mean	—	—	—	—	—	—	—
E-Modulus x 10³ kg/cm²							
longitudinal							
limits	106–117	106–108	81–90	110–140[2]	100–109 (89–108)	100–110	117–127 (105–115)
mean	112	107	85	126[2]	106 (100)	106	122 (108)
transverse							
limits	67–76	72–78	53–66	—	90–100 (96)	104	108–117 (72–75)
mean	70	75	58	—	—	104	114 (73)
diagonal							
limits	—	—	—	—	—	29–31	— (28–29)
mean	—	—	—	—	—	30	— (28)
Bonding strength (moist) kg/cm²							
limits	15.9–23.6	30–36	24.8–30.6	9.3–10.7	14.6–35.9	35.5–45.4	15.5–25.8
mean	20.6	35	30.4	9.9	30.2	38.8	(19.6)

Note : [1] Web of spars from two different grades of plywood.
[2] Longitudinal and transverse respectively.

A puzzle for Chinamen?...

Not quite, but when these gun heater tubes, here intertwining an undercarriage door frame, become an integral part of a mighty war plane, they will serve as a nightmare for Nazis. And these aluminium or light alloy tubes are shaped and welded by Ranalah craftsmen with such accuracy and to such fine limits that interchangeability of parts is guaranteed.

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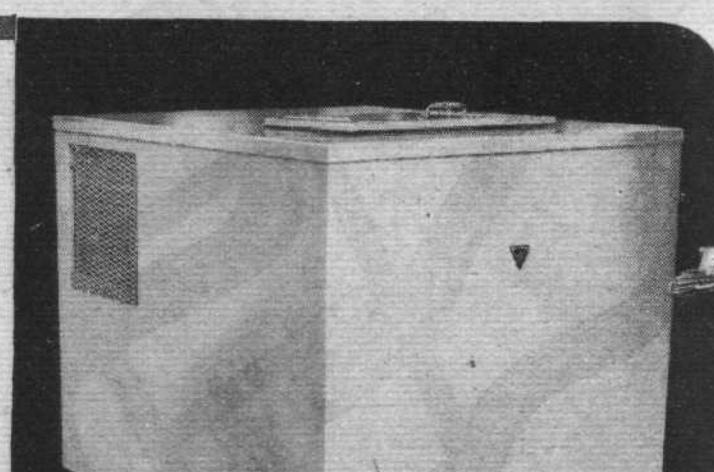
Industrial refrigeration is contributing increasingly to national production...



Low temperature refrigeration has provided a practical and permanent answer to many problems of wartime industry. The simple cabinet shown is a general purpose unit supplied to leading aircraft factories for the shrink fitting of bushes, tubes, ball races and inserts. In this way rapid assembly is made possible without risk of distortion. Other applications are available for the controlled large-scale cooling of oil baths, the regulation of altitude temperatures and pressures in stratosphere instrument and material testing and the automatic air conditioning of factories. All enquiries relating to any aspect of temperature control engineering are invited.

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RUSSIAN AIRCRAFT MATERIALS

surfaces of the MIG and LAGG, and pine for ribs and stringers. The spar flanges on the YAK-1 are glued together from numerous pine laminations. The fuselage is developed as a monocoque, divided along the vertical section in two half-shells. The half-shells are built up of birch veneers glued over a former. The veneer sheets (about 0.5 mm. thick and 180 to 220 mm. wide) are placed diagonally over the former, and successive layers are, of course, laid crosswise.

The number of veneer layers to form the complete skin is varied along the length of the shell to meet the local stresses, thus achieving the requisite strength with a minimum of weight.

The quality of the material employed can be gauged from a report of the German Experimental Institute for Aeronautics (*Deutsche Versuchanstalt für Luftfahrt*) at Berlin-Adlershof, which made thorough tests of the material of captured YAK-1, MIG-3 and LAGG-3 fighters. The results of this examination, which are embodied in the accompanying tables, were obtained from material exposed for some length of time to atmospheric influences. The German examiners assume therefore that some of the rather low values for the plywood covering are not due to variations in quality of the material, but are rather the result of weathering.

TABLE II.—LAMINATED AND PROCESSED WOOD USED IN SOME RUSSIAN AIRCRAFT

Type of Aircraft	YAK-1		LAGG-3		MIG-3	
Type of wood	Laminated Pine		Compacted Birch "Delta"		Compacted Birch "Delta"	
Construction	Thickness of lamination 13 mm.		Thickness of veneers 0.3 mm. when compressed. 12-ply longitudinal. 1-ply transverse.		Thickness of veneers 0.2 mm. when compressed. 11-ply longitudinal. 1-ply transverse.	
Specific gravity g/cm³	0.53		1.34		1.33	
Moisture content (per cent.)	10.5		—		—	
	Limit	Mean	Limit	Mean	Limit	Mean
Tensile Test—						
Tensile Strength kg/cm²	544–977	738	2340–2720	2574	2020–2145	2090
E-Modulus × 10³ kg/cm²	113–176	143	320–337	326	289–305	296
Compression Strength kg/cm²	A 482–492	488	a 1340–1435	1377	a 1207–1300	1244
	B 97.5–98.4	98.0	b 2070–2410	2100	b 1565–1625	1598
	C 161–165	163	c 1212–1410	1291	c 1015–1057	1033
Bending Test—						
Bending Strength kg/cm²	B 960–1045	1007	a 2675–3180	2928	a 2590–3090	2840
	C 820–1080	992	c 2575–2660	2612	c 2630–2755	2693
E-Modulus × 10³ kg/cm²	B 137–141	139	a 282–310	297	a 287–289	288
	C 99–142	125	c 294–307	300	c 270–300	285
Synthetic Adhesive—						
Between structural parts	Urea Formaldehyde		Phenol Formaldehyde		Urea Formaldehyde	
Between veneers	—		Phenol Formaldehyde		—	

Note: A=Along the grain. B=Across the grain. C=Tangential to grain.
a=normal to laminations. b=along laminations with the grain. c=along laminations across the grain.

Plywood employed in the wing skin of the YAK-1 and MIG-3 shows strength values corresponding to 1935 German Standard Specifications and, according to the German report, "are not better than the average German material used at present." In the case of the LAGG-3—says the report—the corresponding grades are much higher than those for current German material. The high-resistance coefficients of the LAGG-3 are, in the opinion of the German examiners, largely due to the employment of an adhesive based on phenol-formaldehyde. As will be seen from the table, very good results were obtained from resistance tests of the plywood used in wing spar webs of the three fighter types.

The German institute examined a length of laminated [pine] of 13 mm. thickness showing satisfactory resistance qualities, but described as "not superior to corresponding German types." On the other hand, the compressed birch wood, known in Russia as "Delta" wood and used for flange members of the MIG-3 and LAGG-3, is classified by the Germans as showing "a definitely superior resistance." It is hardly possible to expect a German statement to be more complimentary than this guarded description. Here, again, the resistance coefficients of the compressed wood used in the LAGG-3 are said to be largely due to the use of the phenol-formaldehyde adhesive, as against the YAK-1 and the MIG-3, where urea-formaldehyde bonder is employed. Another outstanding quality of compressed birch wood in the LAGG 3 is the high tensile strength coupled with high coefficients for compression strength.

In conclusion, it should not be overlooked that of the three types described the LAGG-3 is the more recent one, and further improved versions, the LAGG-4 and 5, are known to have been produced. One can therefore assume that the experience gained with this type is being applied by the Russian aircraft industry to the construction of other current developments of aircraft which are now being supplied to the Russian Air Force.

Cost of the Anglo-American Offensive

VARIOUS programmes of new works and expansion in connection with the joint R.A.F. and U.S. Army Air Force offensive from Great Britain will, it is anticipated, involve a capital expenditure of over £615,000,000, the Air Ministry News Service has announced.

About £118,000,000 is being spent on airfields and depots for the U.S.A.A.F.

Hundreds of heavy and medium bombers of the United States Eighth Air Force, with the support of the fighter squadrons based in Britain, are engaged in the daylight attacks on Germany's industries, airfields and communications, interlocking this effort with the R.A.F. Bomber Command's onslaught by night.

To accommodate these great air fleets a vast network of airfields, camps and depots has been constructed.

In the allocation of constructional labour, the requirements of the U.S.A.A.F. rank equally with those of the R.A.F., but the manpower shortage in Britain would have prevented the execution of the huge airfield construction programme with the urgency required if American constructional units had not assisted. As far as possible these units are allocated to work for the American Forces, and at one in seven of the U.S. airfields and depots they are supplying the bulk of the constructional labour and plant.

The greater part of the material used in constructing the airfields is provided by the British Government, and British contractors are employed on certain specialist installations. American constructional units are carrying out miscellaneous services on other airfields, including the provision of temporary track runways on selected grass airfields.

Where the U.S.A. units are "main contractors" a rough valuation of the respective efforts of the U.S. and the U.K. by way of labour, plant and stores is: United States, £5,000,000, and United Kingdom, £11,500,000. The miscellaneous services by the American units will probably account for a further £5,000,000.

Over the whole constructional programme of airfields, camps, depots and miscellaneous installations in the United Kingdom for British, Dominion and Allied Air Forces, the respective efforts of the two countries, by way of labour, plant and stores are United States, £10,000,000, and United Kingdom, £605,000,000. The U.S. contribution in services and materials to the total constructional cost of airfields, depots, etc., in Britain is about 1.6 per cent., and towards those constructed for the U.S.A.A.F. about 8.5 per cent.

In a country of the size of Great Britain, the construction of so large a number of airfields has involved serious encroachments on land formerly available for agricultural and other purposes. It is not possible to express in money form what this diversion has involved, but it is very considerable.

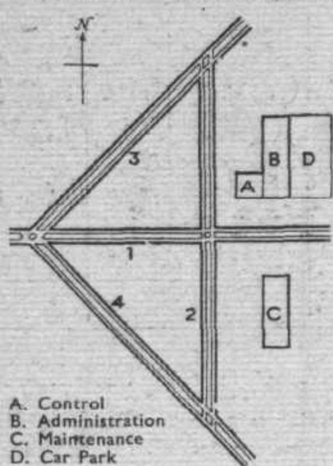
CORRESPONDENCE

The Editor does not hold himself responsible for the views expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

AIRPORT DESIGN

Another Suggested Layout

WITH reference to the letter in *Flight*, November 11th, *re* "Airport Design," I enclose a small scale plan of a type of airport I have designed which might be considered suitable for the four "Metropolitan Air Terminals" which will be required to take care of the future Northern, Southern, Eastern and Western air traffic to and from London.



Care should be taken when erecting airports to take into consideration the points of the compass and the resultant lighting of the runways from the control tower view. Further, arrangements should be made for radio and night flying beacons and other auxiliary equipment necessary for the most up-to-date and efficient design, construction, maintenance and operation of metropolitan and municipal air termini.

I should be pleased to confer with responsible authorities interested in this matter.

W. R. DAINTY,
Hon. Capt. R.A.F. (R.N.), Ret., Consulting Engineer.

TECHNICAL TRAINING

Purely a Matter of Finance

I READ with interest in the November 11th issue of *Flight* that Mr. Biles, of Blackburn Aircraft, Ltd., stressed the need for more advanced technical training of aircraft engineers when he recently addressed the Hull Rotary Club.

Whereas I am in agreement with this statement, in the interests of the industry and civil aviation in general, I wonder whether he realises the cause of the present state of affairs. In my opinion, it can be summed up in one word—"finance."

The average father is not going to send his son to the university to sit for a degree unless he thinks that there is going to be a reciprocal action financially at the end of it for his son, and the number of technical posts which command a salary commensurate with the outlay, in this country, is very few.

On the other hand, the father will let his son go into the practical side of aircraft engineering, knowing full well that at the age of 21 he will command at least a living wage, and by using a little intelligence and interest he can amass sufficient knowledge to command a post where he will be at least as well, if not better off, than he would be had he studied at a university for some years.

The matter thus reverts to the law of supply and demand. If the public demand is great enough the universities will see to it that a specialised branch of study—in this case aeronautical engineering—is created. If, on the other hand, it is the industry which requires the product, would it not be a good idea for them to sponsor the scheme themselves and then see to it that these young men are treated financially in accordance with their expenses and consequent qualifications.

Pre-war, the market was flooded with B.Sc.s, expensive to acquire, but virtually worthless on the average, because the industry favoured the practical man.

I myself was fortunate in being guided by some of the leading men in aeronautics on to the practical side of the industry, and although I regret the lack of technical knowledge in the true sense of the word, I am sure that I am just as necessary and important a member of the team of constructors as the man employed on design, and, age for age, there is no comparison from the remunerative aspect. I quote this fact because no doubt the father of the budding aeronautical engineer of the future will see it in the same light, and before sending his son to the university to study for an aeronautical degree will want some guarantee as to the outcome.

"THIRTY-YEAR-OLD."

THEORY OF FLIGHT

Mathematical Argument

WITH reference to an aircraft gliding into wind, suppose it be at height h above the ground, gliding steadily at angle α with velocity V relative to a head wind velocity v. Take the A.U.W. to be W.

Then with the conventional notation, we have

$$\text{Lift} = C_L \cdot \tfrac{1}{2}\rho SV^2 = W\cos\alpha$$
$$\text{Drag} = C_D \cdot \tfrac{1}{2}\rho SV^2 = W\sin\alpha$$

Dividing, we get $\dfrac{C_L}{C_D} = \cot\alpha$

Now the range in still air is

$$h\cot\alpha = h\frac{C_L}{C_D}$$

Thus the total range into the head wind is $h\dfrac{C_L}{C_D} - vt$.

The term $h\dfrac{C_L}{C_D}$ defines the optimum gliding angle (for $\left(\dfrac{C_L}{C_D}\right)_{max}$) and is independent of W, depending solely on the aerodynamic properties of the aircraft.

As W decreases, for the same value of $\left(\dfrac{C_L}{C_D}\right)_{max}$, V decreases, and hence t and vt increase, thereby diminishing the range into wind, and similarly increasing the range downwind.

That is, landing into wind, retain all weight to get down in the shortest possible time, but landing down wind, lighten as much as possible to remain airborne as long as possible.

D. RAYMOND HORNER.

VICTORY THROUGH AIR POWER

Air Battleships Not Practical

THE recent article by Frank Murphy on "Victory Through Air Power" may be all right for an armchair dream but not as a practical policy, since an air battleship cannot hope to obliterate enemy planes as visualised.

At present, by air-bombing, an aircraft factory producing, say, 30 planes per week, can be put out of action for several months at least at a cost of about ten bombers. This means an Axis loss of about 400 machines—a 40-1 ratio. Could the air battleship do this?—certainly not! A battleship is a ship to give battle, granted, but to do this it is fitted with the largest calibre guns so that it can shell a smaller vessel which has not the range for return fire.

The air battleship, with its loads of ammunition, armour-plating, gun turrets, etc., would be much less manœuvrable than a fighter, which rules out the idea of carrying fixed armament. A conventional fighter with fixed large calibre cannons has a considerably greater fire range than a turret-mounted weapon, which is much more restricted in size. Is it therefore still an air battleship?

The jet-propulsion idea is as amusing as it is impossible. The author says it can be silent (but what about the turbine motor plant?), and by being inside the fuselage can be well protected. But, if you have the propulsive flow through the fuselage, where are the numerous turrets to be fitted? *Re* the repair advantage, if the single central motor plant is damaged in flight, the plane probably would not return to base to be repaired.

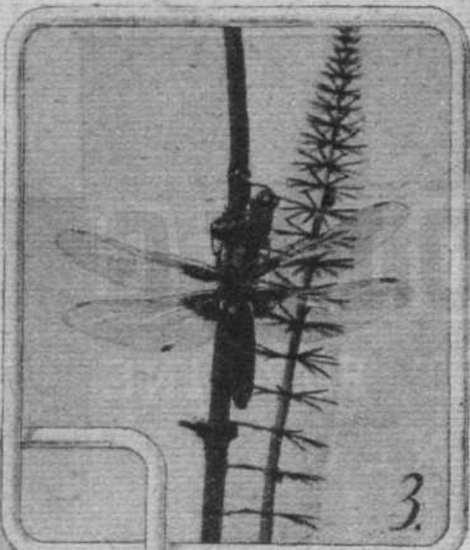
The article states that it is not too late to start building them; that they could be built in 12 months, despite the fact that jet-propulsion will be several years before it is of practical every-day use. Even using a modified bomber with standard power plant, it would be almost two years before a prototype could be perfected and 1,000 machines built only at the cost of making a big hole in our bomber programme.

The idea appears to be to store the machines until the 1,000th is made then use them all at once. What a magnificent waste of labour and material!

By this time (supposing the war is not over) our present expanding bombing policy would have stopped the enemy plane flow at its source, i.e., the factories, and done the job of the air battleships, so that there would be 1,000 more machines for the scrap-heap.

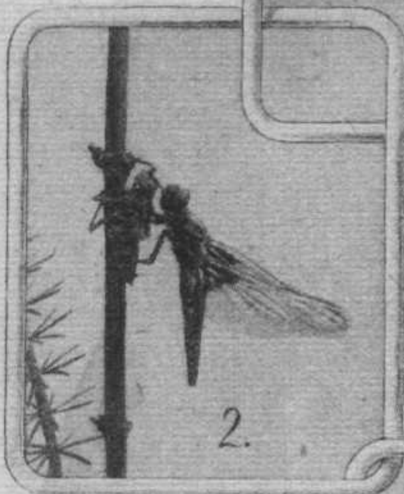
DONALD H. LORD.

EVOLUTION OF A "Sprog"



3. *Spreading its wings ready for flight.*

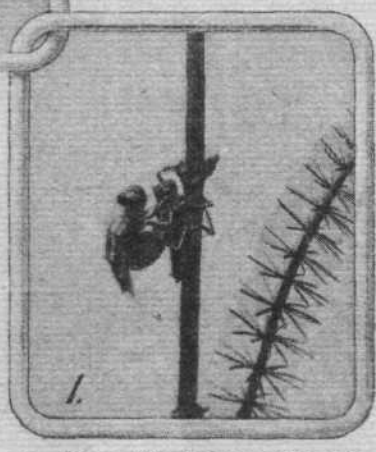
This advertisement — like every aspirant to flight—has to start at the bottom. It shows the speedy acquisition of "Wings"—without tuition—of how to become a master of miles without a Miles Master.



2. *Newly born Dragon Fly drying its wings.*

Reynolds had to start from the bottom (*i.e.*, terra firma) before they "took to" the air, many years ago. They are constantly being assured that their Aircraft Components are masterpieces of strength and lightness.

Photographs : John J. Ward, F.R.E.S.



1. *Dragon Fly Embryo emerging from the water.*

But Reynolds are wise—they've never stopped learning. Nor do they intend to, while British Aeronautical design demands their research.

TUBES·RODS·SECTIONS·SHEET·STRIP IN "HIDUMINIUM" ALUMINIUM ALLOYS

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"Most spectacular A.A. action of the week is credited to a mixed 3.7 battery. With a direct hit they brought down a Me.109 reconnaissance plane flying at 36,000 feet (seven miles)."
—*Daily Press*, 22/8/43.

OFFICIAL comment: "Remarkable for A.A. gunnery to score a direct hit at such a terrific height." The precision engineering which made it possible is not less astounding. What marvels of accuracy, for instance, in the radio location instruments and the gun ranging mechanism—the zero of error! Such precision engineering, in pre-war days, distinguished the British Salmson car, but for the duration it is being devoted to war work.

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SERVICE AVIATION

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Royal Air Force and Fleet Air Arm News and Announcements

Mark I Hawker Hurricanes of the Greek Air Force on a desert airfield in the Middle East.

Promotions

GENERAL DUTIES BRANCH.

Air Comdre. S. E. TOOMER, D.F.C., is granted the rank of Act. Air Vice-Marshal. September 2nd, 1943.

TECHNICAL BRANCH

Air Comdre. (temp.) R. O. JONES, A.F.C., is granted the rank of Air Comdre. (war subs.). October 28th, 1943.

Air Commodores (temp.) are granted the rank of Group Captain (war subs.):

[illegible] H. ALLEN, D.F.C. May 1st, 1943.
W. [illegible]THEAK. June 15th, 1943.

Awards

THE KING has been graciously pleased to approve the following awards in recognition of gallantry displayed in flying operations against the enemy:—

Distinguished Service Order

Act. Wing Cdr. E. F. J. CHARLES, D.F.C., R.A.F.—Wing Cdr. Charles is an inspiring leader, whose great skill and tenacity have contributed materially to the successes obtained by the formations with which he has flown. In September, 1943, he led a formation of fighters which acted as escort to a bomber force detailed to attack an airfield in Northern France. During the operation, 12 enemy fighters were engaged and, in the ensuing combats, four of the hostile aircraft were shot down, one of them by Wing Cdr. Charles. This officer has destroyed at least 15 enemy aircraft and has displayed great courage and unflagging devotion to duty.

Sqn. Ldr. D. H. DUDER, D.F.C., R.A.F.O., No. 77 Sqn.—Since being awarded the D.F.C. this officer has completed many sorties. He has attacked his targets fearlessly and vigorously and thereby has achieved much success. Sqn. Ldr. Duder is an ideal leader, whose example of sustained gallantry and devotion to duty has merited the highest praise.

Distinguished Flying Cross

F/O. W. E. HOOL, R.A.F., No. 462 Sqn.
F/O. J. C. JOHNSON, R.A.F.V.R., No. 104 Sqn.
F/O. D. B. WILLIAMS, R.A.F., No. 34 Sqn.
P/O. F. E. MCLAREN, R.C.A.F., No. 104 Sqn.
P/O. G. W. PALMER, R.N.Z.A.F., No. 159 Sqn.
W/O. G. S. HALLEY, R.N.Z.A.F., No. 462 Sqn.
Act. Sqn. Ldr. D. B. HODGKINSON, R.A.F.O., No. 179 Sqn.
Act. Flt. Lt. M. R. CHICK, R.A.F., No. 85 Sqn.
Act. Flt. Lt. S. J. COLEMAN, D.F.M., R.A.F.V.R., No. 83 Sqn.
Act. Flt. Lt. W. R. THOMPSON, R.C.A.F., No. 83 Sqn.
F/O. J. H. COLEY, R.A.F.V.R., No. 83 Sqn.
F/O. D. F. MCCRAE, R.C.A.F., No. 179 Sqn.
F/O. R. K. SENIOR, R.A.A.F., No. 179 Sqn.

Distinguished Flying Medal

Act. Flt. Sgt. D. M. C. SILVERMAN, R.A.F.V.R., No. 156 Sqn.
Act. Flt. Sgt. M. J. E. STONELEY, R.A.F.V.R., No. 156 Sqn.

Fox

W/O. N. F. Williams who has the C.G.M. and D.F.M. and Bar. Note the Pathfinder badge below the ribbons.

Sgt. W. LEARY, R.A.F.V.R., No. 61 Sqn.
Sgt. S. L. WILKIE, R.A.F., No. 156 Sqn.
Sgt. H. D. S. WHITE, R.A.F.V.R., No. 35 Sqn.
Sgt. H. ASPINALL, R.A.F.V.R., No. 61 Sqn.
Sgt. E. J. KEMISH, R.A.F.V.R., No. 61 Sqn.
Sgt. B. KENDRICK, No. 61 Sqn.
Sgt. S. R. DIDSBURY, R.A.F.V.R., No. 605 Sqn.
Sgt. J. GEDDES, R.A.F.V.R., No. 434 (R.C.A.F.)
Sgt. E. HEAP, R.A.F.V.R., No. 101 Sqn.
Flt. Sgt. J. OXENBURGH, R.A.F.V.R., No. 158 Sqn.
Flt. Sgt. A. E. WINN, R.A.F.V.R., No. 158 Sqn.
Flt. Sgt. A. W. E. JONES, R.A.A.F., No. 142 Sqn.
Flt. Sgt. D. W. LLOYD, R.A.F.V.R., No. 420 (R.C.A.F.) Sqn.
Flt. Sgt. J. F. SAMSON, R.A.F., No. 682 Sqn.
Sgt. C. G. NICHOLLS, R.A.F.V.R., No. 420 (R.C.A.F.) Sqn.
Sgt. F. M. JACKSON, R.C.A.F., No. 420 (R.C.A.F.) Sqn.
Sgt. R. E. J. PRING, R.A.F.V.R., No. 142 Sqn.
Sgt. R. H. STOW, R.A.F., No. 51 Sqn.
Sgt. J. TEASDALE, R.A.F.V.R., No. 101 Sqn.
Sgt. D. F. TRIBE, R.C.A.F., No. 12 Sqn.
Sgt. R. D. WILSON, R.A.F.V.R.

Fleet Air Arm

THE KING has been graciously pleased to approve the following award:—

For bravery in rescuing the pilot of a crashed aircraft:

Mention in Despatches

Air Mech. (A) 1st Cl. L. BUTLER.
Act. Air Artificer 4th Cl. F. EVANS.

Roll of Honour

Casualty Communiqué No. 312.

THE Air Ministry regrets to announce the following casualties on various dates. The next of kin have been informed. Casualties "in action" are due to flying operations against the enemy; "on active service" includes ground casualties due to enemy action, non-operational flying casualties, fatal accidents and natural deaths.

Of the names in this list, 103 are second entries giving later information of casualties published in earlier lists.

Royal Air Force

KILLED IN ACTION.—Act. Sqn. Ldr. K. F. D. MacDonald.

PREVIOUSLY REPORTED MISSING BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. E. Hartley; W/O. H. Holcombe; Sgt. A. E. Holland; Sgt. J. Kirby; Sgt. R. B.

SERVICE AVIATION

MacWilliam; Sgt. R. Shaw; Sgt. R. W. Shearen; Sgt. R. McG. Wilson.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. G. C. Adam; Flt. Sgt. C. Bentley; P/O. W. T. C. Chambers; Cpl. R. E. Chandler; Sgt. J. Cooper; F/O. A. Daley, D.F.M.; Sgt. T. Dawson; Flt. Sgt. E. B. Davies; Sgt. P. J. Egan; Sgt. R. G. Elkins; Sgt. J. A. J. D. Hatton; A/C.1 H. H. Hutchinson; Sgt. L. H. Jenkins; Sgt. G. E. Jones; Sgt. A. I. MacKay; Sgt. C. G. H. MacTavish; Sgt. E. Milne; Sgt. H. Moxon; F/O. F. A. Parton; P/O. G. M. Pettigrew; Sgt. W. D. Ramsay; Flt. Sgt. H. F. R. Stettiner; Sgt. R. T. Williams.

WOUNDED OR INJURED IN ACTION.—Sgt. T. A. Campbell.

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—Flt. Sgt. D. H. Bareham; F/O. W. R. Collins; F/O. J. R. Wilcox.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. J. Billington; Sgt. D. R. Browne; F/O. D. J. Carpenter; Sgt. W. E. Candell; Sgt. P. Crow; Sgt. J. Davis; Sgt. W. Findley; Sgt. W. Kidd; Sgt. C. H. McAulay; Sgt. S. Mackrell; Sgt. H. McQuade; Sgt. J. F. Maxwell; Sgt. C. H. A. Warner; P/O. J. F. Waterman.

MISSING.—Sgt. W. M. F. Barnet; Sgt. A. R. D. Bedbrook; Sgt. R. E. Belton; Sgt. J. H. Bennett; Sgt. K. E. Bright; P/O. W. G. Brown; Sgt. G. B. Buchan; Sgt. E. G. Bull; Sgt. W. Burnell; Flt. Sgt. J. T. Carruthers; Sgt. A. S. Carscadden; Sgt. V. J. Caselton; Sgt. J. T. Cawthorne; Sgt. J. S. Clenton; Sgt. B. H. Cockcroft; Sgt. C. J. Cooper; Sgt. R. G. Cooper; Act. Flt. Lt. B. Cottrell; Flt. Sgt. A. R. Crowther; Sgt. E. V. Dean; Sgt. H. R. Delahay; Sgt. D. T. F. Doyle; Sgt. J. Cowap; Sgt. F. J. Edser; Sgt. A. W. F. Edwards; P/O. A. E. Ferguson; Sgt. H. Fisher; Sgt. A. R. Fleming; Sgt. R. V. S. Forsdick; Sgt. K. Gilbey; Flt. Sgt. C. A. Goddard; F/O. W. W. Goldberg; Sgt. E. C. Harris; Sgt. P. Hinson; P/O. S. G. Holman; Sgt. T. Hoyle; Sgt. G. Innis; Sgt. C. G. James; Sgt. H. I. Jones; Sgt. W. Kershaw; Flt. Sgt. W. J. King; Sgt. R. O. Lander; Sgt. R. Lawson; Sgt. R. McKeag; Sgt. H. R. Mantle; Flt. Sgt. W. J. H. Menlove; Sgt. K. A. Metcalf; Sgt. A. Moore; Sgt. R. Nelson; Sgt. E. E. Nicholls; Sgt. J. P. Parsons; F/O. D. W. Philip; Sgt. W. J. Price; Sgt. G. G. Read; Sgt. J. A. G. Reynolds; Sgt. A. Ridley, Sgt. W. H. Saunders; Flt. Lt. E. D. A. Shepherd; P/O. H. W. Shinn; Sgt. E. J. Smith; Flt. Sgt. J. S. Smith; Sgt. W. L. Smith; P/O. F. E. Somers; Sgt. F. Sumner; Sgt. A. Sutcliffe; Sgt. B. F. Trew; Sgt. W. Tucker; Sgt. N. A. Tyreman; Sgt. L. F. Valentine; Sgt. J. J. Waterman; Sqn. Ldr. R. C. Watson; Sgt. T. Whatley; Sgt. F. Watling; Flt. Sgt. G. S. Wilkinson; Act. Flt. Sgt. G. Wilson; Sgt. R. C. Woolnough.

KILLED ON ACTIVE SERVICE.—Sgt. A. B. Allen; Flt. Sgt. C. H. Baldwin; Sgt. J. W. Bamber; Act. Flt. Lt. D. De B. Banham; P/O. R. W. Browne; Sgt. H. J. Burkhard; Sgt. D. Gale; Sgt. J. A. L. Grant; Sgt. D. G. Keith; P/O. I. C. B. Kenyon; Sgt. W. D. Kershaw; Sgt. N. Kidd; Sgt. L. G. Leatherland; Sgt. J. Leeming; Flt. Sgt. I. R. MacMillan; L.A/C. V. L. Malley; P/O. G. J. Mansfield; Sgt. H. Picking; P/O. A. M. Reith; Act. Flt. Lt. F. J. Robinson; F/O. R. E. Ryan; Flt. Sgt. W. H. Sellars; Sgt. G. Sweeney; F/O. K. R. Taylor; P/O. J. R. Waldron; Sgt. S. W. Whalley; F/O. A. C. Wilson; Sgt. E. Young; F/O. G. H. Young.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Sgt. G. E. Morris; Sgt. F. Robinson.

WOUNDED OR INJURED ON ACTIVE SERVICE.—Cpl. H. A. Buckles; L.A/C. H. K. Dain; Flt. Sgt. R. H. Field; Sgt. S. R. Williams.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—L.A/C. W. S. Gardiner.

DIED ON ACTIVE SERVICE.—L.A/C. F. J. Barnes; P/O. D. R. Ford.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—Act. Flt. Lt. D. R. Bigg; Sgt. W. E. Broxup; Sgt. J. Egleston; F/O. F. A. James; Sgt. M. J. Maloney; P/O. A. G. Sadler; Sgt. E. H. Stanton.

Royal Australian Air Force

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Flt. Sgt. P. J. Cramer; Flt. Lt. T. H. Gordon-Glassford; P/O. E. P. Heinrich, Sgt. D. Hood; Sgt. A. Knight; Flt. Sgt. G. J. Matheson; Sgt. H. T. Waddell.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. N. E. Bellman; Flt. Sgt. R. T. Gregory; Flt. Sgt. B. A. Kelly; F/O. S. T. J. Rundle.

MISSING.—Sgt. W. E. Bryden; Flt. Sgt. W. J. Browne; P/O. J. C. Collins; P/O. N. H. Denyer; P/O. D. L. Dodds; Flt. Sgt. C. A. Fleisch-Fresser; Flt. Sgt. E. A. Hill; Flt. Sgt. D. Livingstone; F/O. J. D. Mackay; Sgt. G. V. McMurray; Flt. Sgt. A. N. Moore; Flt. Sgt. F. O'Dwyer; F/O. L. W. Roper; F/O. M. O'M. Shanahan; Act. Flt. Lt. H. N. Stafford; P/O. R. W. Wildman.

KILLED ON ACTIVE SERVICE.—Flt. Sgt. A. E. Manners.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Sgt. P. J. Fitzgerald; Sgt. J. H. W. McDonagh; Sgt. H. S. Stockbridge; Sgt. S. R. Wright.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—Flt. Sgt. A. Burton.

Royal Canadian Air Force

KILLED IN ACTION.—Flt. Sgt. W. H. Allan; P/O. W. I. St. Johns; F/O. C. R. Wharram; P/O. R. W. Wolfe.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. J. E. Audy; Flt. Sgt. J. J. B. A. Dugal; Sgt. W. C. Forbes; P/O. J. V. L. Gauthier; P/O. J. Glassberg; Flt. Sgt. V. R. Henry; Flt. Sgt. J. W. M. E. Lanctin; Flt. Lt. F. E. Luxford; Flt. Sgt. W. J. McAlpine; Sgt. G. E. McDonald; Flt. Sgt. J. D. White.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. E. A. Applegate; P/O. M. E. Barker; F/O. D. E. Bennett; P/O. J. L. R. Cartier; Flt. Sgt. D. G. Culver; Sgt. F. H. De Nevers; Sgt. C. B. Finley; F/O. E. D. Fleishman; Sgt. W. E. Foster; P/O. R. Graham; Sgt. P. B. Gustavsen; P/O. H. G. Harwood; Sgt. R. G. Hill; Flt. Sgt. G. T. Hillman; Sgt. W. Kwasney; Sgt. J. C. Lamond; Sgt. H. T. A. Lawson; Sgt. H. F. MacArthur; F/O. J. K. MacDonald; Act. Flt. Lt. J. A. McKinnon; Sgt. S. B. Robson; Sgt. G. G. Sawatzky; Flt. Sgt. H. M. Slezak; Sgt. P. Sutherland; Flt. Sgt. R. T. Taylor; P/O. F. E. Vale; Flt. Sgt. J. O. Way.

WOUNDED OR INJURED IN ACTION.—Sgt. C. McD. Gauthier.

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—F/O. J. C. Miller.

MISSING.—Sgt. E. A. Cannon; Flt. Sgt. E. B. Capin; F/O. P. H. Coates; Sgt. R. W. B. Collins; Sgt. C. W. Gibbs; P/O. W. E. Grindley; F/O. J. M. Lauder; Sgt. H. Perry; Sgt. H. M. Porteous; Sgt. A. F. Todd; Sgt. J. R. Trace; Sgt. K. D. Wellwood.

KILLED ON ACTIVE SERVICE.—P/O. K. B. Thomas; P/O. E. L. Ware.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Sgt. M. H. Hargreaves.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—P/O. E. W. Davidson.

Royal New Zealand Air Force

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. G. B. Marsh.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. I. F. Bailey; Sgt. J. H. Beebe; Sgt. D. H. Gordon; P/O. D. Harding-Smith; P/O. M. R. Jeffery; Sgt. A. Scott; Flt. Sgt. J. A. Tovey.

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—Flt. Sgt. J. G. G. Turner.

MISSING.—F/O. P. T. Brosnahan; Sgt. R. W. Cooke; Flt. Sgt. G. S. Dougherty; F/O. B. F. Edge; W/O. T. H. Hatchard; F/O. N. R. S. Humphreys; Sgt. L. H. Kainamu; P/O. S. T. Schmidt; Flt. Sgt. L. A. Squire; P/O. E. S. Wilkinson.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—Flt. Sgt. E. A. Brown; F/O. A. E. Boulton; Flt. Lt. K. Neilson.

Casualty Communiqué No. 313.

Of the names in this list 89 are second entries giving later information of casualties published in earlier lists.

Royal Air Force

KILLED IN ACTION.—P/O. A. D. Ashton; F/O. J. G. Finney; P/O. N. H. Gale; Sgt. A. L. Mellor; Sgt. G. Weston.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Act. Flt. Lt. H. P. Atkinson; Sgt. G. T. Tattam.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. J. H. A. Beath; Sgt. W. J. S. Boyd; Sgt. H. Chatterton; Sgt. J. S. Dobie; Sgt. G. G. Ellis; Sgt. R. E. Elvin; Flt. Sgt. W. R. Erasmus; Sgt. R. W. Grellier; Sgt. K. H. Hogarth; F/O. J. B. Lapping; F/O. R. G. Lewis; P/O. D. Llewelyn; Sgt. M. McKenzie; Flt. Lt. J. B. Michie; F/O. A. L. Munro; Sgt. J. G. J. Nolan; Sqn. Ldr. W. H. Powdrell; Flt. Sgt. J. V. Roper; Sgt. G. S. Pring; Sgt. S. J. Rose; Sgt. J. Smith; F/O. D. J. N. Southern; Sgt. M. W. Stephenson; Sgt. T. F. Stocks; Sgt. C. J. Tiley; Sgt. J. A. Todd; Sgt. J. S. Turner; Sgt. E. S. Waghorn; P/O. D. Young.

WOUNDED OR INJURED IN ACTION.—Sgt. H. G. Foster; Sgt. E. P. L. Marvin.

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—F/O. L. J. Wood.

PREVIOUSLY REPORTED MISSING, NOW REPORTED DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—F/O. R. J. T. Brown.

MISSING, BELIEVED KILLED IN ACTION.—P/O. Arch; P/O. W. Biggs, D.F.M.; Flt. Sgt. Billows; Sgt. R. D. Britton; F/O. R. T. Carnery; Sgt. R. G. Craig; F/O. S. B. Cuthbert; Sgt. R. E. Fuller; W/O. W. A. Jeffries; Sgt. J. Jennings; Sgt. H. Moran; Flt. Sgt. L. E. Moyler, D.F.M.; F/O. J. M. Reed; Sgt. H. Revell; Sgt. R. B. Spence; Flt. Lt. A. R. Wall.

MISSING.—Sgt. A. Astin; P/O. H. Basnett; Sgt. W. J. Batty; Sgt. J. Baxter; P/O. A. J. Beazleigh; Sgt. A. E. Best; P/O. P. T. Beszant; P/O. G. E. Bilke; P/O. W. Booth; Act. Flt. Lt. C. D. Boothby, D.F.C., D.F.M.; Flt. Sgt. R. F. Broad; P/O. A. J. E. Brown; Sgt. D. W. Burdett; Sgt. P. B. Cameron; F/O. W. J. Cameron; Sgt. R. E. Clark; Sgt. J. C. Combes; P/O. E. C. Cook; Sgt. W. A. Cooper; Sgt. A. Cousins; Sgt. F. E. W. Crowther; Sgt. K. W. Darrah; Sgt. T. S. Davies; Sgt. J. O. Davies; P/O. D. M. D'Earth; P/O. E. H. Dee; Sgt. A. S. D. Dobie; F/O. A. G. Douglas; Sgt. C. P. Ellins; Sgt. L. J. Ellis; Sgt. M. Emmerson; Sgt. B. A. Fear; P/O. C. R. Fraser; F/O. A. Guthrie; Flt. Sgt. S. Hatton; Sgt. T. J. Hegarty; Sgt. S. H. Hill; Sgt. J. E. Hoey; Sgt. N. T. Holmes; Sgt. J. S. Hornsby; F/O. J. P. Ingham; Sgt. L. T. Johnson; Sgt T. Jolly; Sgt. A. G. Jordan; Sgt. H. F. Jowett; Sgt. R. T. H. Kearnes; Sgt. G. Leedham; Sqn. Ldr. C. R. Kelaher; Flt. Sgt. W. H. Lowe; P/O. W. T. Mathison; Sgt. H. Milner; P/O. P. T. Murphy; Sgt. P. C. O'Kill; Sgt. R. J. Partridge; F/O. D. B. Pope; P/O. J. Read; P/O. J. A. Reid; Sgt. A. Rolfe; Sgt. K. Runciman; P/O. G. A. Scarcliffe; Sgt. J. A. Smith; Sgt. G. W. S. Spriggs; Sgt. T. Stewart; Sgt. R. E. Tate; Sgt. E. A. C. Thirkettle; Sgt. W. Todd; Sgt. C. R. Varley; Sgt. W. Walker; P/O. W. Wardrop; Sgt. J. C. Whitley; Sgt. F. P. Wilby; Sgt. A. J. Williams; W/O. L. Williams; Sgt. A. E. Woodacre; Sqn. Ldr. N. W. Wright.

KILLED ON ACTIVE SERVICE.—Sgt. J. Abbott; Sgt. D. N. Barker; F/O. B. Barkworth; Flt. Lt. G. W. Bellis; F/O. A. C. Burzell; F/O. H. Cameron, D.F.C.; Sgt. D. H. Collings; Sgt. A. W. V. Fear; W/O. V. P. Friese; Sgt. J. J. Garner; Sgt. D. I. Goolellow; Flt. Sgt. J. E. Green; F/O. R. Hellewell; L.A/C. G. J. Kilgallon; P/O. A. M. McBride; L.A/C. N. A. Manning;

Pupils of the Indian Air Force bombing-up a Vultee Vengeance dive bomber.

MoI ~~CNA~~ 1940

Flt. Lt. T. R. Meggitt; Sgt. R. Morriss; A/C.2 W. H. O'Dell; F/O. H. V. Plumb; W/O. R. Renaut; Act. Sgt. R. J. C. Rinaldi; L.A/C. D. O. Robbins; Act. Sqn. Ldr. J. E. Scott, D.F.C.; Sgt. B. M. Semark; W/O. W. L. Smith; Cpl. W. Somerville; Sgt. D. L. Spence; F/O. H. Stevens; Act. Sgt. D. H. D. Thompson; A/C.2 J. White; Sgt. W. A. Widdowson.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED ON ACTIVE SERVICE.—P/O. E. J. Almeroth; A/C.2 F. C. Bell; Sqn. Ldr. D. J. Brown; Sgt. N. R. Brunt; Sgt. E. W. Carter; Flt. Sgt. C. A. Cowley; Sgt. W. Elliott; Cpl. E. L. Hall; Sgt. M. G. B. Hall; P/O. H. V. Iggulden; Sgt. B. Jackson; Flt. Lt. C. W. Johnstone; Flt. Sgt. D. G. Kelly; Flt. Lt. H. L. Madge; Sgt. J. R. O'Meara; Sgt. G. Overhill; Flt. Lt. D. J. W. Page; Flt. Lt. W. Parkinson; P/O. C. A. Rodgers; P/O. V. P. Rogers; Cpl. J. W. Sherwin; P/O. R. W. Sills; Sgt. K. C. Simpson; P/O. K. A. Simpson; Sgt. A. Skinner; Flt. Lt. J. F. Soden; Sgt. N. S. Stedman.

WOUNDED OR INJURED ON ACTIVE SERVICE.—F/O. J. S. Hemmings; Sgt. R. C. McCallum; Sgt. L. W. Thompson.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—F/O. T. C. Morris, D.F.C.

DIED ON ACTIVE SERVICE.—A/C.2 H. T. Bailie; Cpl. R. Carswell; A/C.2 D. McP. Craig; L.A/C. C. Crowe; L.A/C. H. Griffin; L.A/C. G. Jones; Sgt. A. E. Joyce; A/C.2 G. DeB. McCann; Sgt. D. McC. Morton; L.A/C. A. Mott; A/C.1 S. Murphy; L.A/C. W. P. Newman; L.A/C. G. Robson; L.A/C. R. W. Sainsbury; L.A/C. R. Scrase.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—P/O. F. W. Bennett; Sgt. A. D. Gillespie; Sgt. E. W. King; P/O. D. W. Lusty; Act. Flt. Sgt. R. F. MacDonald; Sgt. V. G. A. Moss; Sgt. W. R. Readhead; P/O. C. B. Reynolds; Sgt. C. T. W. Samways; Sgt. A. O. Simpson; Sgt. W. I. Thomas; Sgt. R. L. Watson; Sgt. H. Williams.

Royal Australian Air Force

KILLED IN ACTION.—Flt. Sgt. B. S. Evans.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Flt. Sgt. A. E. Pearce.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—F/O. J. I. Craig; Sgt. H. F. Ford; Sgt. M. C. Harrison; F/O. E. S. Hayes; Sgt. W. F. Higson; F/O. F. H. Mitchell; P/O. J. L. Rollins; Sgt. N. G. Smith.

PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED IN ACTION.—Flt. Sgt. L. A. Pearce.

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—W/O. R. E. Percival.

MISSING, BELIEVED KILLED IN ACTION.—Flt. Sgt. C. R. Gordon; Flt. Sgt. E. C. Hobbins.

MISSING.—Sgt. E. J. Anderson; W/O. E. G. Carthew; W/O. C. K. Dickson; F/O. S. M. Forrester; P/O. I. M. Holmes; Flt. Sgt. W. L. Jarvis; P/O. C. C. Logan; P/O. W. G. Nolan; Flt. Sgt. F. J. Page; F/O. M. G. Parker; Flt. Sgt. C. R. Thurston; W/O. C. A. Walsh.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE.—Flt. Sgt. F. A. Noonan; Flt. Sgt. R. R. Waddle.

KILLED ON ACTIVE SERVICE.—Sgt. E. N. Death; Flt. Sgt. D. J. Fernance; Flt. Sgt. L. B. Haberecht; Flt. Lt. N. G. Stewart; Flt. Sgt. F. C. Stringer; P/O. T. F. Swinney; Flt. Sgt. A. J. Vickerman.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW REPORTED PRISONER OF WAR.—F/O. E. N. W. Gray.

Royal Canadian Air Force

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—P/O. J. E. Bunt; Flt. Sgt. R. S. Donald.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. P. A. Campbell; Sgt. R. E. Dresser; P/O. A. Jackson.

MISSING.—Flt. Sgt. S. W. Abrams; Flt. Sgt. W. D. Anderson; F/O. L. B. Clifford; F/O. J. M. Downs; Sgt. D. C. Elliott; Sgt. J. P. Heinig; Flt. Sgt. J. T. Kendall; F/O. C. L. McPherson; Flt. Sgt. H. G. Northway.

KILLED ON ACTIVE SERVICE.—Sgt. J. G. L. Boisvert; Sgt. G. Henderson; Sgt. G. W. J. Hopkins; F/O. T. E. U. Lister; P/O. K. A. Norris; F/O. J. H. Rooney; Sgt. G. D. Scott.

DIED ON ACTIVE SERVICE.—Cpl. E. J. Ferrier.

Royal New Zealand Air Force

KILLED IN ACTION.—F/O. I. R. Menzies.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Flt. Sgt. R. O'Neill; Sgt. R. E. Sharp.

MISSING, BELIEVED KILLED IN ACTION.—Flt. Sgt. D. Bennett.

MISSING.—F/O J. A. Ainge; F/O. H. P. Sands; Flt. Sgt. G. P. Sowerby; Flt. Lt. G. Stenborg. D.F.C.

KILLED ON ACTIVE SERVICE.—F/O. F. H. Evers-Swindell; Sgt. W. Lauder.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Sgt. L. Hurst; W/O. E. O. Johnson.

South African Air Force

KILLED IN ACTION.—Lt. C. F. L. Ellis; Act Air Sgt. A. Harvey.

MISSING.—Lt. H. F. Boy.

Wing Cdr. Duncan Smith, D.S.O., D.F.C., Maj. Malcolm Ostler, D.F.C., and Group Capt. Fryan Kingcombe, D.S.O., D.F.C., and Bar, outside their mobile operations room in Italy. Group Capt. Kingcombe seems to have recovered from the facial injuries he received when a jeep turned over recently.

Casualty Communiqué No. 314.

Of the names in the list 102 are second entries giving later information of casualties published in earlier lists.

Royal Air Force

KILLED IN ACTION.—Act. Sqn. Ldr. D. J. H. Maltby, D.S.O., D.F.C.; Sgt. W. A. Morgan; Sgt. W. Watters.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. T. J. Daley; Sgt. G. S. Holme; Sgt. J. C. Lilley; F/O. L. Meakin; Sgt. A. D. Nicholson; Sgt. M. D. Peters; Sgt. A. Segal.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. V. D. Farmer; F/O R. A. Heywood; P/O. J. R. A. Hodgson; Sgt. R. Isaacs; Sgt. V. E. Jack; Sgt. A. M. James; Sgt. D. Keenan; Sgt. G. L. K. McCallum; Sgt. S. P. Shaw; Sgt. C. Wignall.

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—P/O. P. R. Colls; F/O. E. J. Pollock.

MISSING, BELIEVED KILLED IN ACTION.—F/O. A. G. G. Atkins; Sgt. K. S. H. Lawson; Sgt. D. B. Leslie; Sgt. E. J. Liptrott; P/O. S. A. R. Tanner; P/O. S. C. Turner.

MISSING.—Sgt. K. A. Adams; Sgt. G. E. Agate; Flt. Sgt. H. K. Bartlett; Sgt. A. W. Bentley; F/O. W. Birdsall; Sgt. C. A. Bradshaw; Sgt. J. H. Briggs; Flt. Sgt. T. J. Bright; Sgt. D. Bruce; Sgt. A. C. Brunton; Sgt. P. Cansfield; Act. W/O. R. B. Cant; Sgt. R. V. Chinnery; Sgt. S. F. Clarke; Sgt. C. Cobley; Flt. Lt. M. W. Colledge; Sgt. R. D. Collis; Sgt. A. S. Corlett; Sgt. R. C. L. Cummins; Sgt. T. W. Darvill; Sgt G. E. Davies; Flt. Sgt. B. P. Devine; Flt. Sgt. E. D. Dickson; Sgt. K. D. Ennis; Flt. Sgt. M. J. T. Finn; Sgt. J. Fletcher; Sgt. N. E. Fletcher; F/O. N. J. Fletcher; F/O. J. Fort, D.F.C.; Sgt. T. R. Fox; Sgt. E. G. O. French, D.F.M.; Sgt. L. C. Gay; Sgt. B. R. Giles; P/O. T. H. Gill; Sgt. W. Goldsbrough; Flt. Sgt. R. V. Gough; Sgt. R. Gough; Sgt. M. E. Haffenden; F/O. E. C. Hart; Sgt. W. Hatton; Flt. Sgt. V. Hill; Sgt. D. E. J. Hobbs; Sgt. E. Hollamby; Sgt. H. J. Hudson; Flt. Sgt. J. Hudson; Flt. Lt. R. T. Hunter; P/O. M. Irwin; Sgt. R. S. Johnson; Sgt. F. A. Jones; Sgt. J. H. C. Kilpatrick; Flt. Lt. B. L. Kenyon, D.F.C.; Sgt. J. C. Knowles; Sgt. K. McDonagh; Sgt. R. McKee; F/O. I. MacLean; Sgt. M. McPherson; F/O. G. L. Marshall; Flt. Sgt. G. W. Mayo; Sgt. J. G. Mein; Flt. Sgt. J. Mellor; W/O. K. F. Middlemist; Sgt. W. Milburn; Act. Flt. Lt. A. J. M. Milne, D.F.C.; Sgt. W. A. Morton; Sgt. W. H. Mudge; Sgt. G. A. Muffett; Flt. Sgt. V. Nicholson; Sgt. K. R. Norie; Sgt. H. Nuttall; Sgt. A. C. Powell; F/O. A. C. Puttick; Flt. Sgt. P. G. Quayle; P/O. P. E. Rollins; P/O. J. R. Scarles; Flt. Sgt. F. Shuttleworth; Sgt. H. T. Simmonds; F/O. W. R. Simpson; Sgt. A. R. Slaney; Flt. Sgt. C. Smith; Sgt. E. W. Smith; Sgt. S. J. Smith; Sgt. E. J. Smyth; Flt. Sgt. W. F. Speedie, D.F.M.; Flt. Sgt. A. J. Stone; Flt. Sgt. J. G. Stuart; Sgt. T. D. G. Teare; Sgt. G. C. Tew; Sgt. B. J. Thomas; Sgt. G. F. Thomas; Sgt. E. G. Truman; Sgt. J. E. Vidler; P/O. M. W. B. Walsh; Sgt. F. P. C. Walters; W/O. J. L. Welch, D.F.M.; P/O. T. R. Wilson; Sgt. G. S. Wood; F/O. R. Woodford.

KILLED ON ACTIVE SERVICE.—P/O. R. A. Baker; Sgt. T. Baker; Cpl. P. J. F. Beer; Flt Lt. T. D. B. Blake; Sgt. A. Bracey; Act. Group Capt. W. D. Butler; Sgt. E. J. Cooke; L.A/C. G. G. Crake; F/O. F. W. Easton; Flt. Sgt. L. W. J. Goodfellow; Sgt. H. P. G. Harris; F/O. C. T. Hicks; Sgt. E. D. Huntley; F/O. W. S. Jobling; Sgt. G. A. Kemp; Sgt. A. H. Lacey; L.A/C. D. McAlpine; Sgt. C. J Ringer; F/O. J. DeM. Rudolf; Flt. Lt. C. R. Sanders; P/O. N. C. A. Simms; Sgt. S. M. Smart; Sgt. A. J. Taylor; Sgt. G. H. Uttley.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Sgt. J. M. W. Barber; Sgt. R. J. Barrett; L.A/C. J. F. Bartlett; L.A/C. L. K. Baughan; Sgt. R. K. Blower; L.A/C. C. F. Briercliffe; Sgt. P. S. Burrow; L.A/C. J. G. Burton; L.A/C. J. Buxton; Sgt. W. Carpenter; Sgt. F. Chilton; L.A/C. B. A Clemow; Sgt. E. O. Cookson; Sgt. S. J. Coombes; L.A/C. C. V. Cox; Sgt. C. H. Cripps; P/O. P. H. Cumming; Flt. Sgt. G. R. J. Davis; Sgt. J. L. Davis; Sgt. L. J. Derrick; L.A/C. R. G. Dodson; Sgt. W. T. Dynes; L.A/C. E. Eccles; A/C.1 J. S. Elias; L.A/C. H. J. Emery; L.A/C. D. R. Evans; L.A/C. A. Fairhurst; P/O. J. G. Firth; Sgt A. E. Hammarton; P/O. C. Hanley; Flt. Sgt. W. Hann; P/O. E. H. C. Hanson; L.A/C. E. W. P. Hedley; A/C.2 J. E. Hill; Sgt. H. R. Hughes; Cpl. F. S. Humble; Cpl. W. J. Hunter; Sgt. D. G. Jackson; L.A/C. T. A. James; L.A/C. R. C. Jeskins; Cpl. G. Jones; Sgt. R. W. Kelsall; Cpl. J. W. Kent; Sgt H. F. King; P/O. H. Ledgerwood; Sgt. D. Y. McRobb; L.A/C. J. Martin; Flt. Sgt. R. Maslen; Sgt. D. Mason; Cpl. A. Moore; W/O. C. J. Morgan; L.A/C. D. S. Murray; L.A/C. J. McD. Nelson; L.A/C. W. J. R. Parry; Sgt. R. E. Pearce; Sgt. J. C. Perry; L.A/C. H. Pinchin; Sgt. E. S. Rhodes; L.A/C. W. Riley; Cpl. A. S. Stevens; Sgt. T. J. Street; Cpl. C. A. Swann; Sgt. R. W. Taylor; Act. W/O. C. E. Tuck; Sgt. L. G. Wiltshire; Sgt. A. E. Winstanley.

WOUNDED OR INJURED ON ACTIVE SERVICE.—Sgt. J. Pemberton.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—Sgt. H. G. Bright; Sgt. G. P. Cormier; Sgt. J. W. Swann.

DIED ON ACTIVE SERVICE.—L.A/C. F. W. Anderson; L.A/C. B. Batty; Cpl. F. Bickers; Cpl. F. Boswell; A/C.1 H. J. Coley; W/O. L. Edmunds; A/C.1 J. H. C. Goldfinch; A/C.2 J. L. Jefferies; Sgt. K. S. Kent-Phillips; L.A/C. J. Kyle; Sgt. J. C. Lloyd; L.A/C. F. S. Lucas; L.A/C. J. Marley; Group Capt. H. G. Wheeler.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—F/O. P. Daulby; Flt. Sgt. J. S. Foster.

Women's Auxiliary Air Force

DIED ON ACTIVE SERVICE.—A/CW.1 B. M. Wells.

Royal Australian Air Force

MISSING, BELIEVED KILLED IN ACTION.—Flt. Sgt. A. R. Breakspear.

MISSING.—Flt. Sgt. C. E. Adair; Sgt. F. B. Allan; F/O. W. Austin; Flt. Sgt. N. J. Conway; P/O. W. T. Farmer; Flt. Sgt. J. C. Gibney; P/O F. E. Mathers.

KILLED ON ACTIVE SERVICE.—Flt. Sgt. R. W. W. Frankish; P/O. G. A. McDougall; Flt. Sgt. M. F. Nolan.

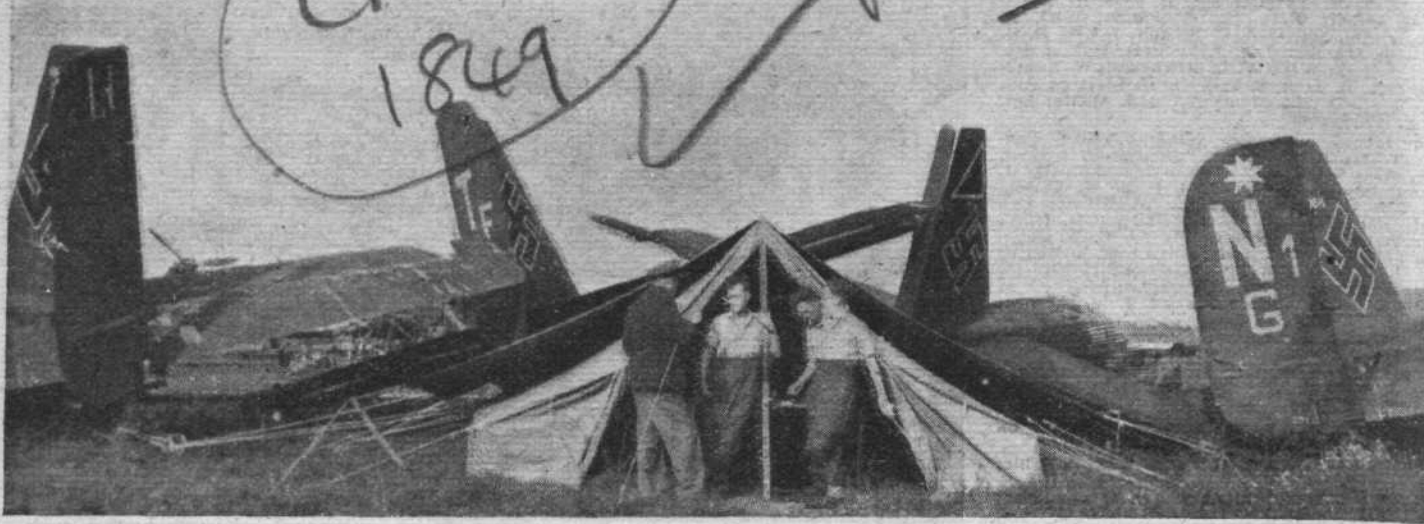
PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—Sgt. R. Shannon.

Royal Canadian Air Force

WOUNDED OR INJURED IN ACTION.—Sgt. F. D. Goodey.

CNP 1849

NOT



WIND BREAKS: Men of the R.A.F. Regiment pitch their tent in a Ju 52 graveyard in southern Italy. The initials on the tail on the right are singularly appropriate.

SERVICE AVIATION

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. H. G. Black; Flt. Sgt. J. E. Bradley; Sgt. T. E. J. Casey; Flt. Sgt. A. L. Cross; P/O. K. H. Dalton; Sgt. R. W. Drury; P/O. H. G. Farrington; F/O. G. D. Fitzgibbon; F/O. M. D. Fox; P/O. R. T. Hanbridge; Sgt. J. Maguire; Sgt. L. W. Phillips; Sgt. E. W. Roberts; Sgt. W. W. Scrimgeour; Sgt. H. W. Traver; P/O. A. M. Wark.

MISSING.—F/O. L. E. Aspinall; Flt. Sgt. L. J. M. Broderick; F/O. R. W. Burke; F/O. J. D. L. Cloutier; W/O. W. P. Coleman; P/O. H. G. Dickson; Flt. Sgt. R. S. W. Esmay; Sgt. L. F. Martin; F/O. H. F. E. Smith; Sgt. L. A. Stemmler; Sgt. K. C. Windsor.

KILLED ON ACTIVE SERVICE.—F/O. R. W. Conway; W/O. J. P. Haughey; Sgt. G. W. Munch; W/O. H. Pincock; Sgt. C. E. Russell; Sgt. R. H. Smith.

WOUNDED OR INJURED ON ACTIVE SERVICE.—W/O. J. R. West.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—W/O. J. A. R. Cote.

DIED ON ACTIVE SERVICE.—L.A/C. J. F. R. Gallant; Act. Flt. Lt. S. S. Williams.

Royal New Zealand Air Force

MISSING.—Sgt. D. C. W. Hamblyn; Flt. Sgt. J. S. J. McPhail.

KILLED ON ACTIVE SERVICE.—P/O. D. W. Wacher.

South African Air Force

MISSING.—Maj. E. C. Saville, D.F.C.

KILLED ON ACTIVE SERVICE.—Flt. Lt. R. Swart.

Casualty Communiqué No. 315.

Of the names in this list, 102 are second entries giving later information of casualties published in earlier lists.

Royal Air Force

KILLED IN ACTION.—Sgt. T. W. Brittain; Sgt. D. R. Coe; Sgt. C. R. K. Fay; Sgt. A. R. J. Gaiger; Act. Sqn. Ldr. A. T. Maudsley, D.F.C., D.F.M.; Sgt. R. Phillips; Sgt. E. T. Potts; Sgt. C. W. Shephard.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Flt. Sgt. A. Allan; Sgt. L. Barker; Sgt. A. R. Dawson; Sgt. J. Freel; Sgt. R. Heslop; Sgt. G. A. Hyatt; Sgt. R. J. Jenkins; Sgt. J. W. C. Kidd; Sgt. K. A. Mills; Sgt. P. Moulton; P/O. R. J. Paul; Sgt. F. Stephens; Sgt. K. J. Teague; Sgt. L. E. Thomas; Sgt. R. Wilson; Sgt. J. G. Wiseman.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. A. S. Aitchison; Sgt. J. C. Aldred; Sgt. J. H. Bousefield; Flt. Sgt. L. R. Brettle; F/O. J. D. Brodie; Sgt. L. A. Buckthorpe; Sgt. J. W. C. Clark; Flt. Sgt. B. R. C. Conway; Sgt. A. M. F. Cook; F/O. R. J. Curtis; Sqn. Ldr. D. F. W. Darling, D.F.C.; Sgt. L. Davies; Sgt. H. Dennis; Sgt. E. J. Dollard; Sgt. J. E. Edmeades; Sgt. P. N. Fellowes; Sgt. E. J. C. Florey; F/O. J. E. Foli-Brickley; Sgt. R. Frazer; P/O. S. E. Groves; P/O. C. R. Hall; Sgt. J. Harrison; Sgt. P. C. Harrison; Sgt. E. J. R. Hart; Sgt. N. J. Hill; F/O. D. J. Hopson; Sgt. C. Hotchkiss; Sgt. F. C. Howe; Sgt. J. W. Humphries; Sgt. S. Hunt; Act. Flt. Lt. R. O. Jones; Sgt. H. Kay; Sgt. K. A. S. Keston; Sgt. K. G. Lambert; P/O. W. G. Lee; Sgt. A. M. Limbrick; Cpl. G. Love; Sgt. T. McCall; Sgt. H. S. McCartney; Act. Flt. Lt. J. McMillan; Sgt. F. R. Marples; Act. Flt. Lt. G. L. Maxton; Flt. Sgt. E. A. Meadwell; P/O. G. H. Miller, D.F.M.; Sgt. E. Mudd; P/O. A. J. S. Ollar, D.F.M.; Sgt. W. H Parsons; Sgt. C. G. Phillips; Sgt. P. Popoff-Rikovsky; Sgt. N. Pringle; Sgt. G. F. Roberts; Flt. Sgt. W. J. Semple; Sgt. W. Skinner; Sgt. C. D. Smith; Act. Flt. Sgt. D. Smith; W/O. L. Smith; Sgt. D. R. South; Flt. Lt. G. W. Stanhope; Flt. Sgt. K. C. Taylor; Act. Sqn. Ldr. P. D. C. Thomas, D.F.C.; Sgt. J. N. Town; Sgt. W. T. Warren; Sgt. H. V. Watson; Sgt. R. G. Weaver; W/O. F. Westcott; P/O. R. A. B. Willmott; Sgt. H. Woodfield; P/O. R. G. Woods; F/O. W. Wright; Sgt. W. H. Young.

WOUNDED OR INJURED IN ACTION.—Flt. Sgt. J. D. Bulman; Flt. Sgt. C. J. Houbert; F/O. J. McKee; Flt. Sgt. N. Smyth.

MISSING, BELIEVED KILLED IN ACTION.—F/O. J. Affleck; F/O. K. A. C. Ayling; Sgt. J. A. Baxter; Sgt. F. J. Brown; Flt. Sgt. T. C. Foster; Sgt. G. W. Moss; P/O. F. Norris; Sgt. A. E. G. Price; Sgt. R. A. Sims; Flt. Sgt. R. W. Staveley.

MISSING.—Flt. Sgt. D. W. Anderson; Sgt. J. P. Arnold; F/O. C. J. Barber; Sgt. R. W. Barlow; Sgt. G. W. Broadbent; Flt. Sgt. A. A. Brown; F/O. N. H. Carter; Sgt. K. W Chaplin; Sgt E. J. Cumming; Flt. Sgt. A. C. Dalton; Sgt. D. E. Davies; Sgt. J. A. Dobson; F/O. P. R. Driver; Sgt. C. B. Edwards; P/O. E. M. Farrington; F/O. R. E. Favier; Flt. Lt. R. W. Ferguson; Flt. Lt. L. H. E. Gittins; Sgt. P. J. Gone; Sgt. T. G. Goodwin; Sgt. D. A. P. Guest; Sgt. C. M. Harrison; F/O. G. Holt; Sgt. P. C. Jones; P/O. R. D. Large; Sgt. R. E. Lewis; Sgt. S. Lloyd; F/O. R. Lofthouse; Act. Flt. Lt. A. R. A. MacLachlan, D.F.C.; P/O. A. McNair; Sgt. M. Maddison; Flt. Sgt. R. W. Maggs; Sgt. E. Mosey; P/O. R. W. F. Munns; Sgt. J. H. Naylor; F/O. W. S. Neathway; F/O. E. A. Pery-Knox-Gore; Flt. Sgt. R. J. Pettit; Sgt. B. A. Phillis; Sgt. G. R. Potter; Sgt A. E. Salt; Sgt. H. A. Saunders; Sgt. D. W. Savoy; P/O. K. G. Sheward; Sgt. W. C. Smirk; Flt. Sgt. C. G. Smith; Sgt. D. Smith; Sgt. W. W. Smith; F/O. P. A. Stevens; Sgt. L. L. Stone; Sgt. E. E. Strong; Act. Flt. Lt. S. W. Taylor; P/O. H. S. Thew; Sgt. J. Thomas; Flt. Sgt. K. Timms; Sgt. C. W. Tomlinson; Sgt E. J. A. Trigg; Sgt. F. Trimby; Sgt. D. V. Webb; Flt. Sgt. G. P. Wilkinson; Sgt. E. L. Wilson; Sgt. R. R. Wilson; Sgt. L. R. Wright

KILLED ON ACTIVE SERVICE.—P/O. A. W. Bailey; W/O. A. R. Bayman; P/O. D. Beeley; W/O. D. H. Belcham; F/O. E. Bibby; Sgt. L. S. Breley; Sgt. T. Brewin; Sgt. A. F. Brown; Sgt D. A. Brundell; P/O. M. M. Caplan; Sgt. T. Clelland; Sgt. E. Cook; Sgt. W. K. Craig; Sgt. J. A. Crudgington; Sgt. J. G. Curran; P/O. J. A. Elms; Sgt. A. J. Gamble; Sgt. N. T. Duxbury; Flt. Sgt. G. Gibson; Sgt. L. Holding; Sgt. J. Hunter; P/O. T. F. E. Johnson; Sgt. D. A. Lawson; Flt. Sgt. F. Leslie; Sgt. E. L. McCartie; Sgt. C. H. Markham; L.A/C. G. R. Martell; Sgt. K. J. May; Sgt. A. T. Nicholas; Flt. Sgt. D. H. Owen; A/C.2 W. S. Penfold; L.A/C. A. N. Perrin; Sgt. F. W. Pratt; P/O. H. G. Price; A/C.2 J. E. Price; L.A/C. T. J. Price; A/C.2 W. J. Ralph; Sgt. F. Reynolds; Sgt. T. G. Roberts; Sgt. W. B. Routledge; Sgt. J. K. Smith; A/C.1 R. Tarling; Sgt. A. C. Taylor; Sgt. J. G. Taylor; Sgt. A. Thompson; Sgt. I. R. Trower-Foyan; Sgt. H. T. A. Walters; Sgt. E. G. Wilson; L.A/C. G. H. Wilson; Sgt. R. Wilson; Sgt. A. B. G. Williams; L.A/C. R. A. Wood.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Sgt. C. Edwards; Sgt. G. G. Ottley; Sgt. B. H. Parker.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED ON ACTIVE SERVICE.—F/O. W. F. G. Hutchings; Sgt. K. Jenner; Flt. Lt. D. Toone; Sgt. J. A. Wade.

WOUNDED OR INJURED ON ACTIVE SERVICE.—Cpl. R. Higgitt; L.A/C. D. R. C. Scott; L.A/C. R. S. Wilson.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—Sgt. G. A. Wareham.

DIED ON ACTIVE SERVICE.—A/C.1 E. H. Harrison; L.A/C. C. W. Hopkins; Sgt. J. Howie; L.A/C. N. Lewis; L.A/C. C. W. Munt.

Women's Auxiliary Air Force

KILLED ON ACTIVE SERVICE.—Sgt. O. M. Morse.

DIED ON ACTIVE SERVICE.—Assist. S/O. J. M Easton.

Royal Australian Air Force

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. R. J. Haire.

MISSING, BELIEVED KILLED IN ACTION.—P/O. R. R. Whitaker; Act. Flt. Lt. J. L. Wilson.

MISSING.—F/O. L. F. Quinton; Flt. Sgt. F. Weaver.

KILLED ON ACTIVE SERVICE.—Flt. Sgt. E. M. Buckby; Flt. Sgt. R. R. Clegg; F/O. L. K. Lindsay; Flt. Sgt. H. C. O'Neill; F/O. H. A. Poulter; Act. Sqn. Ldr. S. G. Proudfoot; Sgt I. H. Shields.

Royal Canadian Air Force

KILLED IN ACTION.—P/O. K. B. Begbie; Sgt. A. Chibanoff; Sgt. H. W. Frost; F/O. E. V. Webb.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—P/O. J. W. Flt. Sgt. A. L. Croll; F/O. D. M. Wither.

MISSING.—Flt. Sgt. W. McI. Brown; Flt. Sgt. W. E. Chambers; Flt. Sgt. E. Fedi; Sgt. A. V. D. Humphries; Flt. Sgt. R. Moore; Flt. Sgt. L. T. Olmstead; Sgt. P. M. Shulman; P/O. D. E. Stiver; Sgt. G. W. Sutherland; Flt. Sgt. D. D. Witts.

KILLED ON ACTIVE SERVICE.—P/O. R. S. Arnold; P/O. C. E. Coons; F/O. L. G. Dunlop; F/O. V. R. Folkersen; Sgt. H. J. Hanson; W/O. W. J. Louden; P/O. J. Low; P/O. O. K. Main; Sgt. S. R. Parker; P/O. R. E. Ritscher; Flt. Sgt. D. K. Stroud.

WOUNDED OR INJURED ON ACTIVE SERVICE.—W/O. C. T. Mills.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—Flt. Sgt. R. W. Ogston.

DIED ON ACTIVE SERVICE.—L.A/C. J. Pawliuk.

Royal New Zealand Air Force

KILLED IN ACTION.—Act. Flt. Lt. J. A. Gunn.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Flt. Sgt. A. J. D. Barton; Act. Flt. Lt. E. C. Cox, D.F.C.; Sgt. P. P. D. Freeman; Sgt. R. E. Redding.

MISSING.—Flt. Sgt. D. H. W. Badcock; W/O. A. V. Douglas; Flt. Sgt. A. H. Holms; P/O. E. G. Little; F/O. M. Metcalfe.

KILLED ON ACTIVE SERVICE.—Flt. Sgt. J. S. Price.

South African Air Force

PREVIOUSLY REPORTED MISSING, NOW REPORTED DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—Lt. Col. M. E. Whitaker.

DIED ON ACTIVE SERVICE.—Air Mech. R. Bruyns.

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