The ROUNDEL

NORTHERN SKYTRAILS
(Page 28)

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The ROUNDEL

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John Griffin Library

A MESSAGE From The CAS



It is my present and very agreeable task to introduce to the RCAF the first issue of our new magazine, "The Roundel." This affords me the opportunity to say a few words concerning the purpose of the publication.

In Service as in civil life, these are days of increasing specialization. While specialization is absolutely essential to the operation of so complex an organization as an Air Force, the danger always exists that the specialist's view of the woods may eventually become somewhat obscured by the trees.

Against this danger there is only one safeguard: extensive reading and discussion. Only thus can we retain that wider perspective which gives full meaning to our individual tasks.

Few of us have the time or even the opportunity to ferret through the mass of available literature in the hope of here and there coming upon something that may contribute towards our complete mental orientation. How many of us, indeed, can do much more than merely keep abreast of developments in our own variously limited spheres?

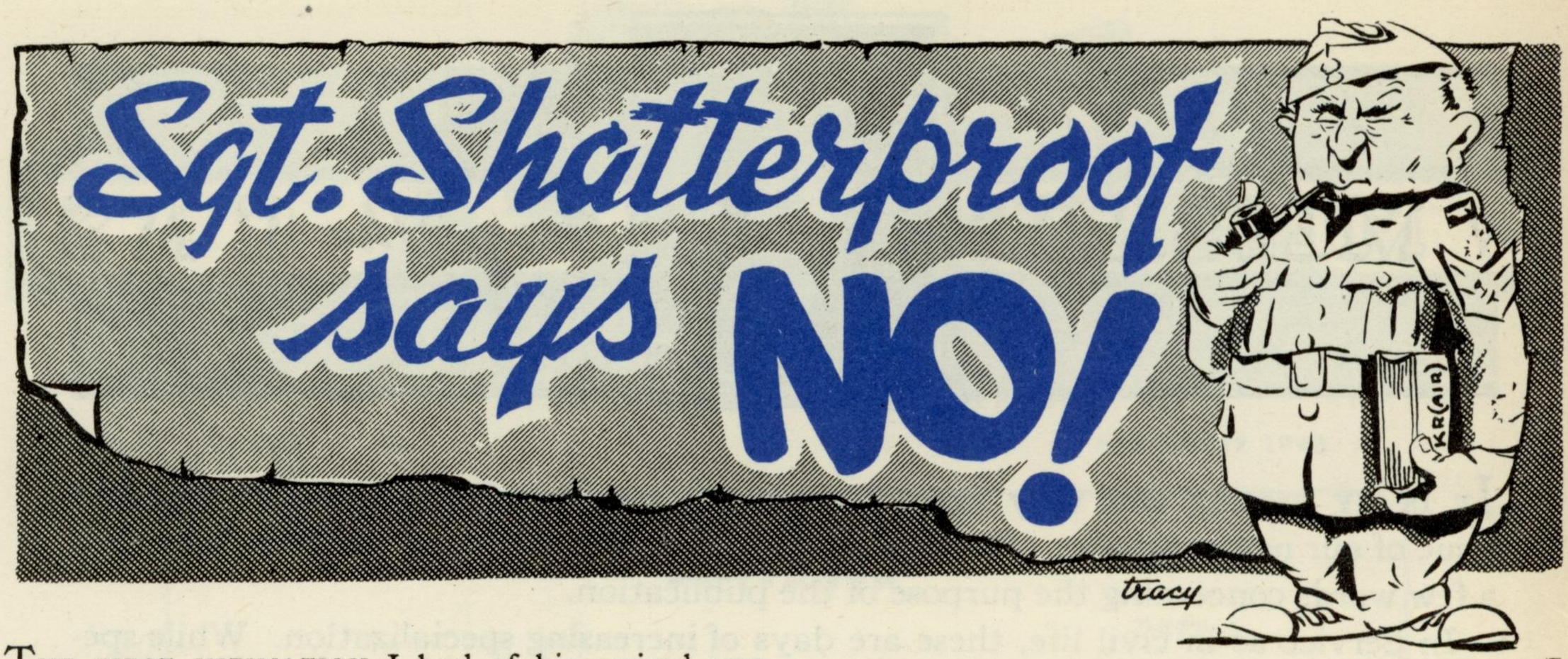
"The Roundel" is an attempt to overcome the restrictions imposed upon our reading by lack of leisure. Drawing from all possible sources, it will contain such material as the Editorial Committee considers to be of particular interest and value to all ranks and trades of the RCAF.

No single issue, it is realized, can be composed entirely of articles which will make an instant appeal to every member of the Service. None the less, I cannot too strongly recommend that every member of the Service read "The Roundel" from cover to cover. To peruse only those portions which relate directly to one or two particular trades would be to defeat the whole purpose of the magazine.

And now, in wishing "The Roundel" the best of luck, let me express my sincere hope that all RCAF personnel will, by their unfailing support, assist it to become a permanent and vital part of our Service lives.

W. A. Curtis,
Air Marshal,
Chief of the Air Staff.

Sgt. Shatterproof says NO!

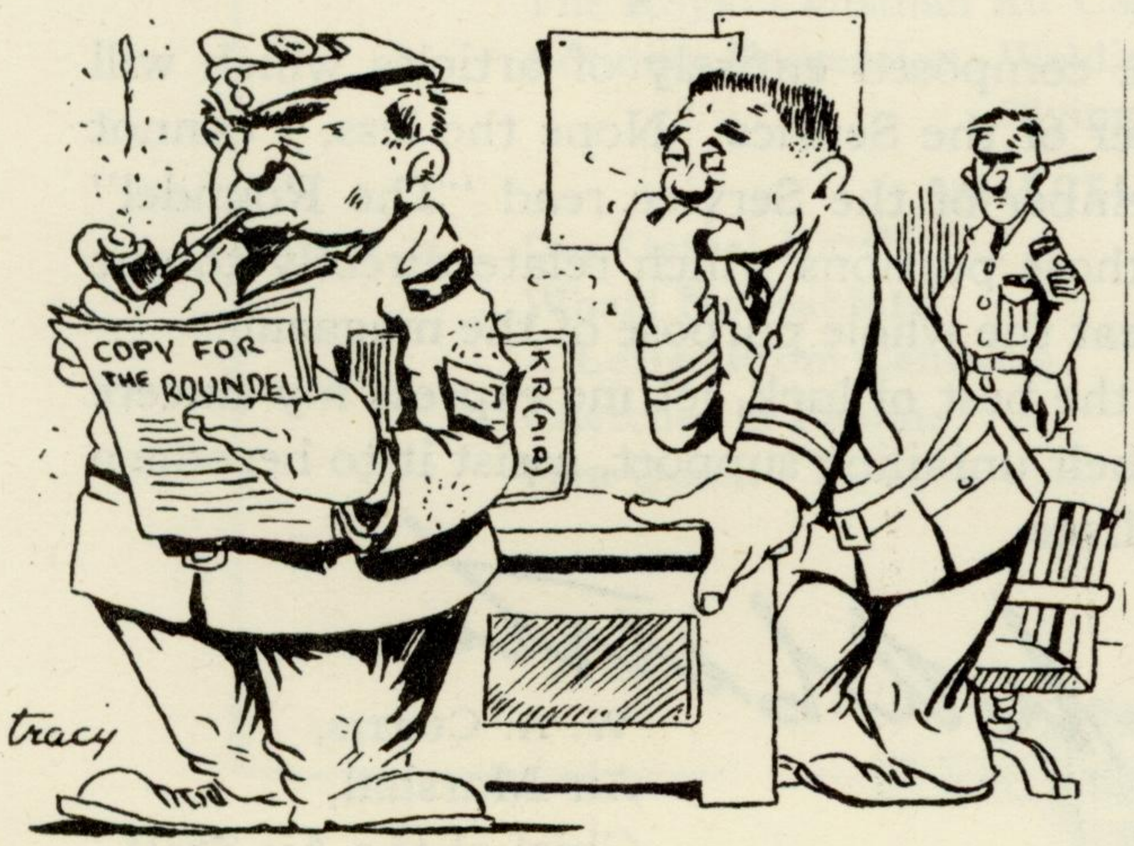


THE FIRST INTIMATION I had of his arrival was the sudden silence of the typewriters. I glanced up from the sheet of uninspired prose I was writing, and—well, there he stood in the doorway.

He was, indeed, a figure that would have stopped more than a typewriter. tracy has caught his likeness to a T (which last, by the way, is something tracy might well catch for himself). No mere drawing, however, can do justice to the aura of implacability which hung like a cloud about our visitor.

Eyeing me with a sort of gloomy speculation, he approached the editorial desk. Then he removed the pipe from his mouth and, in a very deep voice, said:

"They tell me the Air Force is starting a magazine."



"Correct, Sergeant. And what—"

"Shatterproof. Shatterproof's the name, sir. Twice a WO2 and three times a Flight Sergeant."

He gave me a knowing wink and tapped the side of his nose with the stem of his pipe.

"I knew too much for the big boys," he said. "They don't like it when you know too much. Ask WO1 Gallstone." A reminiscent chuckle rumbled in his throat.

Since WO1 Gallstone wasn't there, I did not ask him. Instead, I said:

"Well, what can I do for you, Shatterproof?"

"I came," he replied, "to find out what sort of a magazine it's going to be."

I pointed to the basket which contained the copy for the first issue.

"Look for yourself. I hope you like it."

He picked it up with evident distaste. The top sheet bore the CAS's introductory message. He read a few lines, then shook his head.

"I was afraid of this," he said. "They should have asked me first. The boys in the field don't want to learn any more. They want to laugh."

"But tracy's cartoons, Sergeant — they're funny."

Shatterproof flipped over a few pages.

"I'm not laughing," he said ominously. He glanced back towards the beginning. I saw him start.

"'Lt. Col. Sprung'," he read aloud. "Who's he? And why's he here?" His eyes grew stern. "Let's

be loyal to our own Service, sir. Disloyalty will get us nowhere." He read on. "'The Battle is One'! Why, the Colonel can't even spell!"

"Col. Sprung," I informed him with some warmth, "is one of this country's smartest Intelligence officers. That article is of interest to every member of all the Armed Services. Furthermore, he isn't trying to spell. That's a pun."

Sergeant Shatterproof frowned.

"A pun! I hate puns. All right-thinking men hate puns."

"What the boys in the field want," he proceeded, "is human interest. Sports—"

"We intend to start a sports page later," I interrupted eagerly, but the pipe-stem enjoined me to silence.



"—sports, cheesecake, and above all, letters from the readers."

"But there aren't any readers yet, Sergeant."

"And there never will be, sir. Take my word for it."

He stopped abruptly in his leafing and peered a second time at one of the pages.

"Transistors!" he exclaimed. "And what, if I may ask, is a transistor?"

"The greatest radio discovery in years," I told him. "That article will tell you all about it—if you care to read it."

"Can't say I do," he said, without looking up. "Nor will the boys in the field." An expression of amazement came over his face. "And what on earth is this? What are those skeletons doing?"

"They're not doing a thing. They're just lying there. They're moose—or they were."

"Are they funny?"

"Well, no," I admitted.

"Do they teach anything about the Air Force? Do they—" he hurriedly referred back to the CAS's foreword "—do they contribute towards our complete mental orientation?"

"Perhaps not."

The Sergeant carefully replaced the copy in its basket. Then he refilled his pipe, lit it, tapped down the tobacco with his KR's, and said:

"There you are, sir. Just what I was saying. The boys in the field don't care about transistors and they aren't interested in moose, particularly skeleton ones .that aren't doing anything. You should have got in touch with me before you began this business."

He gazed at me for a few moments in pity, sighed deeply, and moved away towards the door.

I stood up, flinging out an arresting hand.

"But surely, Shatterproof, there is some hope, somewhere?"

He turned.

"Hope? I'm afraid not, sir. None."

Then, with a final shake of his head, Sgt. Shatterproof was gone.

—THE EDITOR.



The BATTLE is ONE

The Case for an Armed Forces General Staff

by LT. COL. G. M. C. SPRUNG, M.C.

THE PROBLEM

Should generals have air forces under their command?
Should air marshals command army formations?
Should either give orders to naval forces?
Should admirals command air or army forces?

IF THE ANSWER to any or all of these questions were "yes," under what circumstances would such a procedure be necessary or advisable? Further, what staff organization and what staff training of the officers and men involved would make it workable? In short, towards what type of co-operation in battle should our armed forces strive to evolve?

I intend, in the paragraphs which follow, to examine several typical operations of the Second World War in an attempt to answer, however tentatively, this main question. The historical examples are introduced, not in order to ascertain the solutions arrived at in each case, but to review the kinds of decision, affecting more than one service, which had to be made in the course of the planning and conduct of the battle. From this agreed base of fact it should prove easier to advance into the field of speculation.

It is not merely superfluous eagerness which leads one to raise the delicate question of inter-service co-operation. The question is *not* one that is better left alone. It appears to me, on the contrary, to be a question which will not leave *us* alone. All too often it fetches us a ringing slap in the face and demands to be answered. In fact, I believe the problem to be so fundamental that if we do not unravel some of its knotty skeins, it will, in the emergency, undo us. If I were writing a paper for the Staff College I would say that this problem before all others inevitably lies athwart the clear direction of martial progress in our generation.

Why should this be so? Why do these questions press themselves upon us at this time? If the air and naval readers of this periodical will excuse the analogy, I would say that the need for an interservice point of view, for joint service or martial training, and for the unified employment of all armed forces in battle, recalls a similar situation within the Army during the nineteenth century.

As land battles grew in space, becoming extended in time and involving hundreds of thousands of men and many types of machines, it dawned upon the generals that they needed a staff organization to control these far-flung actions and to bring into proper interplay the various arms involved—cavalry, artillery, engineers, and infantry.

However, before the horse-proud cavalry officer could grasp the principles which governed the employment of so vulgar a lot of people as the infantry, he had to be trained. The same was true of officers from the other arms. Each had to learn enough about all so that he could see the battle as one thing—and not as a purely infantry struggle topped off with some superfluous galloping about by the horse types, nor purely as a

cavalry charge preceded by a spot of a vulgar rifle work on the part of those too lowly to own horses. Hence the Staff College.

So it is to-day. The problem has grown in scope but remains the same in essence. The battle is even more complicated. There are many new weapons. Some operate from the ground and others from the air. In certain types of battle, weapons operating from ships join with the other two. While there are vital engagements fought in the air, or at sea, without the apparent co-operation of other portions of the armed forces, such unilateral actions are in fact always made possible by the hidden influence of the remainder.

The Battle of Britain was an air battle. We easily forget that it would have been pretty difficult on the whole if there had been no Britain. Yet, in the long view, the security of the air base in this was guaranteed also by the Navy and the Army. The action in which the Bismark was sunk was a unilateral naval action, but the ships of the Royal Navy were based on the British Isles, the securing of which was shared by the Air Force and the Army. For Canadian, British and American Armies there can be no offensive action without conjoined naval and air action. These things are very simple when they are put simply. We should not be confused by the complications of the modern problem. The need is still to see the battle as one, and to employ properly the many weapons, craft and arms in their tactical interdependence. *Which of the services happens to "own" the weapons and craft at any given time should be a question of secondary importance.*

But how is this best done? In the face of the baffling mass of decisions, big and little, which must be made before and during a joint operation, how are the staffs of the three services best organized to perform their interdependent duties? Firstly, and above all, what are the decisions which, in operations, must have an interservice validity?

This brings us to an examination of several joint operations conducted during the recent War.

DRAGOON

It will be remembered that allied forces, principally American and French, invaded Southern France on 15 August 1944 (operation "Dragoon"). The landings were made on the Riviera coast between TOULON and NICE. The subsequent thrust up the Rhone Valley succeeded in linking up with forces from Normandy within one month, thus making common front against Germany from Switzerland north.

The major formations in this joint operation which had been ordered by the Combined Chiefs



Canadian Infantry Landing on Normandy Beach: D-Day (R.C.N. Photo).

of Staff and was under the supervision of the Mediterranean Theatre Commander (General Sir Henry Maitland Wilson), were the Eighth Fleet (U.S.), the Twelfth Airforce (U.S.) and the Seventh Army (U.S.), with two French corps included in the last). In December 1943 the planners at Theatre Headquarters prepared an outline plan for the operation. In January 1944 planning staffs of the three major formations met in Algiers, and later in Naples they worked on the detailed plan.

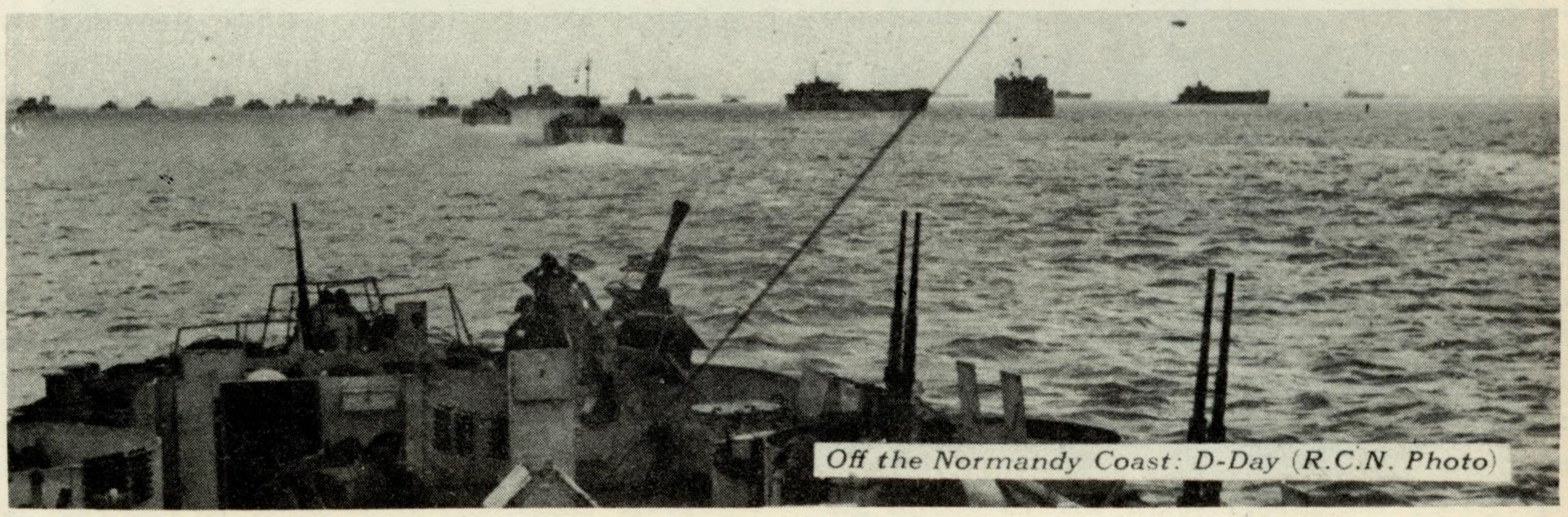
It will be noted that there was no one commander and staff dealing with the execution of this operation. Matters affecting more than one service were, presumably, threshed out in conference or committee by the Eighth Fleet, the Twelfth Airforce, and the Seventh Army.

In order to make a plan, landing beaches had to be selected by the Army and Navy.

Now, every beach has two aspects. It has an approach which is of Naval concern and it has a hinterland which affects the Army. Beaches also have defences, which in so far as they are underwater or consist of coastal artillery, interest the sailor, and in so far as they are ashore and consist of field weapons, arouse the soldier's curiosity. Yet so indifferent is the law of battle to the customs of the services, that underwater obstacles are removed largely by the Army, coastal batteries are dealt with by air bombing and landing parties (as well as by naval bombardment), and beach defences are attacked on behalf of the army by the navy and the air. During the detailed planning for the landings in Southern France the Seventh Army did in fact agree to a change in the selection of beaches because of naval difficulties in approaching the original area through a group of off-shore islands.

In planning the grouping of forces for the movement to the assault areas, the enemy's strength at sea and in the air is the decisive factor. In the present instance the German naval surface units were negligible and the number of submarines operating in the Mediterranean was estimated at ten. Under these circumstances it was not nceces-sary to employ land-based air against the enemy at sea. German air strength in the invasion area was approximately 200 aircraft, although reinforcements up to a further 1,300 were possible. It was much more likely therefore that carrier aircraft would be needed against shore targets. They were in fact so used. Nevertheless I note that there was at no time during this operation a single staff responsible for applying naval and air intelligence to the problem of movement at sea, nor for controlling the employment of all types of air whether in an anti-submarine role or for air tasks over the assault area.

In one further respect appreciations and decisions made by each of the three services have (or should have) a single impact on the completed plan. The estimated rate of progress ashore determines the rate of build up and affects every step in the operation right back to the loading of



Off the Normandy Coast: D-Day (R.C.N. Photo)

merchant ships in home ports across the sea. Based initially upon anticipated enemy air and ground strength and tactics, the rate of progress is itself affected by the shipping available, the capacity and efficiency of the mounting out ports in the theatre and by the Navy's appreciation of its ability to maintain a flow of supplies—in short, by a host of naval factors. To bring the inter-service complications full circle it is clear in turn that the navy's ability to dispatch loaded ships depends in part upon the army and air supply services having the right stocks available in the right quantities at the right time at the right ports.

One has to bear in mind the mere outline of the operation under discussion to feel the full force of this point. While the planners were busy in Naples the French armoured divisions were mounting at Oran, in North Africa, the French infantry divisions were concentrated in Southern Italy and embarked at Taranto and Brindisi, the American assault divisions were mounted out of Naples and a French follow-up division was prepared for the operation in Corsica. Furthermore, assault shipping had to be brought in from other theatres and supplies shipped from the United States.

* * *

So much for a review of some important inter-service matters which arose during operation "Dragoon." As far as I can see from the material available to me, there was at no point in the staff organization a merging of service interests. The many decisions made (and apparently well made) were achieved by the techniques of liaison, conference and committees guided by an attitude of reasonableness and, in a pinch, by the formula, "If you concede me this point, I'll concede you that." The one point of joint organization lay in the command of the expeditionary forces. Until the Army was firmly established ashore, Admiral Hewitt, commander of the Eighth Fleet, held unified command over all forces afloat. This, of course, did not include land based aircraft. Even so the arrangement had only nominal force, as there was no prospect of serious action until the Army was ashore.



Canadian Section of Normandy Beach
(Can. Army Photo.)

OVERLORD

The Allied Expeditionary Forces which carried out the landings in France in June 1944 (operation "Overlord") during the assault were, in nearly all essential points, organized in the same way. An army general (Eisenhower) held unified command over all naval, ground and air forces assigned to the task. For the purposes of planning and executing the landings and capturing a lodgement area in France he appointed subordinate commanders for naval units (Admiral Ramsay), for ground forces (General Montgomery), and for air forces (Air Chief Marshal Leigh-Mallory). As Eisenhower's headquarters did not attempt initially to command the battle directly, all details had to be settled between the three service headquarters by consultation and agreement. *Field Marshal Montgomery at least has recorded his belief that appointment of a joint commander for the asault would have made planning and command somewhat easier.*

It is significant that the magnitude and complexity of the supply problems facing the staffs forced the adoption of a certain measure of joint organization. An interservice staff known as

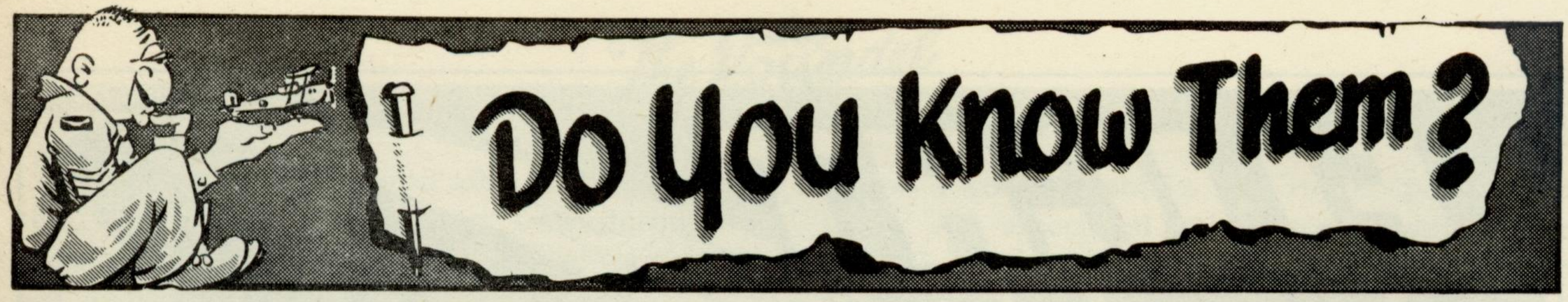
Build Up Control (BUCO) was formed and operated, I believe, under the direction of the Allied Naval Commander-in-Chief. This staff was charged, primarily, with shipping across the Channel the men and material which the commanders in France needed. These needs, in the face of an uncertain ground situation, had to be fitted to the ships available as dictated by losses and damage and weather. Swift flexibility was the thing most needed by army, air and navy. To meet this need BUCO was composed of navy, air and army staff sections together with representatives of the Ministry of War Transport which was responsible for supplying the merchant shipping and for rail transport in England. BUCO can therefore be described as a composite staff, though not as an armed forces staff.

A further feature of the Normandy operation should interest us not because the problem was peculiar but because the solution, by being unique, emphasizes the crucial nature of the problem. Everyone has heard of the artificial harbours (Mulberries) which were built in England, towed across the Channel, and erected off the British and American beaches in Normandy. These measures were judged necessary because there were no mentionable ports in the assault area. Had the landings been carried out opposite Dover, for example, there would presumably have been adequate port facilities for the initial phase. Yet for the ground forces the battle was appreciated to be more favourable in Normandy. The Air Force probably did not share this view, and it was the Navy which had to decide whether or not the Mulberries would be acceptable substitutes for permanent ports, although their purpose was the satisfying of army and air supply needs. Was the lessened risk to ground forces in Normandy sufficient to justify the risks inherent in the untried Mulberries? Truly an involved decision. Fortunately, it appears to have been taken on the joint level.

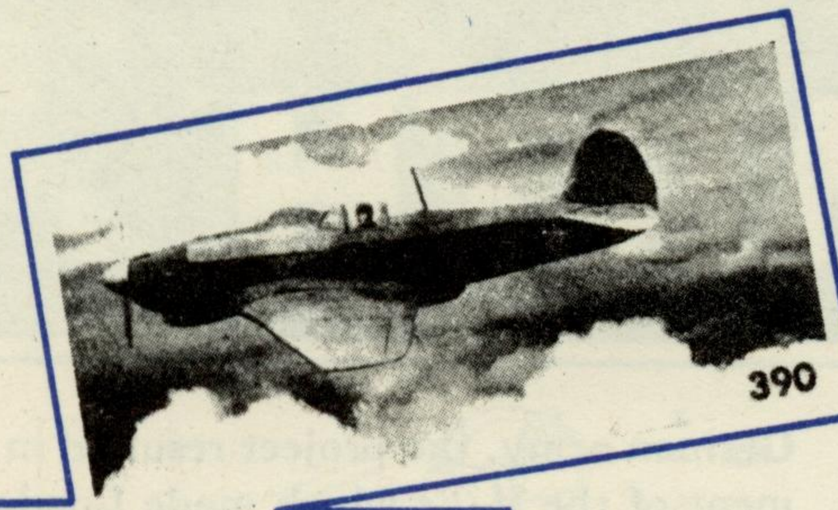
In one point of command organization (though not staff) the Allied Expeditionary Forces differed from the Dragoon forces which operated in Southern France. From 1 September the Supreme Commander, while continuing to command all forces in the operation, himself assumed personal responsibility for the direction of the armies. Supreme Headquarters thus took up the duties for which its composition fitted it, although the strain imposed upon the Supreme Commander (that of thinking on two levels and retaining perspective for each) must have been very great. Later in the campaign, on the departure of Air Chief Marshal Leigh-Mallory, certain sections of the air staff moved to Supreme Headquarters where, presumably receiving direction from Air Chief Marshal Tedder, Eisenhower's deputy, they lived side by side with the army staff. While this arrangement might be described as a joint or "jointed" staff, it bears no resemblance to an armed forces general staff as I picture it.

In the second, and final, instalment of his article, Col. Sprung discusses what he considers to be the most interesting example of operational co-ordination of naval, ground and air forces to be found in the course of the Second World War.

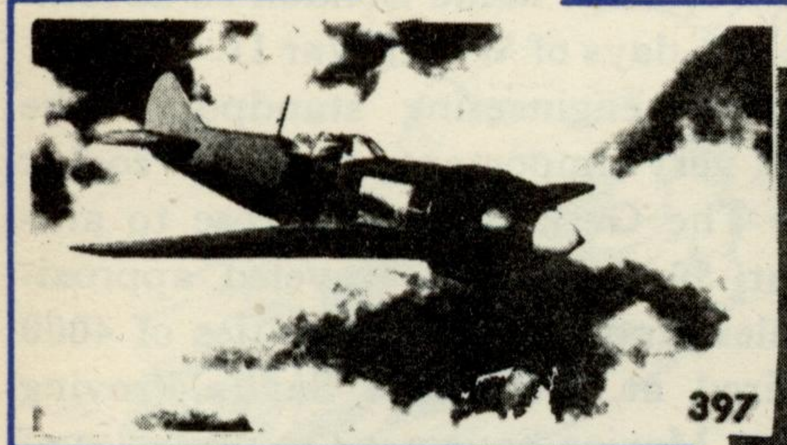


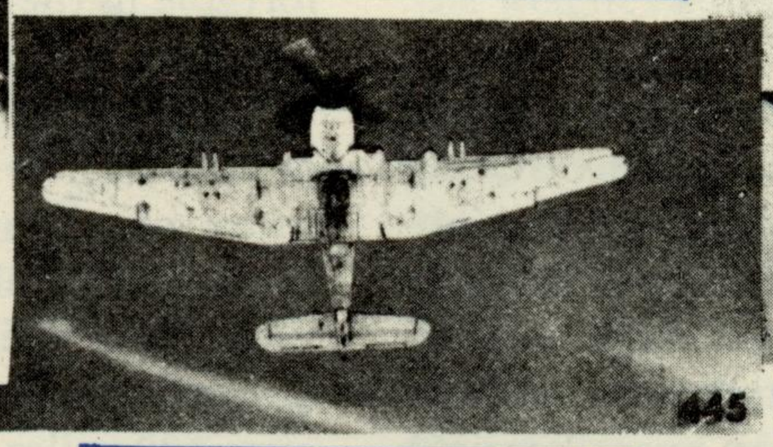


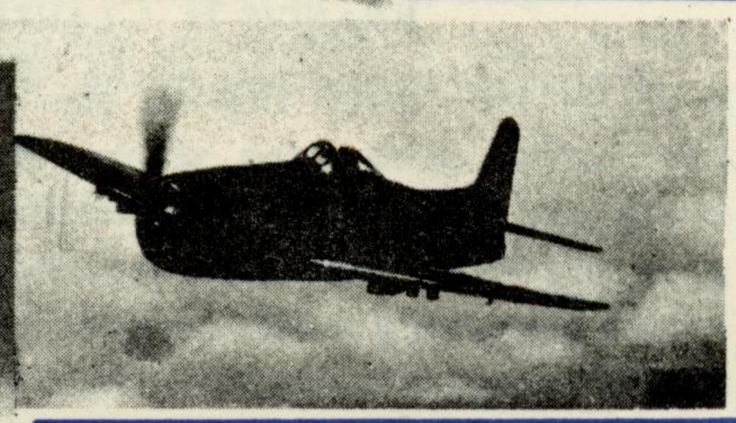
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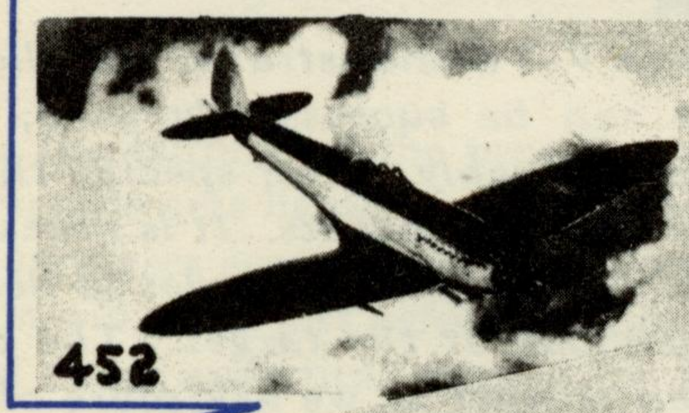


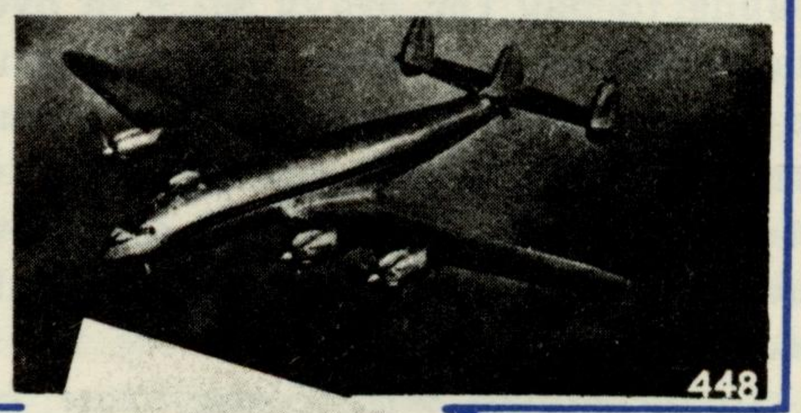


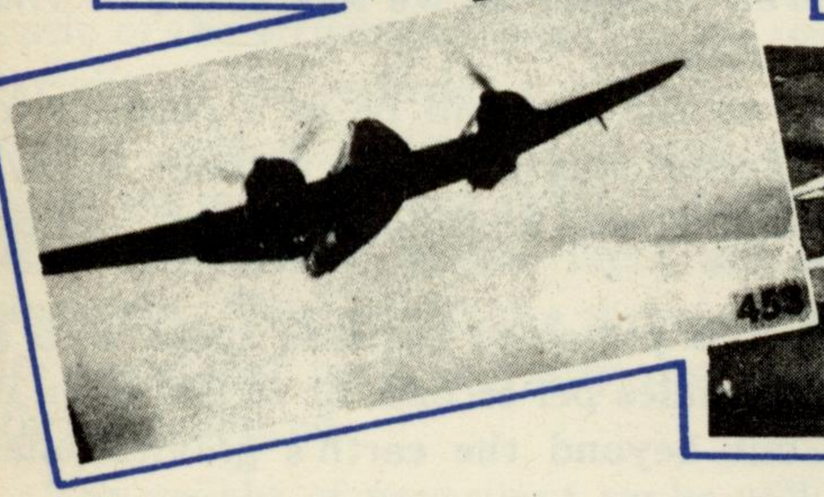


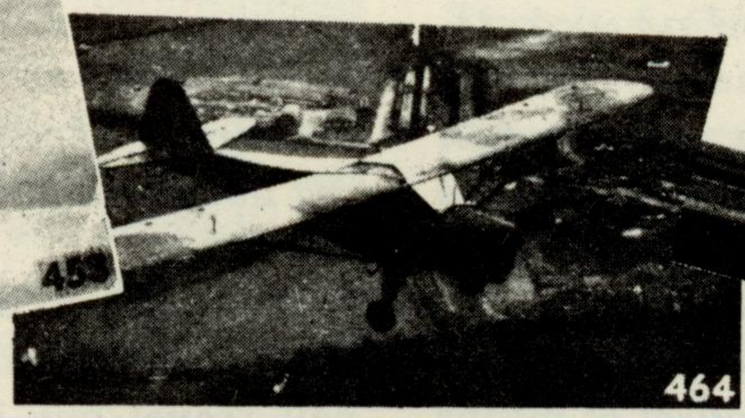


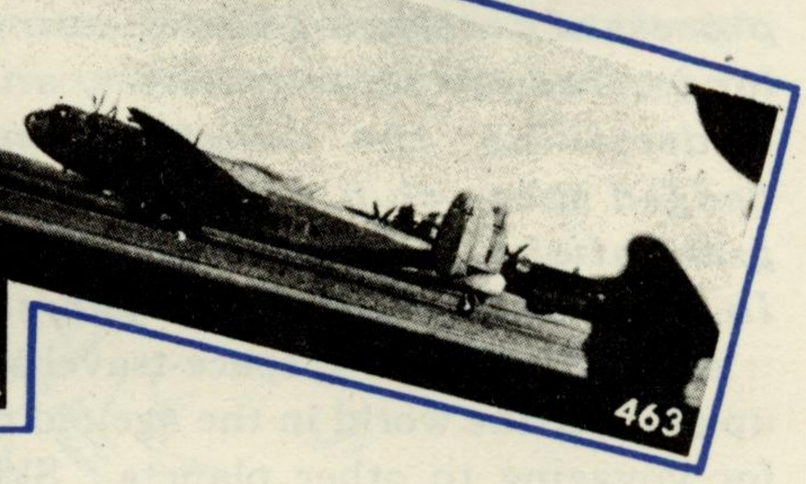


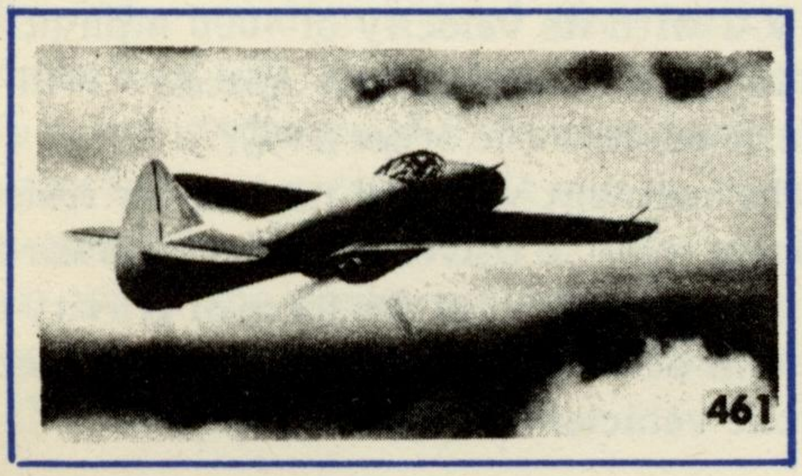


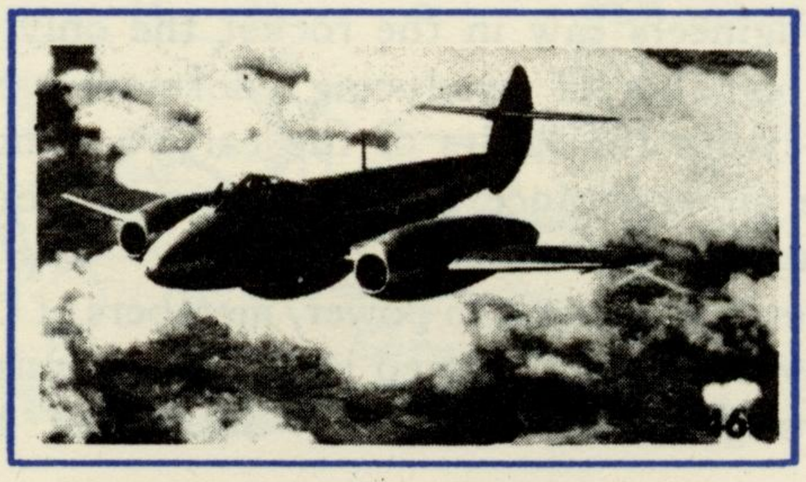












(By courtesy of "The Inter-Services Aircraft Recognition Journal")



Digest of paper by

FRANCIS H. CLAUSER

(Reprinted by courtesy of the "S.A.E. Journal")

REALISTIC APPRAISAL shows that space travel is not just around the corner. It is most certainly going to have to await the development of high-velocity rockets with weights too low for easy attainment.

Existing power plants might do the job, were we willing to pay the heavy price in overall weight that would be necessary. However, when we begin to compute the weights required if human beings are to be taken along as passengers with adequate provision for their health and safety, the astronomical numbers that result surely rule out such projects.

Space travel will come, but by gradual process of developing better sounding rockets, longer range rocket missiles, and eventually undertaking the construction of a full fledged space-ship, capable of leaving earth's gravitational dominance. The time scale? In decades rather than in years.

After World War I, space-travel societies sprang up all over the world in the age-old quest of means for voyaging to other planets. Skilled scientists and engineers saw in the rocket the only power-plant capable of producing enormous velocities out beyond the limits of the earth's atmosphere where air resistance and compression would not burn up a space vehicle.

After Hitler came to power, members of German society became interested in building a missile for long-range bombardment. Supported by the German army, the project resulted in the development of the V-2's which made London so uncomfortable in the last days of World War II.

From a purely engineering standpoint, the V-2's mark a very important stage in rocket development. The German version rose to altitudes of about 50 miles and traveled approximately 200 miles, and attained velocities of 4000 mph. V-2's fired at the White Sands Proving Grounds in New Mexico have gone to altitudes of over 100 miles.

The German V-2 demonstrated that liquid fuel rockets can be successfully used, and these give considerably better specific thrust than solid propellant rockets. It is necessary to expend a 12-ton vehicle in order to deliver one ton of payload at the target. The price becomes even steeper as we ask more of the rocket powerplant.

Successors to the V-2 will be in a position to accelerate to enormous velocities without worrying about the drag and heating caused by friction of the air.

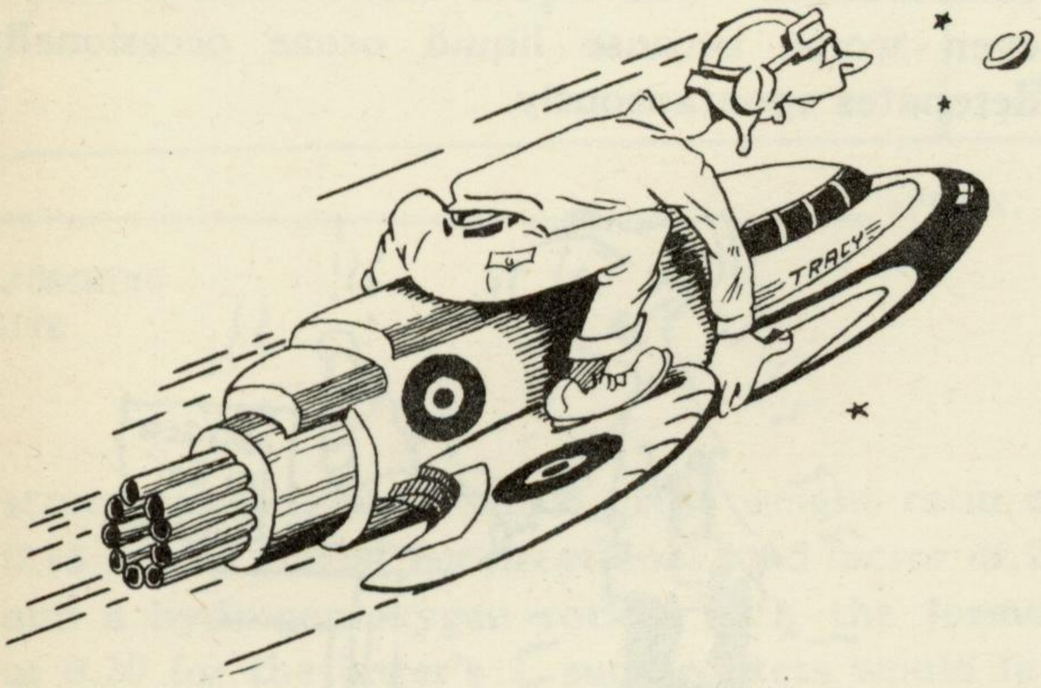
If an object is projected out into space with a speed of seven miles per second, or 25,000 mph, it will travel out beyond the earth's gravitational field.

The V-2 with its velocity of 4000 mph achieved about 16% of the required speed. Will it be possible to achieve the other 84%?

For the moment we shall neglect air resistance. As a rocket vehicle travels vertically upwards, the rocket thrust overcomes the force of gravity on the vehicle and at the same time provides an acceleration of the vehicle.

Weights to be considered are the payload, the total load of fuel and oxidizer used during the acceleration process, and the total remaining weight of structure, tanks, motors, controls, and so forth, that constitute the basic weight of the vehicle.

If the rocket thrust is nearly constant throughout the burning period, as is the case for the V-2, the vehicle will experience an initial accelerational load factor equal to the ratio of the thrust to the initial weight.



As the burning of the propellants takes place, the vehicle gets lighter in weight and its acceleration increases accordingly. The maximum acceleration will occur just before burnout of the rocket.

An exact analytical method for predicting the ratio of the structural weight to the instantaneous weight of the vehicle is virtually impossible to evolve because it depends to such a great extent upon the ingenuity and skill of the design engineer. However, a few simple facts are immediately apparent. The weight of a rocket powerplant and its associated parts is nearly proportional to the thrust produced.

The weight of propellant tanks will be proportional to the maximum load they carry. This maximum load will occur when the product of the load factor and the weight of propellants remaining in the tanks is greatest. It can be shown that for a constant thrust rocket, this product is greatest when the tanks are full. During rocket burning the propellant weight decreases faster than the acceleration increases.

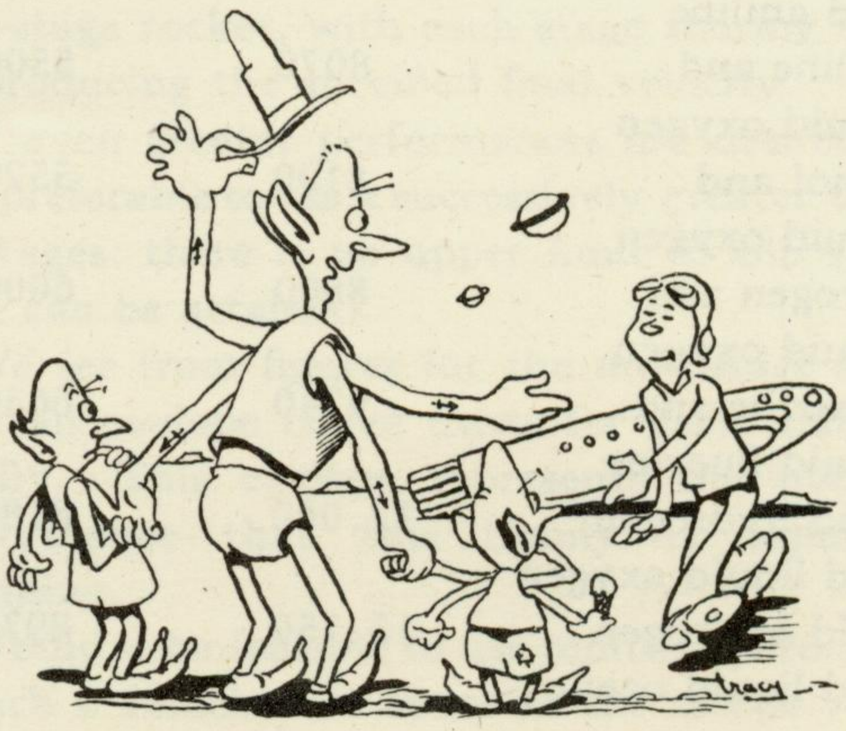
For a rocket vehicle, the rocket powerplant tanks and associated equipment constitute the major items of structural weight. Since these are proportional to the initial accelerational load factor, that is, the ratio of the thrust to the initial weight, we shall have a better indication of the effect of load factor on structural weight if we use this factor as our characteristic parameter instead of the maximum acceleration factor.

The operational V-2's had a structural weight ratio of about 0.24 for an initial acceleration of 2g. Later experimental models dropped down to 0.18.

One frequently sees rocket weights quoted as the ratio of the initial weight to final weight. Thus the weight ratio of the operational V-2 is 3.25 to 1.

Consequently, the weight ratio can be used directly in computing the performance of a given rocket. However, in design work it is desirable to be able to determine the effect of changes in payload on performance. Such changes will, of course, alter the ratio of initial weight to final weight. Consequently, a single quoted value of this ratio is of little aid in design studies. It is for this reason we use the more fundamental weight ratios of structural weight to instantaneous weight and payload to the initial gross weight.

Preliminary experience has shown that as propellants are exchanged for payload, the change in tank weight just about offsets the change in weight of supporting structure for the payload. Therefore, the structural to instantaneous weight will stay nearly constant when payload-propellant changes are made.



It is interesting to note that the vehicle can attain velocities greater than the velocity with which the exhaust is being expelled. Under these circumstances, the exhaust will be travelling forward. The ratio of the instantaneous weight of the vehicle to its payload gives an indication of the size of the vehicle for a given payload.

The velocity ratio improves with decreasing ratio of total structural weight to instantaneous weight and increasing initial accelerational load factor. That is, it improves as less weight is used in structure and as less time is spent combatting the pull of gravity. However, it is impossible to take advantage of both these improvements simultaneously because increasing the latter adversely increases the former.

PROPELLANT DETERMINES DESIGN

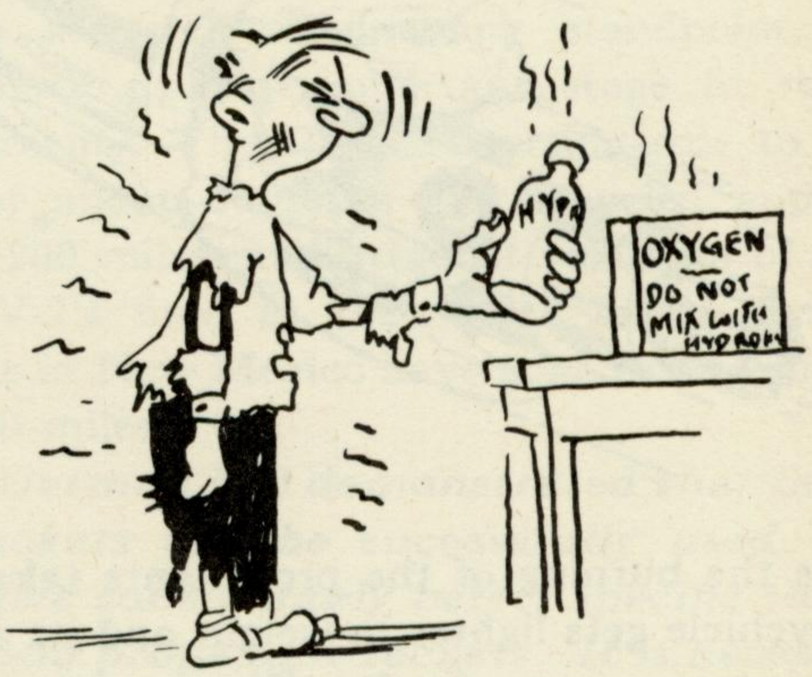
The velocity of the rocket exhaust cannot be arbitrarily selected by the designer. It is more strictly a characteristic of the propellants used, being determined to a large extent by the molecular weight, the temperature, and the specific heats of the combustion products. Other factors affect the exhaust velocity so little that it is possible to state the exhaust velocity of a given rocket with reasonable accuracy solely from a knowledge of the propellants used.

This table shows exhaust velocities of some of the best known rocket propellant combinations:

PROPELLANT COMBINATION	EXHAUST VELOCITY Fps	Mph
Nitric acid and aniline	7300	4980
Gasoline and liquid oxygen	8070	5500
Alcohol and liquid oxygen	8100	5520
Hydrogen and liquid oxygen	8800	6000
Hydrazine and liquid fluorine	9740	6630
Liquid hydrogen and liquid oxygen	12,000	8180
Liquid hydrogen and liquid ozone	13,150	8970

It is seen that liquid hydrogen-liquid oxygen and liquid hydrogen-liquid ozone have quite high exhaust velocities. However, the fact that liquid hydrogen has a low density, a low boiling point, and a low heat of vaporization makes pumping, piping and storing extremely difficult. The high diffusivity of hydrogen makes sealing almost impossible.

This, combined with the fact that hydrogen and oxygen are violently explosive in mixtures anywhere from 2 to 98%, makes them a dangerous combination. The liquid ozone combination is even worse because liquid ozone occasionally detonates spontaneously.

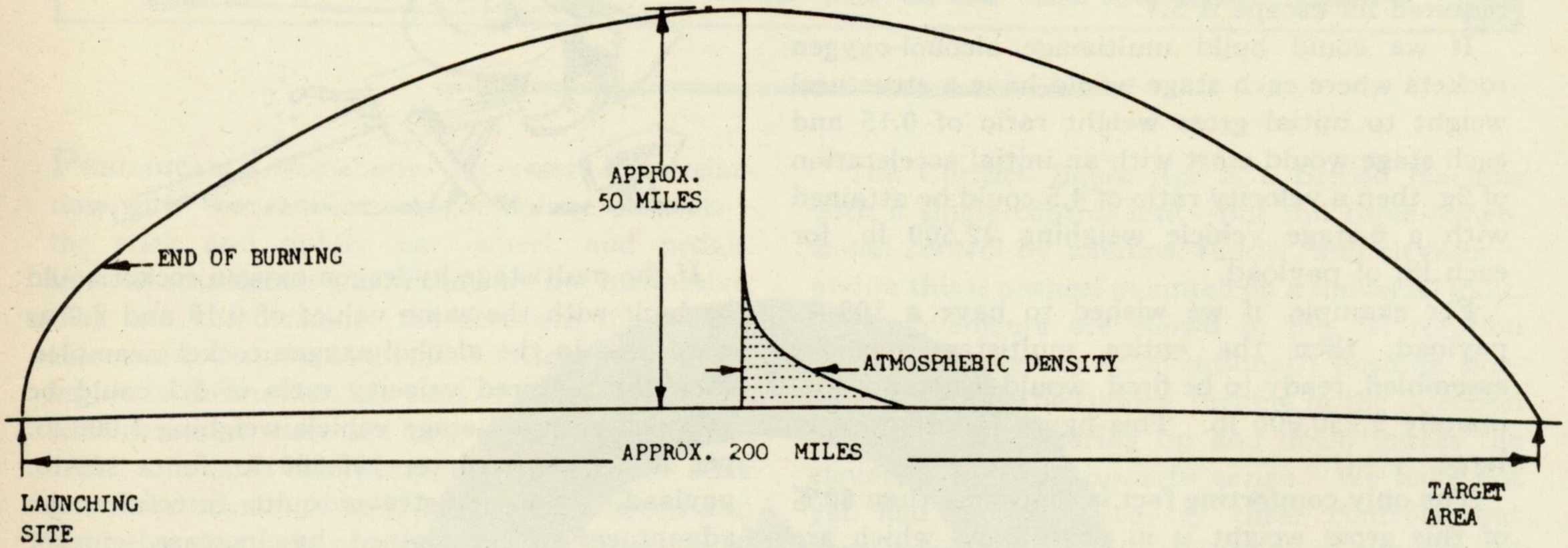


In order to overcome these difficulties, hydrogen-oxygen and hydrogen-ozone rockets will have to be unusually complex in their design, with a resulting penalty in structural weight.

To avoid such drawbacks, alcohol and liquid oxygen were used in the V-2. Although these propellants have less exhaust velocity than liquid hydrogen-liquid oxygen, this is at least partially offset by the lower structural weight ratios possible.

Let us return to the problem of launching a vehicle into interplanetary space. It will be remembered that a velocity of 25,000 mph is required to escape from the gravitational pull of the earth. This is 4.5 times the exhaust velocity of an alcohol-oxygen rocket and 3.1 times the exhaust velocity of a hydrogen-oxygen rocket. Estimating that in the near future we might be able to build an alcohol-oxygen rocket with a

TYPICAL TRAJECTORY OF THE V-2



structural weight to initial gross weight ratio of 0.15 for an initial accelerational load factor of 2, and a hydrogen-oxygen rocket with the former of 0.20 for the latter's 2, such rockets would fall considerably short of producing the desired velocities. In fact it would appear almost impossible to achieve the desired velocities with any combination of these factors that we could hope to achieve for many years to come.

This is a discouraging outlook. But the encouraging fact is that rockets are able to produce velocities which are a large fraction of the desired velocity. It is logical to ask if there is some way of using rockets to obtain the remaining fractions of the required velocity.

MULTISTAGE ADVANTAGES

Earlier workers in the field saw that this was possible through the use of multistage rockets. To illustrate this concept let us consider a two-stage rocket.

We imagine our previously considered rocket being carried along as the "payload" of a much larger rocket. The larger rocket is fired first, and when it has used up its propellants it is discarded and the smaller rocket accelerates under its own power to even greater speeds.

Calculations show that a rocket with a large number of stages is not always superior to a rocket with a lesser number of stages. If high performance is not demanded of a rocket, that is, if we do not ask for velocities of the vehicle that are comparable to or larger than the rocket exhaust velocity, then the single-stage rocket, with its lack of multiple tanks, motors, and so forth, can be built with smaller overall gross weight to transport a given payload.

However, when the required performance becomes sufficiently high that the single-stage rocket required to do the job would necessarily be large compared to the payload, then it is better to use a two-stage rocket, with each stage sharing equally in producing the specified final velocity.

If even greater performances are desired, then it is preferable to use a successively greater number of stages; there is no upper limit to the velocity that can be attained.

We see from figures for the multistage rockets that an evelope curve exists for each multistage family. This evelope represents the maximum performance that this family is capable of attaining.

Would it be feasible to use multistage rockets to launch a vehicle into space at the escape velocity

of 25,000 mph? For alcohol-oxygen rockets the exhaust velocity is about 5520 mph, and the ratio of vehicle velocity to exhaust velocity that is required for escape is 5.4.

If we could build multistage alcohol-oxygen rockets where each stage would have a structural weight to initial gross weight ratio of 0.15 and each stage would start with an initial acceleration of 2g, then a velocity ratio of 4.5 could be attained with a 6-stage vehicle weighing 22,500 lb. for each lb. of payload.

For example, if we wished to have a 100-lb. payload, then the entire multistage vehicle, assembled, ready to be fired, would weigh approximately 2,250,000 lb. This figure is forbiddingly large.

The only comforting fact is that more than 80% of this gross weight is in propellants which are easier to manufacture than motors, tanks, controls, and so forth. We see that one of the inherent shortcomings of a rocket vehicle is the large gross weight required to transport a relatively small payload, particularly when high performances are desired.

If we could build a hydrogen-oxygen multistage rocket with structural weight to initial gross weight ratio of 0.20 and with an initial accelerational load factor of 2, then the required velocity ratio of 3.1 could be obtained with a 5-stage vehicle weighing 2,900 lb. per lb. of payload, or 290,000 lb. for a 100-lb. payload. This is a much more reasonable figure and could not be ruled out on the basis of size alone.



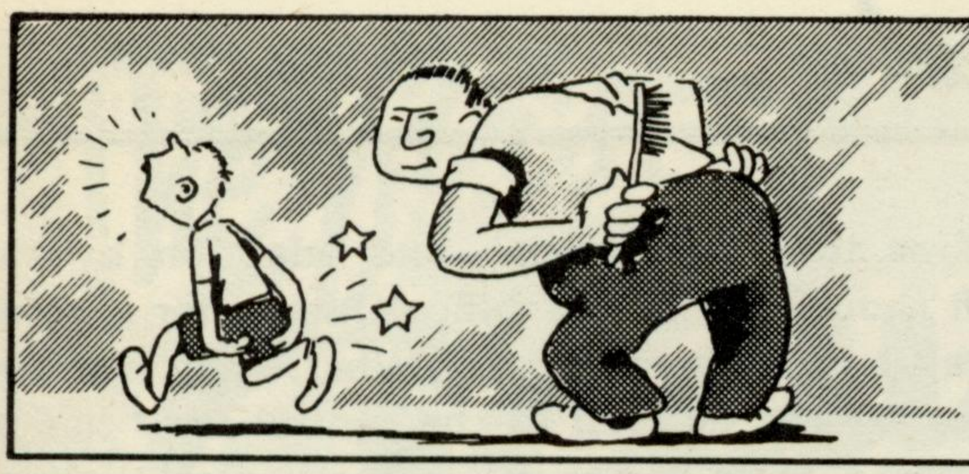
If the multistage hydrogen-oxygen rocket could be built with the same values of 0.15 and 2.0 as were used in the alcohol-oxygen rocket examples, then the required velocity ratio of 3.1 could be attained with a 4-stage vehicle weighing 1,000 lb. per lb. of payload, or 100,000 lb. for a 100-lb. payload. This illustrates quite forcefully the advantages to be gained by increased rocket exhaust velocities.

It should be remembered that the above figures must be corrected for air resistance. Such a correction affects only the first stage rocket in each case because the subsequent stages operate at altitudes well above the atmosphere. The experience with the V-2, which is comparable to that required for the first stage, indicates that the correction for air resistance is only a few per cent of the velocity. However, a few per cent change in velocity corresponds to much larger changes in gross weight, according to our curves.

(Complete paper on which this article was based is available from SAE Special Publications Department. Price: 25c. to members, 50c. to non-members.)

OUR GENIAL NORTH

THE WORLD'S COLDEST SPOTS are not within the Arctic Circle. There probably is no spot on any seacoast within the Arctic Zone that can show a minimum as low as the —90 deg. F. temperatures recorded at Riverside, Wyoming. The lowest temperature recorded at Pt. Barrow, Alaska, is —56 deg. Arctic winter climate on the average is dry. Actually relatively little snow falls. Frequently what appears to be a blizzard is merely old snow being blown from one point to another by a high wind. Annual snowfall added to annual rainfall seldom exceeds 10 inches. Heaviest snows come in the Spring.



Simplified CONTROLS

PERIODICALLY somebody expresses dissatisfaction with the conventional aeroplane controls—the stick and rudder bar, wheel, and pedals. Various reasons are given: they are not instinctive, they are cumbersome, the feet are insensitive, there are too many of them. . . . Generally speaking, it is the rudder bar that is anathema to the reformers and there are two ways of getting rid of it. One is to incorporate its work in the stick (or, more usually, wheel) by linking ailerons and rudder so that only correctly banked turns can be performed, as in the Ercoupe—but in this case the aeroplane's manoeuvres are curbed, since it cannot bank without turning or turn without banking. The other solution is to incorporate the rudder functions in a third movement of the stick or wheel.

Recently, there has been a revival of interest in the last-named arrangement. The enthusiasts always maintain that the system is better in itself, but the general run of aeronautical engineers are more interested in it now as a solution of the problem of flying in the prone position. With rapidly increasing speeds it will soon be essential for pilots to lie flat if they are to resist the high *g* loads in turns. The Germans did experiment with prone piloting positions, but only on research prototypes. One such design by Gotha had a small stick in front of the pilot, and hanging rudder pedals pushed by the feet, an obviously clumsy arrangement.

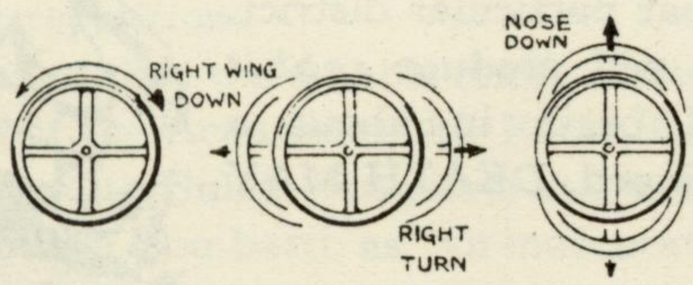


Fig. 1. Diagram of the Chrislea type of single control, showing the responses to the control wheel movements.

The Chrislea Super Ace is a British machine with a single control unit—but full three-dimensional control by ailerons, rudder, and elevator—and in this is a wheel mounted on a universal joint. The movements are shown in Fig. 1: rotation moves the ailerons (conventional); pushing sideways operates the rudder, turning in the direction of push; while bearing up and down moves the elevators *in the opposite sense*. We have not yet had a chance to try these controls, but experienced pilots say they take some getting used to. On the other hand, they are probably as easy to learn from scratch as are the conventional ones.

The Chrislea system is not actually new; Louis Bréguet tried a similar one nearly forty years ago, Nicaise in 1930, Dupuy in 1941, and yet another Frenchman, de Valroger, is in the field. This last control system (Fig. 2), for the details of which

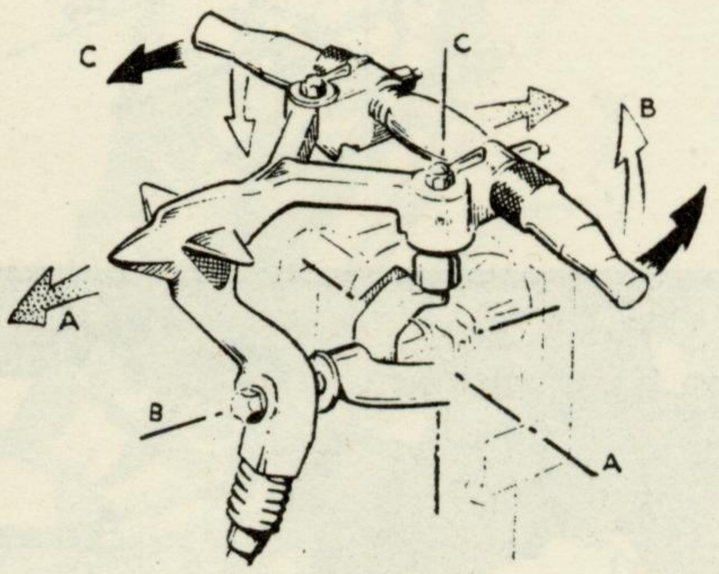
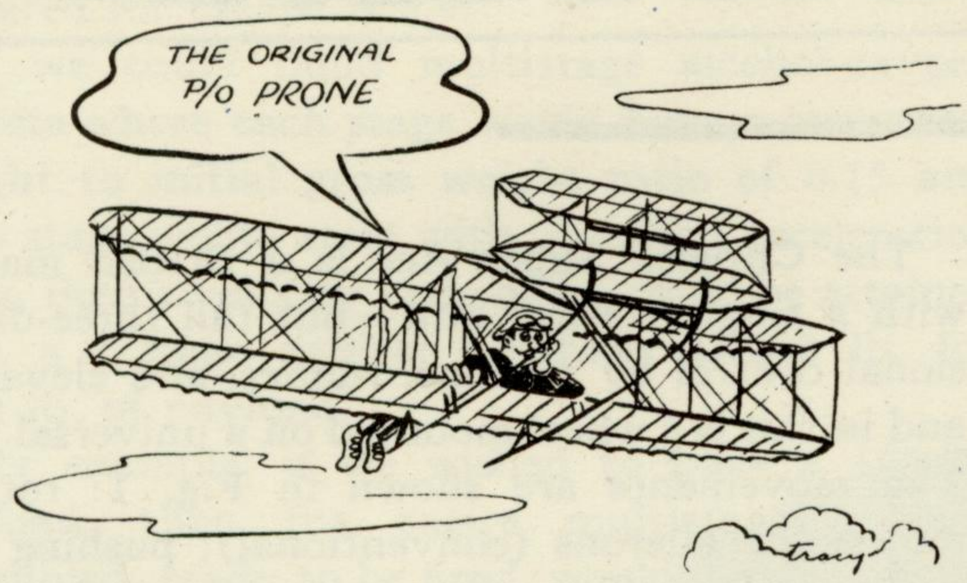


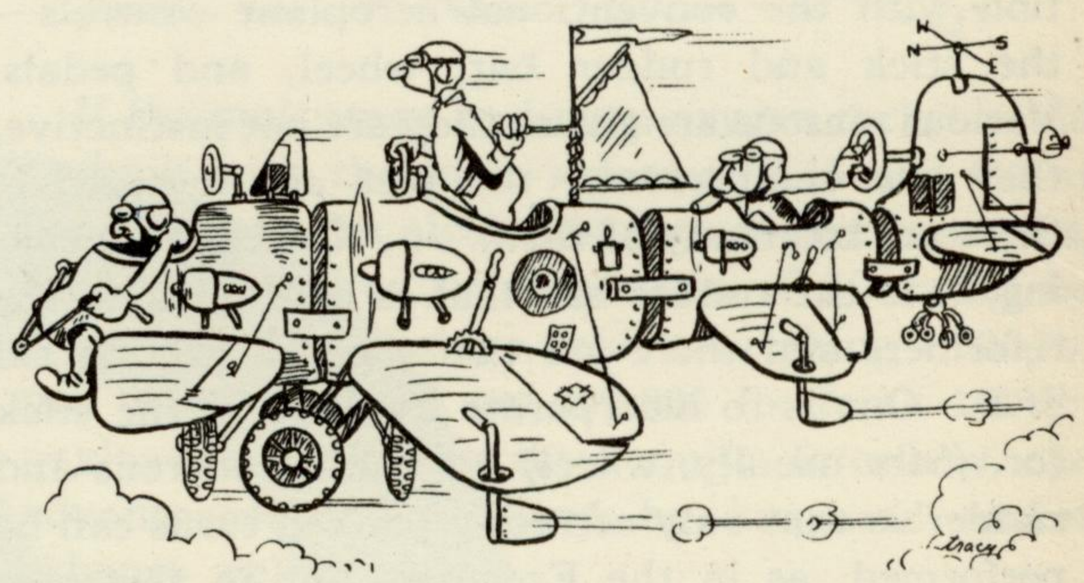
Fig. 2. The control unit of the de Valroger system showing the model and the responses to the handlebar movements
A—pitch movement and axis, back nose up, forward nose down.
B—roll movement and axis, right bank shown.
C—turning movement and axis, left turn shown.

we are indebted to *Les Ailes,* is very ingenious and well adapted to a prone cockpit. The idea of this is that the control unit is mounted on a universal joint carried either on a bracket projecting from the dash or on the top of a pylon rising from the floor. In order to make quite sure that everything goes right, a model fitted to the front of the unit shows what each control movement will do to the aeroplane. The inventor points out,

too, that this model can be used in conjunction with the blind flying instruments.



That the de Valroger control is practical has been demonstrated during a year's flight trials at Brétigny (the French equivalent to our Boscombe Down). Its movements appear at least as instinctive as the conventional, and adaption by the pilot should not be too difficult, while for a prone installation it is excellent. What, then, are the snags? First, as soon as the control *unit* has to include a third function its mechanical linkage becomes more complex. Fig. 3 gives some idea of the complications, out of which must arise another problem, that of "feel." I cannot see how a system with so many linkages and joints, heavily geared to give small control movements for large results, can be really sensitive.



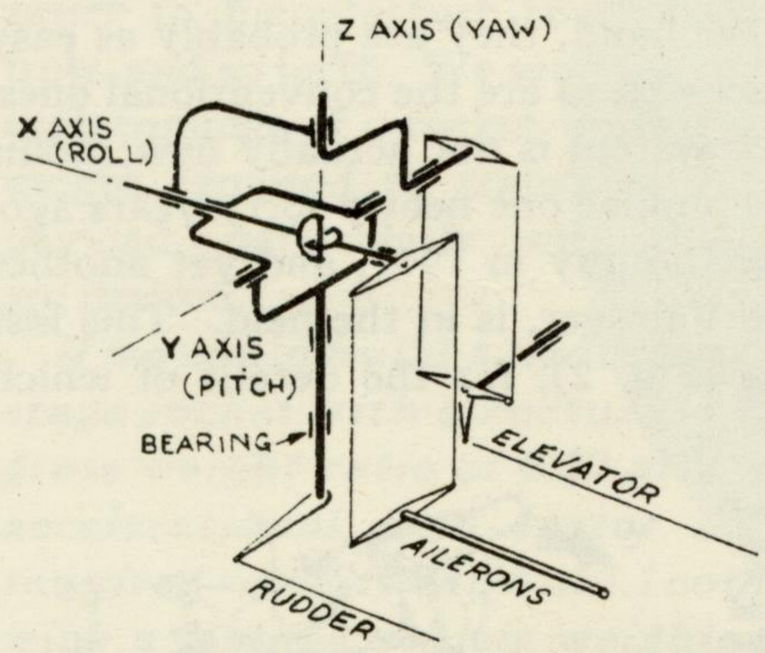
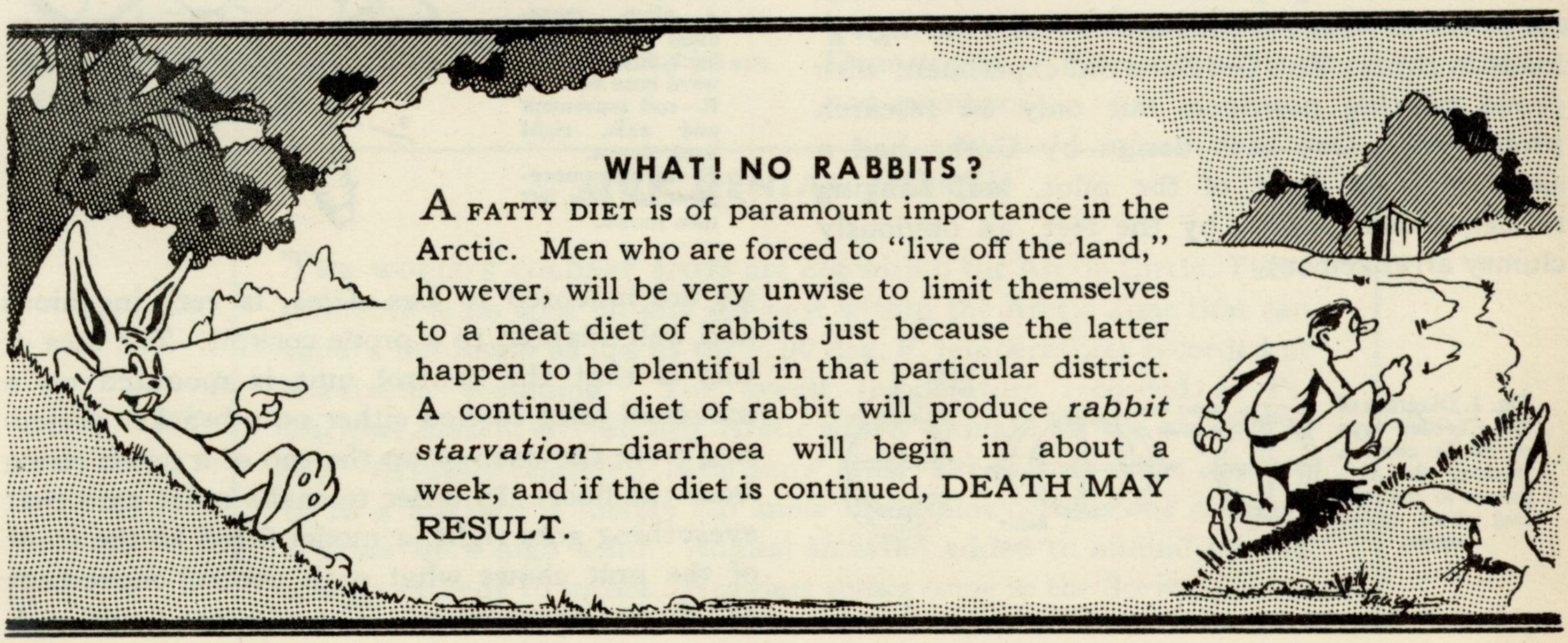


Fig. 3. Diagram of the complicated linkage necessary with the de Valroger flying control unit.

(*Courtesy of the "Air Reserve Gazette"*)



The first Accurasian Affair

by GROUP CAPTAIN E. S. D. DRURY, A.F.C.

(Reprinted by courtesy of "Air Clues")

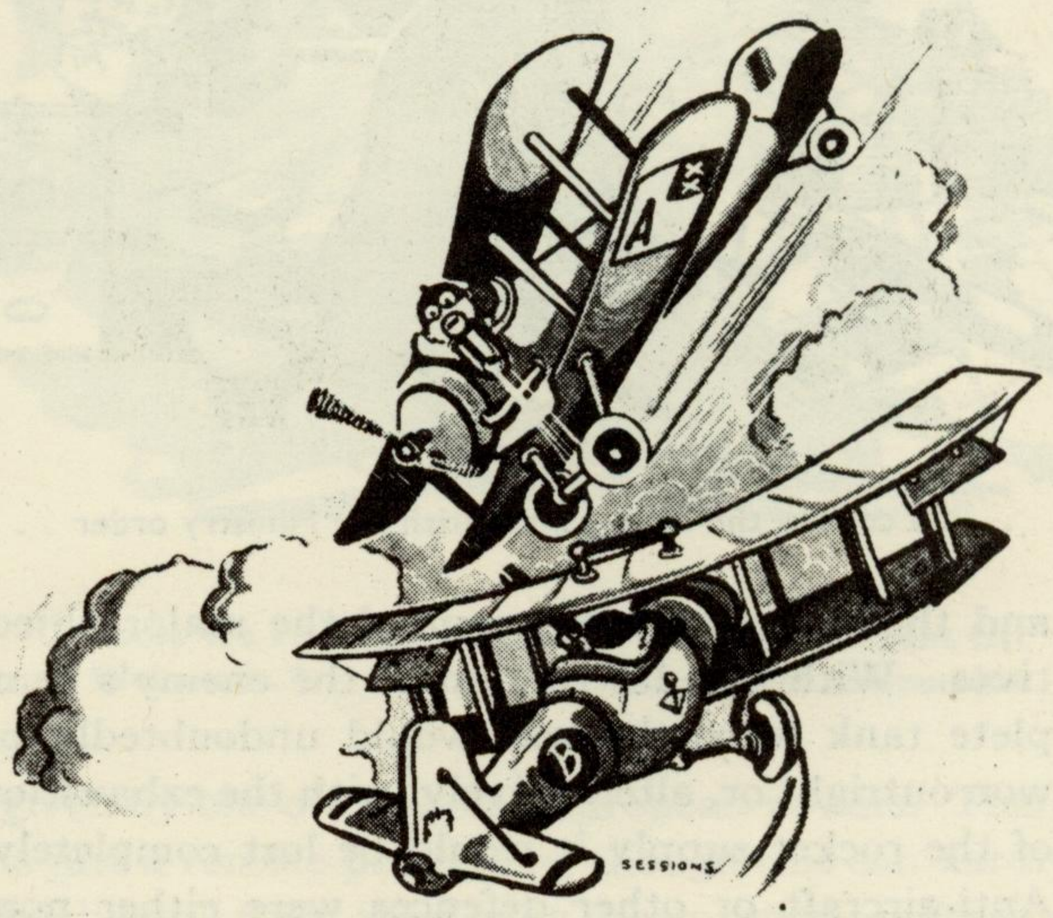
The following article, although it made its first appearance in "Air Clues" more than a year ago, remains one of the classics of R.A.F. literature. It is reprinted here for the benefit of those many members of the R.C.A.F. who have not yet had the opportunity of reading it. "The Second Accurasian Affair" will make its reappearance in our December issue.

IN THE APRIL ISSUE of *Air Clues* the statement was made in an article called *The Art of Heaving Bricks* that the number of attempts required to achieve a given probability of a desired result with air weapons increases as the square of the *inaccuracy* with which the weapons are delivered. It was suggested that this might be a rather important thing.

Recently an extraordinary opportunity has occurred of confirming the square-of-accuracy law through examining important official documents which have only just come to light. These describe the well-known struggle between the States of Accurasia and Bulldozia. This conflict is, of course, now a matter of history, but for the benefit of those who may not have heard of it, some details will bear repetition.

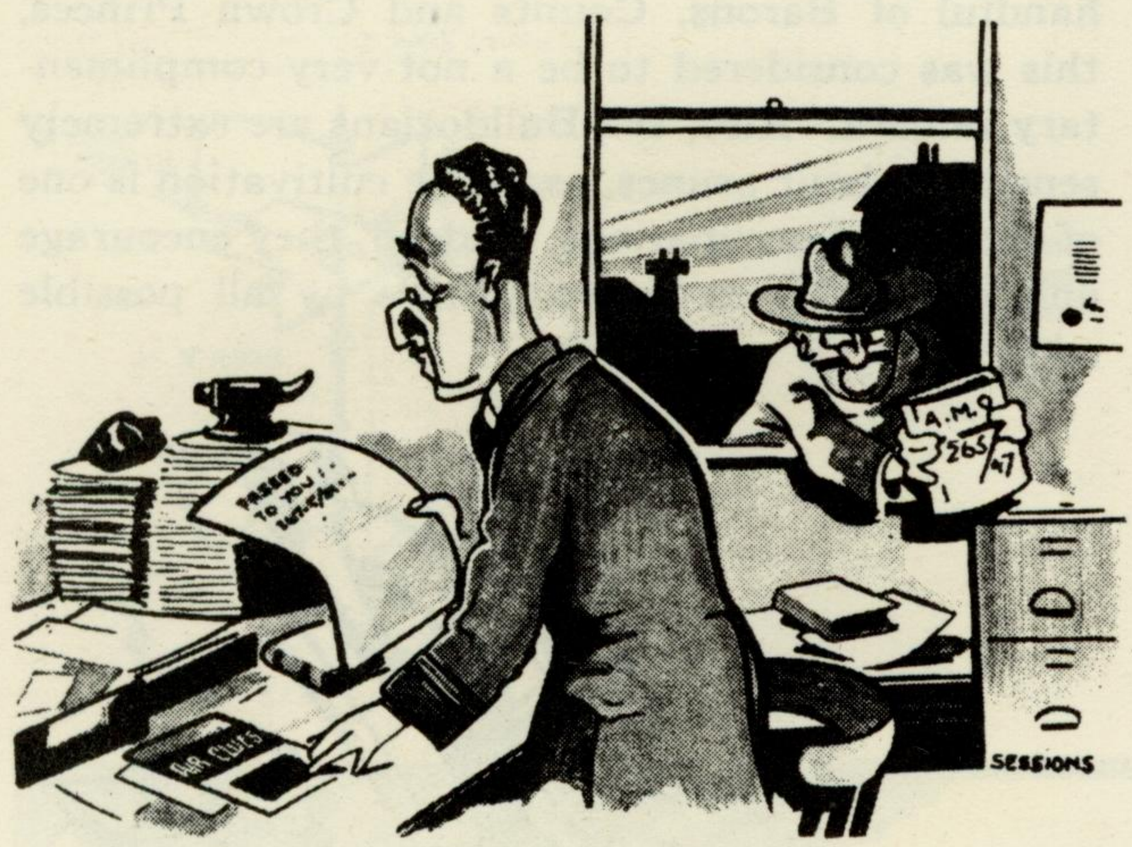
It will be recalled that the trouble really started when the SASO of the Accurasian Air Force, Col. H. Sapiens, referred to Bulldozian pilots in a letter to their SASO, Baron Bombasti, as "an inaccurate, over-confident bunch of weapon-butchers, amounting to no more than a posse of prunes."

Now, both these air forces, as will be seen later, were very small in size—in fact, minute; and as the Bulldozian Air Force consisted only of a handful of Barons, Counts and Crown Princes, this was considered to be a not-very-complimentary remark. Also, the Bulldozians are extremely sensitive about prunes, as prune cultivation is one of their chief occupations. Indeed, they encourage and cherish home-grown prunes by all possible means.



The result of all this was that after the writing of many strongly-worded, but not very effective, diplomatic communications, warfare in its most ferocious form broke out as soon as the Bulldozian pilots could be located and recalled from leave.

The documents show that whereas the policy of Accurasia had been to rely on a tiny well-trained and accurate air force, that of Bulldozia had been to concentrate on quantity rather than quality—so much so that they could generally maintain two first-line serviceable aircraft; whereas Accurasia could only operate one. Each country had bought identical types of foreign aircraft and weapons, the performances of which were precisely the same. The aircraft were equipped only for the ground attack role and could carry only two rockets each. Furthermore, the resources of both States were so limited that each possessed a supply of only 100 rockets, and no more were available as they could neither manufacture them nor afford to buy them. Similarly, the armies of each consisted only of 15 tanks and nothing more,



. . . a copy of the important British Air Ministry order . . .

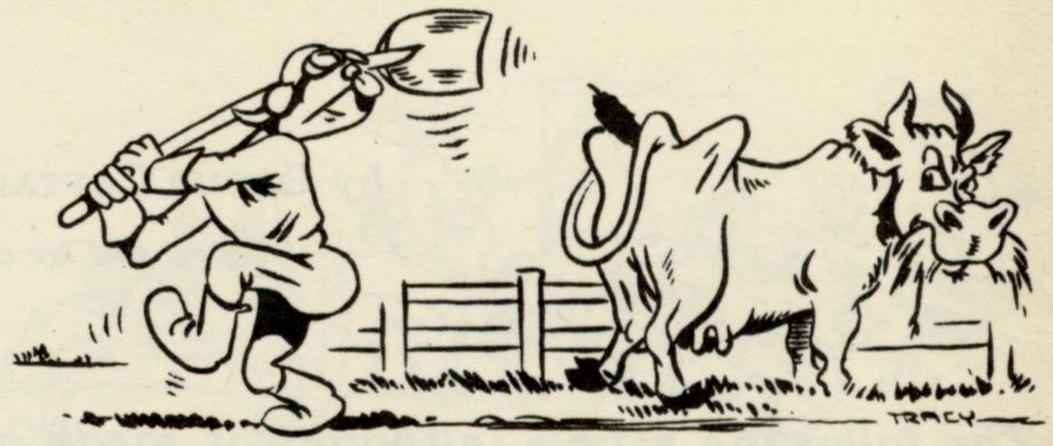
and these naturally represented the major objectives. With the destruction of the enemy's complete tank force the war would undoubtedly be won outright or, alternatively, with the exhaustion of the rocket supply it would be lost completely. Anti-aircraft or other defences were either non-existent or equally ineffective on both sides.

The only differences between the two sides were:—

First: Accurasia could produce each day, on the average, only one single operational aircraft, whereas Bulldozia could manage two.

Second: Accurasian pilots had an average rocket error of 25 yards, whereas Bulldozian pilots averaged 43 yards.

In other words, Bulldozian aircraft were twice as numerous as Accurasian, but not quite twice as inaccurate.



Now, under the conditions which existed in these States, and taking into account the large and very vulnerable type of tank that each used, these average errors meant that Accurasian pilots could, in the long run, destroy one Bulldozian tank in every three sorties flown—that is, for every six rockets fired. On the other hand, it can be seen from the application of the square-of-accuracy law that the ratio of the probabilities of destruction and, therefore, the ratio of the average number of sorties flown for each tank probably destroyed by the two air forces would be:—

$$\frac{\text{Bulldozia}}{\text{Accurasia}} = \frac{43^2}{25^2} \text{ or } \frac{1849}{625}, \text{ which is about } \frac{3}{1}$$

which means: Accurasia probably one tank per 3 sorties; Bulldozia one tank per 9 sorties.

During the war, in spite of many maintenance difficulties, both air forces managed to keep up an effort of three sorties per aircraft per day, and as they could carry two rocket projectiles each, the expenditure of Accurasia was 6 RPs per day and that of Bulldozia twice as much.

One other difference between the two States may be mentioned, and that is that Accurasia had invested some of their air force funds in an armament practice camp and a central gunnery school equipped with second-line aircraft. Bulldozia, on the other hand, had neither, having allotted a large sum to the acquisition of a palatial headquarters building to house a very large staff.

To sum all this up, we may give the so-called "order of battle" of the two air forces at the start of the war thus:—

TABLE ONE

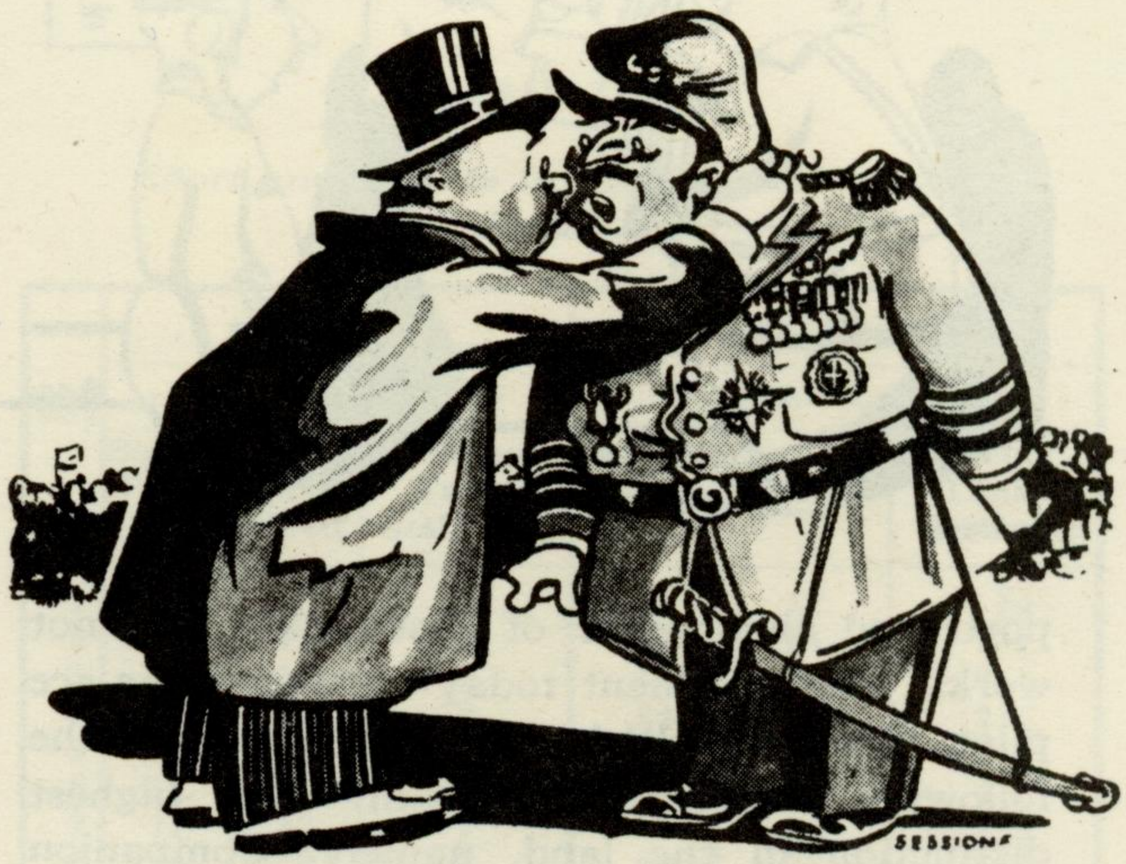
	Accurasia	*Bulldozia*
Type of aircraft and rocket	Same as B	Same as A
Total resources of rockets	100	100
Production or reserve of rockets	Nil	Nil
Rockets fired per aircraft per sortie	2	2
Sorties per aircraft per day	3	3
Daily number of operational aircraft	1	2
Total sorties per day	3	6
Total rockets per day	6	12
Average rocket error	25 yards	43 yards
Ground forces	15 tanks only	15 tanks only

It is, of course, well known by now that Accurasia easily won this war outright by the eighth day. In this time they had destroyed 8 Bulldozian tanks for the expenditure of only 48 rockets; whereas by this time Bulldozia had only destroyed just over five Accurasian tanks, but had used 96 of their total supply of 100 rockets and had, therefore, to surrender.

The extraordinary thing is that a very similar result could have been predicted and was, in fact, forecast by the weapons section of the air staff of Accurasia. It is fortunate that we possess a copy of their estimate of the probable course of the war, and this is shown in Table 2. This table has been checked and is, indeed, found to be a correct forecast of the probable performances of the two air forces based on the known data.

It shows that, in any event, Accurasia would be almost bound to win by the fifteenth day in spite of their numerical inferiority, for by that day they would stand a good chance of having destroyed the complete Bulldozian tank force for the expenditure of only 90 rockets. Alternatively, if Bulldozia could have kept going for 22 days, it is likely that only by then could they have destroyed the complete Accurasian tank force, and to do this they would have had to have used 264 rockets. It is obviously unusual for a war to go exactly according to plan, and we should not always rely on weapon estimates being exactly correct on any given occasion because in more complicated wars there are many factors to be considered. In the Accurasian affair, however, there was invariably good weather and no flak or opposing fighters. It is probably for this reason that the results were so near to those predicted. It was, in fact, a very simple war.

It is also surprising to learn that the Accurasian Air Force employed GD officers on the air staff who had been specially trained in weapons duties. This is a significant fact, and it seems that Accurasia may have been following the lead recently given by one of the great European powers. There is just a remote possibility, though this can hardly be likely, that they may, from some unknown source, have obtained a copy of the important British Air Ministry Order A.265/47.

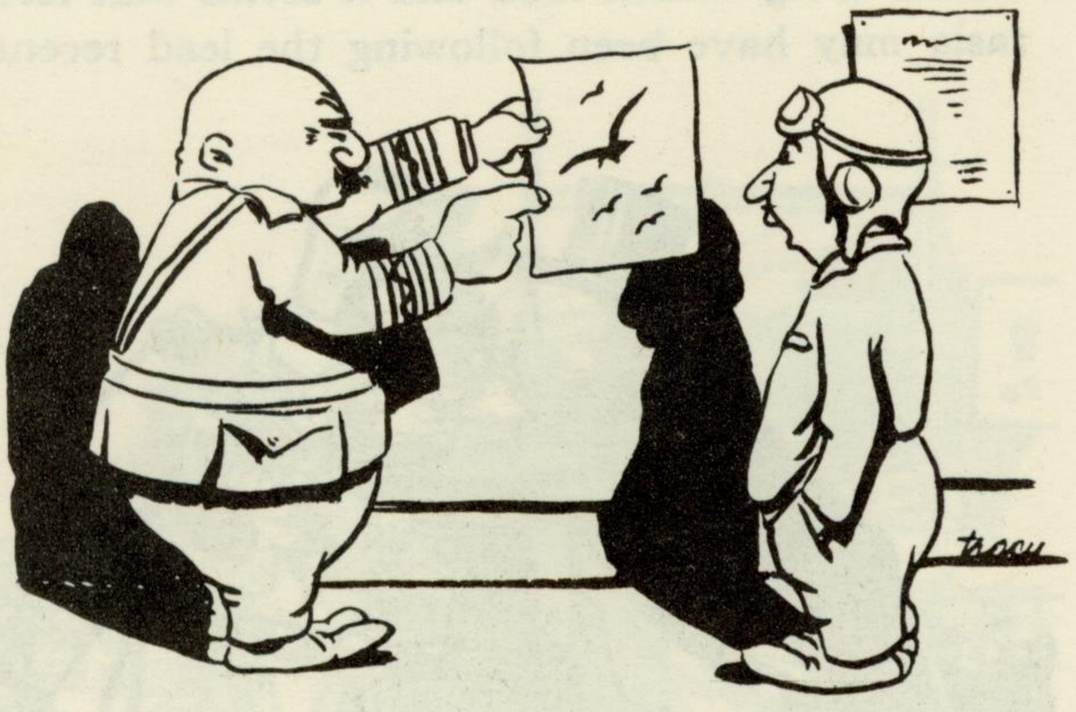


"Today the President embraced our ace pilot, Count Ost Weltwistle." —*Bulldozian communique.*

Extracts from the State war communiques issued by the two combatants make an interesting comparison.

On the very first day of the war the Bulldozian communique read:—

Today our intrepid air force inflicted a crushing defeat on the Accurasian ground forces. Both our ace pilots operated continuously and fired many thousands of the deadly high-explosive rockets recently purchased from abroad. Had the even more lethal foreign armour-piercing rocket been available there can be no doubt that the whole of the Accurasian tank force would have been entirely eliminated. Our pilots observed much smoke, flame and confusion, and all rockets, of course, hit the target area. Many tanks were destroyed. The exact number is not known. Unfortunately, the cine-cameras, which would have vividly



portrayed this welter of destruction, did not work. The President today embraced our ace pilot, Count Ost Weltwistle, and conferred the following honours upon him: The highest distinction in the land, namely, Companion Completely Regardless of the Order of St. Brutus Forcissimus; The C.F.C (Cross for Clobbering) with clasps and clusters.

It was not until the fifth day that a cautious Accurasian communique read:—

A confirmed estimate of results so far achieved against Bulldozia is five tanks destroyed. The use of cine-cameras on all occasions has checked the original estimate based on a probable weapon and accuracy performance. The supply organization is attempting, unfortunately without success, to obtain an additional quantity of the high-explosive rockets acquired from abroad, as it is known without doubt, from observation and trials, that this type is more effective against tanks than the armour-piercing rocket which had been ordered, but fortunately was not supplied. Our original pilot, Lt. Overo Confidento, whose films have been carefully analysed, has shown a tendency to fire at too long a range and with insufficient care. He has, therefore, been withdrawn from operations for further training at our armament practice camp. The spare pilot, Major Wizardo Roceteero, has taken his place. The results achieved against us by Bulldozian pilots are not impressive.

By the seventh day the Bulldozian communique read:—

The war situation is temporarily unfavourable owing to the dastardly use by Accurasia of unfair and uncivilized tactics such as firing at a short range or measuring the wind velocity before take-off. Such barbarous measures will shortly force us to use against them our Very Very Secret Weapons.

On the same day the Accurasian communique stated that:—

The war continues as anticipated. Bulldozians are unbeatable in only one respect and that is as Prunes. The President today conferred on Major Wizardo Roceteero the highest distinction in the land, namely, Companion Grand Velocity of the Order of St. Hispano.

To close the account of the whole extraordinary episode it may be appropriate to give a verbatim translation of extracts from the interrogation of the least successful of the Bulldozian pilots, Count Ost Weltwistle, which was made by Accurasian officers after the surrender.

Question 1: What methods of attack did you employ in your rocket attacks against tanks?

Count Ost Weltwistle: First, from a few thousand metres, with a merry laugh, I wing my ship over into an absolutely vertical dive. Grasping the stick firmly with both hands, I force him violently under full power in the general direction of the target area. At a height of a few hundred metres, if the ship is still under control, I jerk his

nose sharply towards my victim and with a quick jab of the release button I send the deadly rockets roaring on their mission of destruction—straight to the bull's eye. The scene of confusion which results is indescribable, the smoke, the flame, the chaos is . . .

Question 2: Quite, quite. What kind of sight do you use?

Count Ost Weltwistle: Sight? I never use a sight. I seem to have a sort of natural ability and I aim entirely by eye. I can appreciate all the factors in a split second and always my unerring instinct . . .

Question 3: Naturally. What harmonization do you employ?

Count Ost Weltwistle: I cannot understand. Perhaps it might be a matter for the armourer? Such affairs are not becoming to the dignity of a Count. I could not be caring to a very much less extent about harmonization.

Question 4: Did you do much rocket training before operations?

Count Ost Weltwistle: To operational Counts training is not of any necessity. Also it might interfere with operations.

Question 5: How often did you hit your taget?

Count Ost Weltwistle: Bang-on—every time, always, invariably, of course.

Question 6: Then how do you explain the fact that we still had nearly ten tanks left on the eighth day?

Count Ost Weltwistle: The weapons must have omitted to explode themselves. I expect the armourer forgot the insertion of the fuzee or whatever it's called. I've heard that he often does.

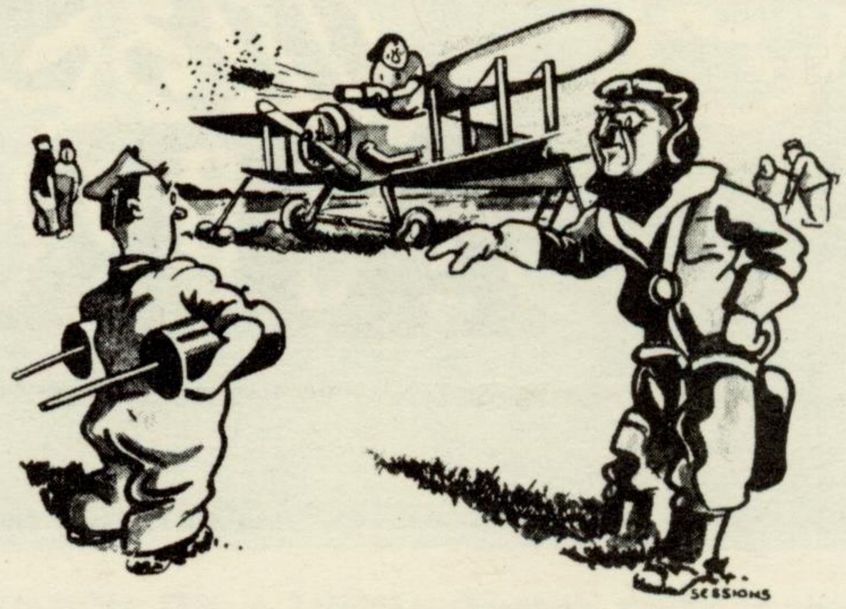
Question 7: We did not recover any unexploded rockets after your attacks. How do you like that?

Count Ost Weltwistle: Not with any great degree of largeness. It is a difficult matter on which I have not any quite crystal clear ideas.

When Major Wizardo Roceteero, the best of the Accurasian pilots, was subsequently asked to what he attributed his success he said:—

> I admit that I learned the hard way, but I tried to profit from my mistakes. Accuracy does not come easily. You have got to understand your problem, train very hard, use every aid that is given you, and pay attention to every detail. I have questioned Count Ost Weltwistle and do not consider him very well provided with clues. He does not amount to very much.

Moral: Numbers matter but accuracy matters more.



. . . the spare pilot Major Wizardo Roceteero . . .

TABLE TWO

Effort and Results in the First Accurasian/ Bulldozian Affair

Day	ACCURASIA			BULLDOZIA		
	CUMULATIVE TOTALS			CUMULATIVE TOTALS		
	Sorties Flown	Rockets Fired	Enemy Tanks destroyed	Sorties Flown	Rockets Fired	Enemy Tanks destroyed
1	3	6	1	6	12	⅔
2	6	12	2	12	24	1⅓
3	9	18	3	18	36	2
4	12	24	4	24	48	2⅔
5	15	30	5	30	60	3⅓
6	18	36	6	36	72	4
7	21	42	7	42	84	4⅔
8	24	48	8	48	96†	5⅓
9	27	54	9	54	108	6
10	30	60	10	60	120	6⅔
11	33	66	11	66	132	7⅓
12	36	72	12	72	144	8
13	39	78	13	78	156	8⅔
14	42	84	14	84	168	9⅓
15	45	90	15*	90	180	10
16				96	192	10⅔
17				102	204	11⅓
18				108	216	12
19				114	228	12⅔
20				120	240	13⅓
21				126	252	14
22				132	264	14⅔

*All Bulldozian tanks now destroyed.
†Only 4 R/P left.

The SOVIET AIR FORCE

by "Polygon"

(Reprinted by courtesy of "The Aeroplane")

DURING A WAR secrecy is essential, but when a war is over it is right and proper that the veil of secrecy should be withdrawn. In both England and in America the despatches of the leading Commanders have been published in the Press and, no doubt, we shall soon be privileged to read another brilliant "World Crisis" series by Mr. Churchill. Meanwhile Service chiefs may make critical and public analyses of operations, as, for example, the series of lectures given by Sir Robert Saundby, which have been reviewed recently in THE AEROPLANE. Much information is laid freely before the student of war and this is all to the good. It seems a great pity that the Russians do not do the same. We have nothing but admiration for the way in which the Russian forces, verging on defeat, gathered up their strength and crushed the powerful invader. We should like to know more about it, for we see plainly to-day how ignorance breeds suspicion, which is the father of hatred.

There seem to be two main schools of thought regarding the Russian war. One school, which apparently worships at the shrine of Lenin, would have us believe that arms, equipment, strategy and tactics, all were perfect, and that the Soviet war-machine is a truly irresistible force. The other school believes that the Russians were ill-equipped and poorly led; that the invading German tide, half-defeated by climate and by distance, was finally dammed and turned by the ruthless sacrifice of millions of men, as locusts may dam a river. Truth often lies midway between opposing schools of thought.

In this series of articles I make no attempt to analyse the operations of the Russian war. My aim is to give a brief picture of the power and organization of the Soviet Air Force. Most of the countries in the World, except America, have had practical experience of air power. The atomic bomb has now intensified that power to an unknown but terrifying degree. *I think that the more nations can appreciate each other's power, the more likely they are to remain at peace, for the strong do not quarrel lightly.* I hope that one day we may all have free access to the great Russian country and that we may collaborate together in aeronautical research. Meanwhile the more we can learn about each other the better.

ORGANIZATION OF THE S.A.F.

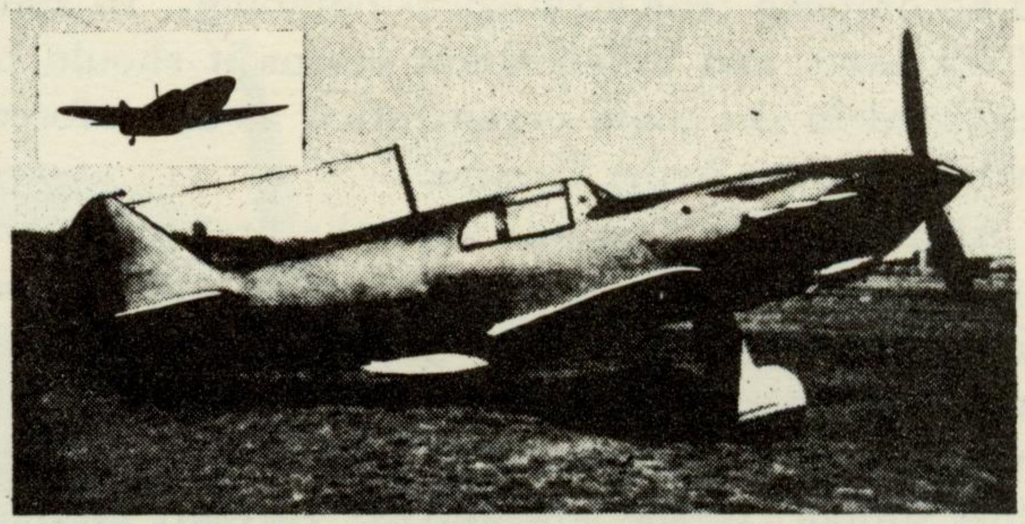
In this country we are apt to think that our own methods of organization must be best. We have



accepted our three separate services for so long now that a reversion to two would be quite inconceivable. Yet an organization suitable for an island power, dependent on long sea communications, may not necessarily be ideal for a great self-contained land power like Russia. The Soviet conception of air power is diametrically opposed to our own, in that there is no Soviet Air Force as such; almost all air units are directly under the Army or Navy. Very naturally in view of the size of the Red Armies, the majority of the Air Units come under direct Army control. Furthermore, the air armies were used almost solely as instruments for the direct and immediate support of the land forces.



We must remember that Germany, also essentially a land power, adopted similar principles in the main organization of its air forces. The Battle of France was a striking example of a swift and economic victory, achieved by land and air power working together, and we can count ourselves fortunate that this island was not conquered by the same methods. Our own policy of strategic bombing was, no doubt, an essential and powerful factor in winning the War. It has left us, however, with the crushing liability of a totally wrecked and uneconomic Germany. Whatever lessons have been taught by the War they have made no difference to the broad policy of the Soviets to air power. As the Red Army grew in power and efficiency in the years between the wars, so did the air squadrons, but always tied closely to the Army. The progress of the War, with its initial defeats and final victories, did nothing to alter the original policy but, if anything, strengthened it. The successes of our Anglo-American strategic bombing forces again had no effect on the Kremlin's policy. The end of the War found Russia with a vastly more powerful air force than she had in 1939, but still its policy and aim remained unchanged. All air forces are divided between the Army and the Navy, the Army having by far the greater proportion.



VARIATION ON A THEME.—Generally similar to the early Yakovlev fighters, the Lagg-3, used in smaller numbers, was the work of a design team led by Lavochkin.

The naval air forces were divided between the fleets of the Northern Seas, the Baltic Sea, the Black Sea and the Pacific. The equipment of the naval forces was similar to the Army Air Forces, thus helping standardization and production, but at a sacrifice of operational efficiency. The military air forces were divided into Air Armies, the Long Range Force and the Fighter Arm of the Air Defence Force. Of these the Air Armies were by far the most important, absorbing some 75 per cent. of the total air strength of Russia. They acted under the control of the Army Group Commanders and their sole purpose was to assist the operations of their Groups.

The Air Armies were divided into Fighter forces, Ground-attack forces, and Bomber forces, the fighters being the most numerous. The Long Range Force, although independent in status, was in no way comparable with the Strategic Air Forces of England and America. Its equipment was the same as that of the Air Armies, and its function was more to assist specific offensives than

to accomplish true strategical bombing. In spite of its name and independent status it should be regarded in the main organization as a reinforcement force for Army Groups.

Although the Russians were the first to experiment on a large scale with parachute troops, airborne forces did not figure largely in their organization. The broad picture, therefore, is one of a force designed and built up to work in close support of the land forces. Aircraft production was standardized for this main purpose and the aeroplanes designed for Army work had to serve the needs of the Navy as well.

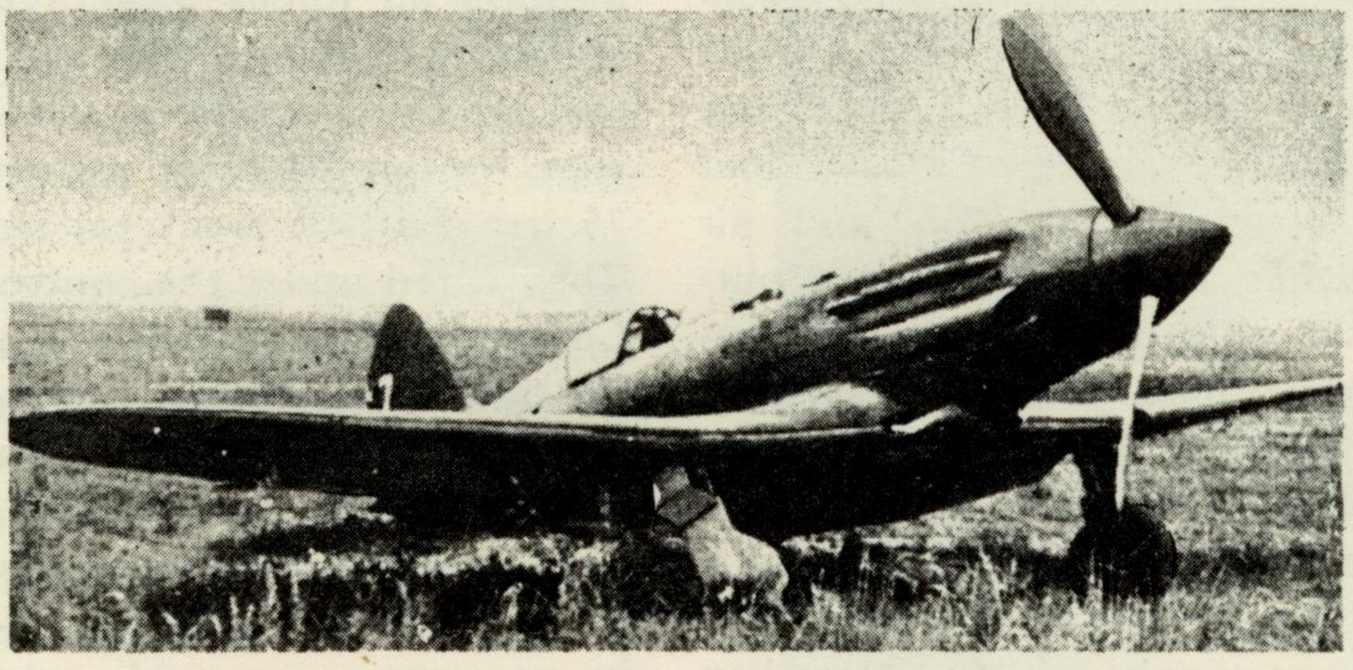
PERSONNEL AND TRAINING

Some of us imagine the Russian nations as being made up of millions of illiterate peasants who call each other "little brother," and whose sole occupation in life is to sit around a stove, drink vodka, and await death. Yet, during the War, these nations built up an air force over a million strong, and they did manage to beat the highly trained and technical Germans.

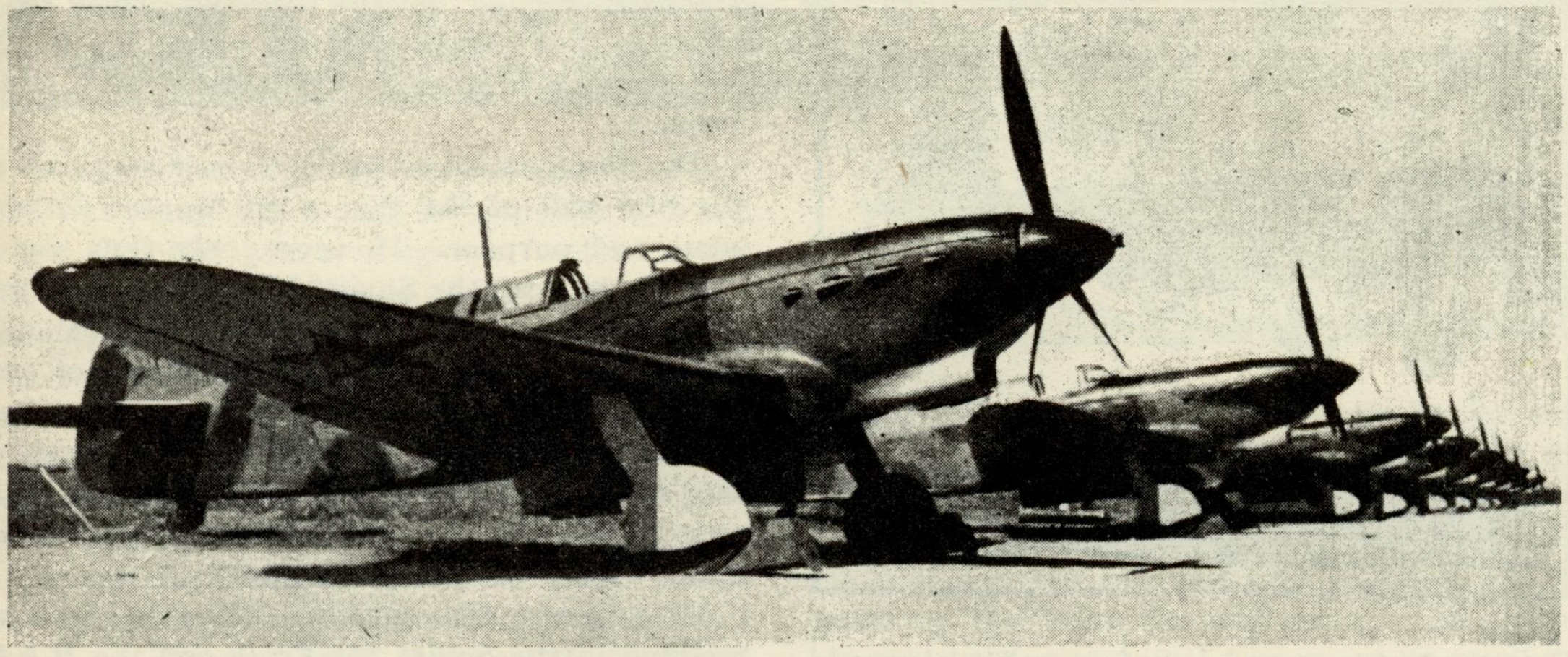
In my opinion there are two main reasons for this apparent paradox. Firstly, whatever we think about Communist teaching, it must be admitted that there has been a wider spread of general education than was achieved by the old regime. Secondly, the Soviet policy of farm mechanization on the grand scale has brought a rough understanding of mechanical devices to many millions of countrymen.

The average level of education in Russia is still far below that of this country, but the average Russian is an intelligent man and he has a natural attraction towards things mechanical. He is keen to learn, inventive, yet good at imitation; as a soldier or airman he is simple-minded, determined, and not given to nerves. He is tough, both physically and mentally, and, once he is in a Service, he does not worry so much as we do about questions of family, property or religion. He may lack initiative but he never criticizes an order—he just carries it out, provided the order is simple and he can understand it. He is a brave fighter and a noble drinker. Above all, he firmly believes his propaganda. For example, many Russians committed suicide rather than be taken prisoner, as they had been told they would be shot if captured.

That was the basic material and there was a wide choice. Fighter pilots were good flyers, excellent in individual combat, but weak in duties such as escort work. Ground-attack pilots also were skilful flyers, and stood up bravely to a casualty rate which gave 10 sorties as an average expectation of life. Both types were apt to be brutal to their engines and consequently did not always get the best performance from their aircraft. Bomber, Naval, and Long Range flyers generally had a better technical understanding of



BIG MIG.—Mikoyan and Gurek have for many years formed a design team specialising in fighters, a typical war-time example being the MiG-3. More recently, the team were responsible for the design of one of the first jet fighters to reach the Russian Air Force squadrons in numbers.



YAKOVLEV'S ALPHA.—The first fighter in the modern tradition designed by Yakovlev was the Yak-1. A line-up of this type, now replaced in service by newer Yak fighters, is seen above.

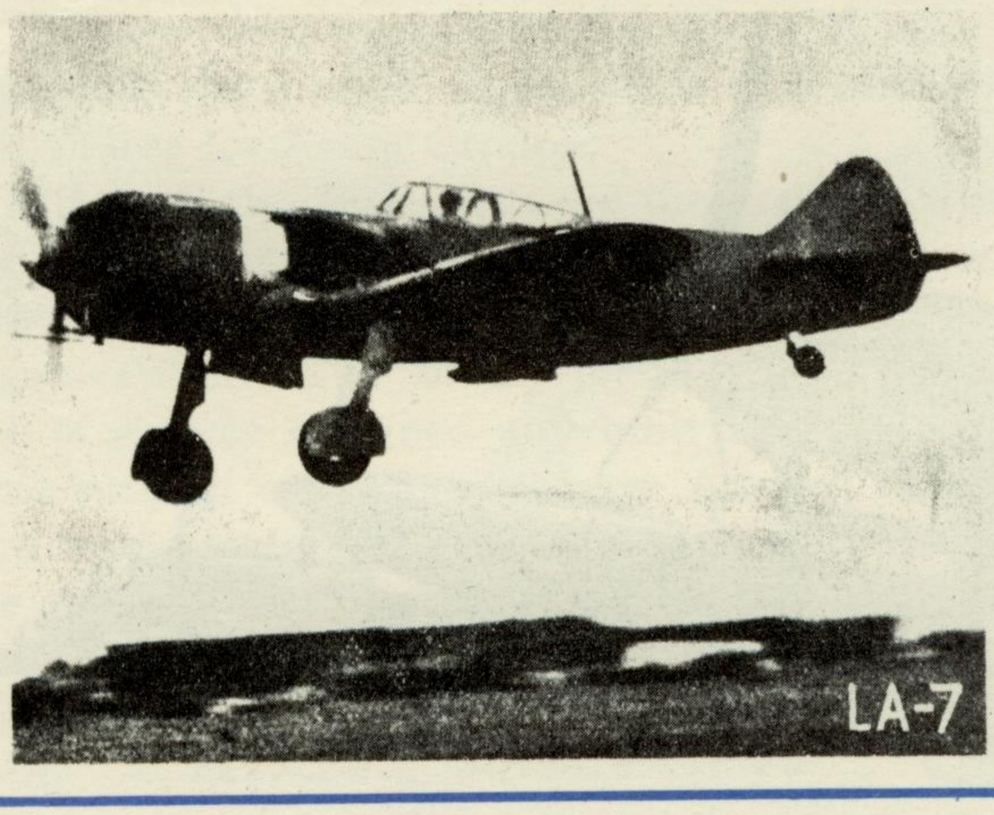
their equipment but, compared with our own standards, were weak in formation flying, navigation, and night flying. Bomb aimers were poorly trained and had inefficient equipment, but the standard for W.T. Operators was good. Air gunners were courageous but often lacked weapon training and frequently wasted ammunition.

Education of ground personnel was low by our standards, but the individual was hard-working and interested in his job. Discipline was good, and excellent in hard conditions, and the Russian capacity for working under terrible conditions was a large factor in the success of their air operations. Repair units were quite competent, but transport was handicapped by shortage of vehicles, although Russian vehicles proved excellent under bad conditions.

The record of a Guards Fighter Air Regiment of the 1st Air Army over the period of May 20 to August 24 (96 days), during the Summer offensive of 1944, which opened on June 22, and in which the Air Regiment was actively engaged, is of interest as an example of what their pilots could achieve. The Air Regiment in question may be taken to be one of the best in the Soviet Air Force. The following table sets out the record of its activities during the period, and gives the estimated number of operational sorties flown. All dates are inclusive:—

May 20 to June 21 (32 days)	Estimated 30 serviceable LA-5 aircraft	960 sorties
June 22	Offensive opened	
June 22 to July 2 (11 days)	Estimated 32 serviceable aircraft declining to about 20	1,300 sorties
June 23 to July 31 (29 days)	Estimated 20 to 25 serviceable aircraft	1,200 sorties
August 1 to August 19 (19 days)	Withdrawn and re-equipped with 40 LA-7 aircraft after handing in 27 LA-5s	
August 20 to August 24 (5 days)	2 aircraft shot down during this period	300 sorties

Training of pilots and air crew was on lines broadly similar to our own; pilots started at elementary flying training schools and then went on to Service schools. The number of pupils at an E.F.T.S. varied from 150 to 2,000, and the range of subjects taught was much the same as in our own schools, but included "political instruction." In the Service schools pilots were given some 70 hours of flying and the course lasted seven to nine months, according to the weather and the student. Pilots selected for the Long Range



Force had a longer training of up to 120 hours and, although this force was rarely employed for strategic purposes, it did contain a nucleus from which a modern strategic force could be built.

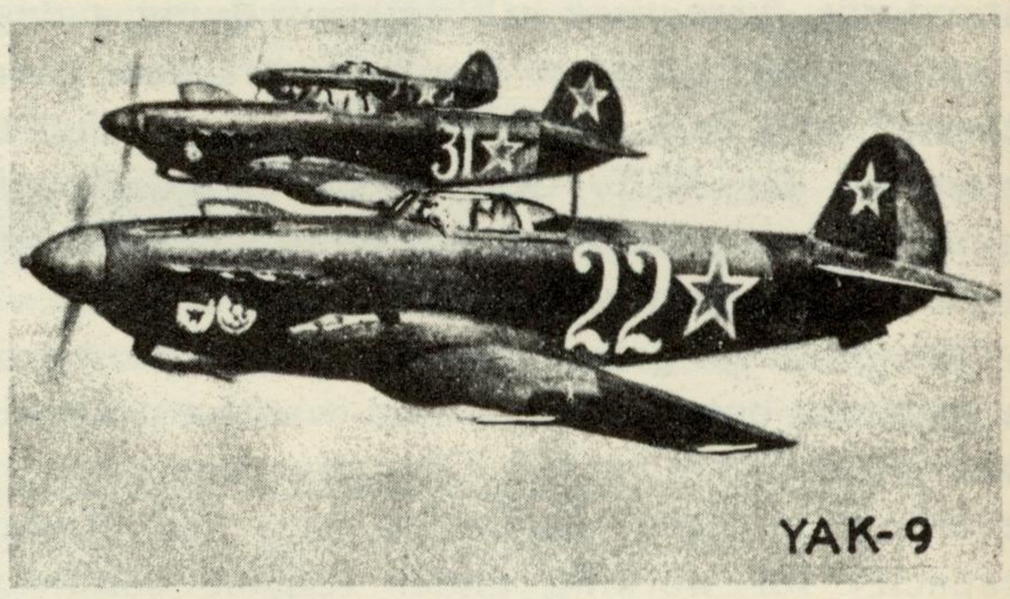
Apart from the E.F.T.S. and the O.T.U., the Russians established special advanced schools for the training of flight and squadron commanders, and there was also at least one Senior Air Combat School for fighter pilots, designed to put a final polish on experienced men. Towards the end of the War, when the air forces had become strong, Air Armies were often sent many miles away to rear aerodromes to provide a rest from operations and give a polish to their training. Also, towards the end of 1943, all operational air regiments were provided with a couple of training aircraft. Pilots appointed to operational units could be tested and given further training if required, and a special officer was detailed for this work. This idea seems very sound.

To summarize air training in the Soviet Union, one could say that whilst not up to British standards it was fully adequate for Russian requirements. That the Soviet Air Force was able to rebuild and greatly expand during the progress of a great war testifies to the validity of that statement.

By far the most outstanding characteristic of Soviet air training was its flexibility. The High Command was ever willing to shift the main effort of training from one type of training unit to another if such action was justified. These shifts were designed to meet pressing operational needs, and they invariably proved to have been made correctly.

The employment of badly trained personnel in the first half of the War might appear without sense and purpose. However, only thus was it possible to keep the Soviet Air Force operational until better-trained personnel became available. The solution of the formidable problem of evacuating training stations from territory threatened by the Germans and of reopening them again in safe areas, must be appreciated as brilliant. It is an example of Russian ability to accomplish much under highly adverse conditions.

In general, the quality difference between training in the Soviet Air Force and the R.A.F. was most pronounced in the technical aspects. The limited amount of modern equipment possessed by the Russians was not properly introduced to trainees.

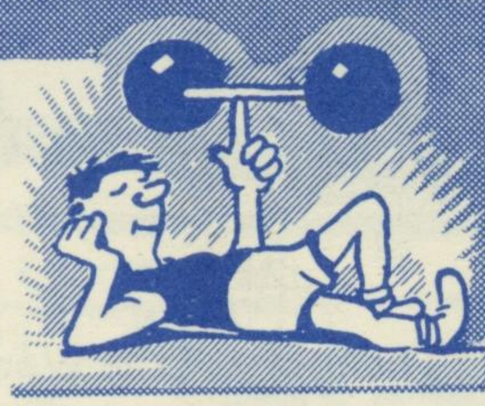


Compared with the R.A.F., flying training in the Soviet Air Force was weaker in bad-weather flying, air gunnery, and formation flying. It is difficult to point out anything in which Soviet training was better than our own, unless it was in operations under poor field conditions.

By the middle of 1945 the Soviet Air Force and its affiliated Services had grown to a strength of over one and a quarter million men.

(*To be continued in our December issue*)

RCAF Strong Man





WEIGHTLIFTER Sgt. James Patrick Varaleau, who was placed 6th among 24 contestants in the recent Olympic games, weighs a fraction under 182 lbs., does not believe in special dieting while training, is married, and has one small daughter. Many of us conform more or less to these specifications, but it is to be doubted whether any of us could ever hope to emulate Sgt. Varaleau's achievements in his chosen field of athletics.

In the Olympics, he lifted 248½ lbs., breaking the Olympic record by 5 lbs. (This new record was broken later by an American.) He then snatched 248½ lbs. and cleaned and jerked 308½ lbs., thus achieving the fine total of 805½ lbs. By being placed 6th in the contest, he gained one point for Canada.

Two evenings later he competed in the British Empire Championships, where the same lifts gained him 1st place.

Sgt. Varaleau began his muscular career in 1937 with 6 months' body conditioning. In 1940 he won the Quebec Junior Championship, following this in 1941 by winning the North American Lifting Junior Championship. Finally, he obtained 1st place in the Canadian Championships for the three consecutive years of 1946, 1947, and 1948.

"Training with weights," Sgt. Varaleau states, "is probably the quickest and simplest way to build up the body for any sport. Care must always be taken, though, to use the proper method, which will differ in every individual case."

When the RCAF altered its trade structure, Sgt. Varaleau exchanged his duties as a P.T. Instructor for those of a Fire Fighter. However, he hopes that he will soon have the opportunity of remustering once more to the trade of Physical and Recreational Training Instructor.

We can all feel justly proud of the Sergeant's splendid record, and we wish him every success both in his Service and athletic careers.



WHAT'S WRONG WITH THIS PICTURE

ANSWERS ON PAGE 48

(Courtesy of "Aviation Maintenance and Operations")

NORTHERN SKYTRAILS

The Story of the Work of the R.C.A.F. in Canada's Arctic and Sub-arctic

by

FLT. LT. E. P. WOOD, D.F.C.

INTRODUCTION

"WILL CANADA REMEMBER that the Royal Canadian Air Force first removed the veil of secrecy from our treasure-laden Northland to mark the opening of an epoch-making period of development? Or that immeasurable wealth was conserved by aerial forest protection and that invaluable photographic and survey work was accomplished with greater dispatch than was hitherto dreamed possible?"

The above quotation is taken from an editorial in *Canadian Aviation*, March 1934. It was, very largely, in order to ensure that the R.C.A.F.'s northern saga *will* be remembered that the volume from which this series of articles is extracted has been prepared.

The task of its preparation was assigned by the Chief of the Air Staff to the Directorate of Intelligence (Air). Several months of research were necessary to dig out and correlate all the available data, but the time and effort expended have been well rewarded. The resultant volume contains about 500 typewritten sheets, some 200 of which read like the adventure stories of our childhood.

In serializing the original volume for publication in *The Roundel*, much material has been omitted as having little interest except for the historian or the arctic specialist. All that is sought in this and the ensuing articles is to give the reader a clear and factual conception of what is perhaps the more romantic, but also the less publicized, aspect of the R.C.A.F.'s activities.

It is thought desirable, however, that before proceeding with the main theme, namely the breaking of our northern skytrails, the reader should be fully acquainted with the background of the Service which has done, and is still doing, so much to break them. This first instalment, therefore, gives a very brief résumé of the R.C.A.F.'s history, from its hesitant beginnings to its honoured and established position among the post-war Air Forces of to-day.

For the sake of those readers who may not be familiar with that history, the writer craves the indulgence of those (it is to be hoped) many who are.

1. THE R.C.A.F.

The Air Board

The termination of the 1914-1918 war released a large number of Canadian pilots, many of whom, on their return home, sought to continue flying as a civil occupation. Small, and often 'hay-wire', flying enterprises made their appearance all over the country, and in the end a situation existed which called urgently for the establishment of regulations for the protection of the general public and the pilots themselves.

The Government therefore created an Air Board (June 1919), whose duty it was to guide and develop Canadian aviation along sane lines. One of the first tangible results of the Air Board's work was the publication of *Air Regulations, 1920*.

The C.A.F.

The Air Board, which included among its members the Ministers of Militia and Defence and Naval Service, gave its attention quite early to the constitution of a Canadian Air Force, which was finally approved by order-in-Council in February 1920.

The idea underlying the formation of the C.A.F. was to invite former officers and airmen of the R.A.F. to offer their services as members of the C.A.F. on the understanding that they would, in peacetime, not ordinarily be called upon for active duty for more than one month in any two years. The force was to be a militia non-permanent force, almost all the personnel were to be non-professional, and the professional personnel (negligible in number) were merely to form a nucleus at a training centre.

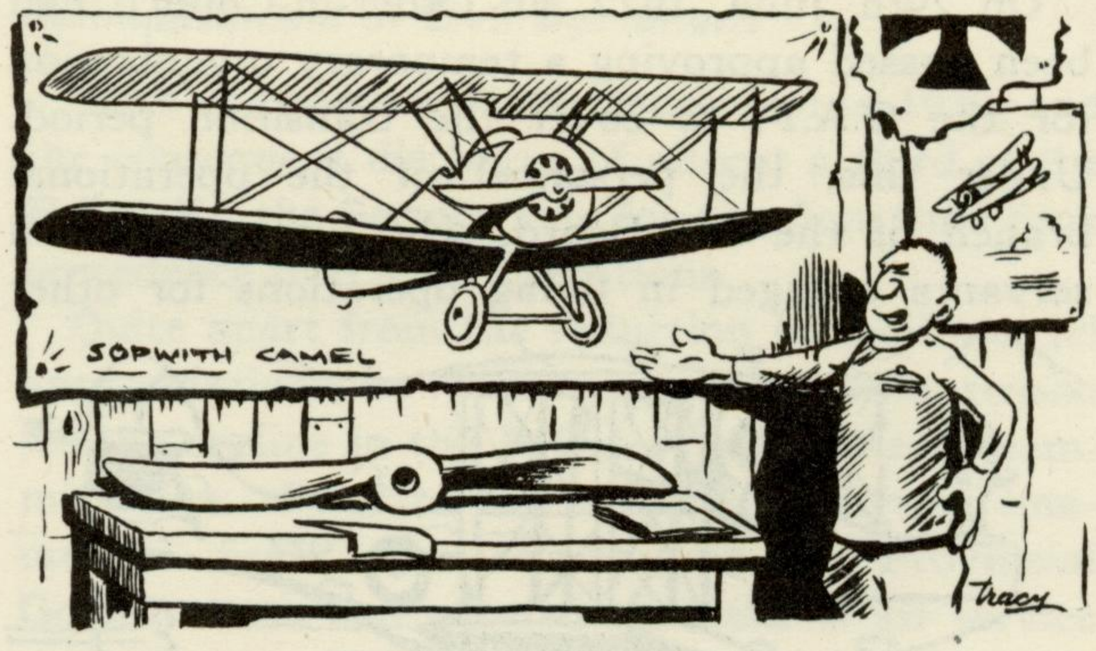


Reorganization of the Air Board

As the original Air Board had completed the preliminary organization work for which it had been appointed, it was decided to reorganize the Board to enable it to perform its dual duty of regulating civil aviation and administering the C.A.F.

The purposes of the new Board, which was reorganized in April 1920, were as follows:

1. The regulation of civil aviation, and its encouragement.
2. The conduct of civil government air operations (forestry protection, photographic surveys, fishery patrols, etc.).
3. The air defence of Canada, including the administration of the C.A.F.



C.A.F. Training (1920-1922)

Camp Borden was opened for training on October 1st, 1920, three weeks after the formation of No. 1 Wing.

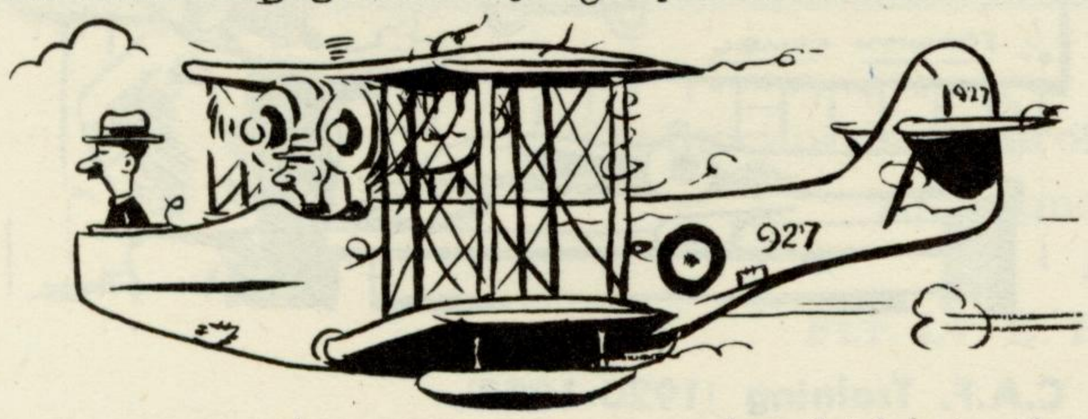
No. 1 Wing comprised a school of special flying (Avro training aircraft), a flight of fighter scouts SE5's and Camels), a flight of bombers (DH9A's), a ground instructional school, and equipment, victualling, medical and camp maintenance branches.

Training was carried out under the 28-day refresher scheme, using wartime equipment, until the end of March 1922. It was realised then, however, that the period of training was too short to keep men properly trained in Air Force duties, and that the expenditure was not really warranted. The granting of refresher courses to officers and airmen who had served in the war therefore ceased, the staff was reduced, and a number of surplus officers was sent to carry out flying operations for other government departments at various stations throughout the country.

Formation of the Dept. of National Defence

In 1922 the Government decided to centralize the control of the defence forces of the Dominion, and an Act of Parliament was passed constituting the "Department of National Defence" by the amalgamation of the Department of Militia and Defence, the Department of the Naval Service, and the Air Board under one minister. The Act came into effect on 1st January, 1923, and simultaneously the Militia Council and Air Board were dissolved.

On 29th June, 1922, an Order-in-Council had been passed approving a temporary organization for the C.A.F. to cover the transition period. Under this, the personnel of the operational branch of the Air Board, who were then civil servants engaged in flying operations for other



government departments, were absorbed into the Air Force. The whole organization was placed under a Director of the Canadian Air Force, who was made responsible to the Chief of Staff (Militia Service) for the control of aeronautics in all its phases, civil as well as military. This was the basis of organization when the National Defence Act came into force in January, 1923. A month later His Majesty the King approved the designation "The Royal Canadian Air Force."

Formation of R.C.A.F. on Permanent Basis

On 1st April, 1924, "The King's Regulations and Orders for the Royal Canadian Air Force," providing for an Active (Permanent and Non-Permanent) Force and a Reserve, became effective.

The Permanent Active Air Force was to consist of officers and airmen permanently embodied or employed for continuous service and available for general service. It was to be maintained for the instruction of the Non-Permanent Active Air Force—the latter to comprise such units or detachments and other formations as were from time to time named by the Governor-in-Council.

The Air Force, the strength of which was at this time 61 officers and 262 airmen, did not immediately engage in activities of an exclusively military nature. Bases were taken over from the Air Board at Vancouver, High River, Winnipeg, Ottawa, and Dartmouth, as well as numerous sub-bases. From these points flying operations were carried on as in the past, except that the personnel engaged in them were no longer civilians.

The establishment of the Air Force as a defence arm was begun under serious handicaps. In the first place, the demand for operational personnel by other government departments was unremitting. In the second, funds were grievously lacking. By degrees, however, primary flying instruction was augmented by courses in military flying and allied subjects, to which officers were posted as they could be spared. The central training establishment was at Camp Borden, and courses in flying and other Air Force duties were held there each summer for a new generation of pilots to replace the older war-trained personnel as necessary.



1927 Reorganization

In July 1927, owing to the increasing requirements for aerial work of all kinds, the following four separate branches of the air services were formed within the Dept. of National Defence:

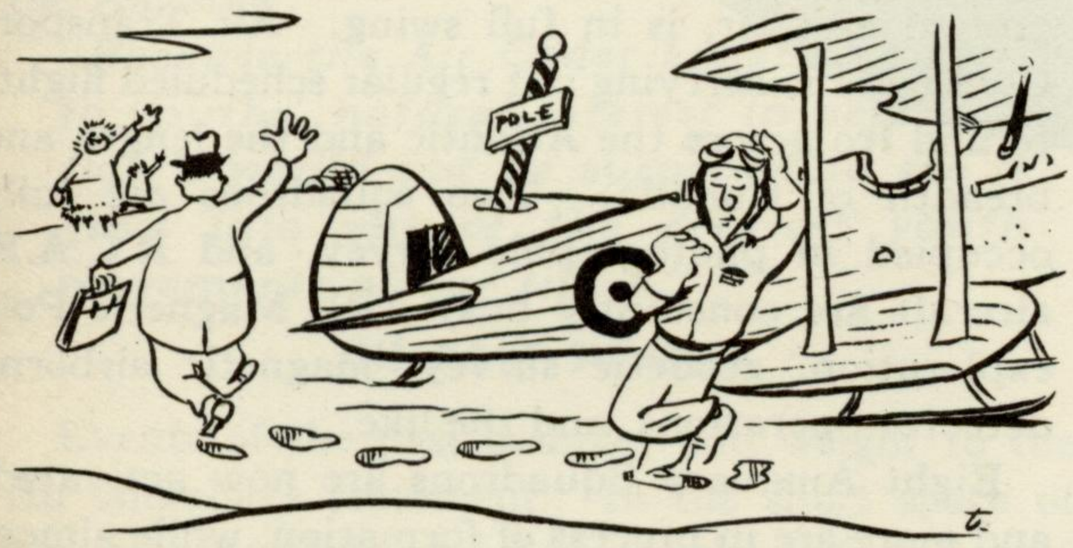
1. *The Directorate of Civil Government Air Operations*
   Responsible for control of all operations by government aircraft other than operations of a military nature.
2. *The Controller of Civil Aviation*
   Responsible for administration of Air Regulations, etc.
3. *The Aeronautical Engineering Division*
   Responsible for all technical matters for the air services.
4. *The Royal Canadian Air Force*

However, civil government work soon increased again to such an extent that it completely overshadowed the training and organization of the R.C.A.F. for war. Added to this, in 1928 the

growth of the flying club movement created a new demand for pilots. By March 1929, out of a total of 131 officers and 590 airmen, approximately half was attached for duty with the other branches of the air services.

Civil Government Air Operations

Much of the work done by the Air Force for other civil government departments embraced the northern section of Canada and came to the knowledge of the public sparingly. By 1932, the Air Force counted as past history the Hudson Straits Expedition, which on its return in 1928 contributed greatly to the knowledge of the meteorological and navigational conditions prevailing in those perilous waters lying along the new grain route from the Prairie Provinces to Europe. It had also photographed approximately 470,000 square miles of the Dominion for mapping purposes, using cameras, equipment and methods specially developed in Canada for the purpose. An area of 140,000 square miles of forest lands was being patrolled annually for the detection and suppression of fires. Air mail routes had been surveyed and experimental flights made. Air Force aircraft were contributing to the efficiency of all government departments by transporting



parties and officials into locations which heretofore had been inaccessible except by canoe and dog sled. The pilots of the force had covered the country from coast to coast and from the United States boundary to the southern shores of the Arctic Ocean, and had gained a vast amount of useful experience in operating aircraft under the difficult conditions found throughout Canada's uninhabited areas.

Relinquishment of Civil Operations

With the coming of the depression in 1932, and the consequent discharge of almost a third of the R.C.A.F., the Service side for the first time took precedence over civil operations.

Quite apart from the reduction in the financial appropriations, however, there was another reason for the decline in the R.C.A.F.'s extraneous commitments. Prior to the depression, several commercial firms and certain of the Provincial Governments had entered the field of air service operations. This fact, coupled with the Air Force's decreased strength, resulted eventually in the taking over by the commercial and government operators of the great majority of the work previously performed by the R.C.A.F. Therefore, in November 1932 the R.C.A.F. and the Directorate of Civil Government Air Operations were consolidated and, together with the Aeronautical Division, were placed under the Director, R.C.A.F., who thereupon assumed the new title of "Senior Air Officer."

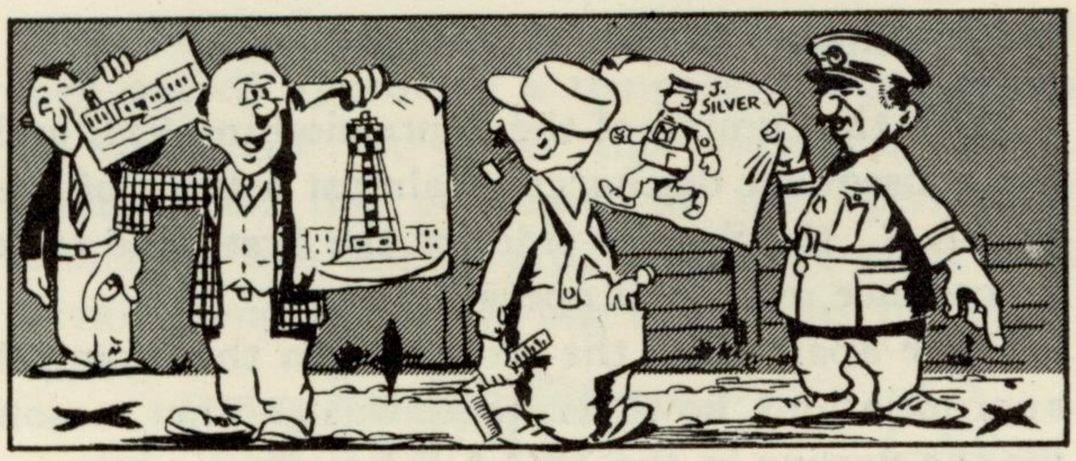
1932-1935

The only development of any real note during these years was the belated formation of the Non-permanent Active Air Force. By 1935, N.P.A.A.F. squadrons had been formed at Vancouver, Toronto, Winnipeg, Montreal, Hamilton, and Regina. It might be noted that the name of the N.P.A.A.F. was not changed to "Auxiliary Active Air Force" until December 1938.

1935-1939

With the increasing political tension in Europe in 1935, a more rapid pace of development was forced. Expansion immediately created a demand for personnel qualified as instructors, and, with the partial exception of survey photography, all operations for other government departments were discontinued.

Construction of the training centre at Trenton, which had been carried on as a relief project during the depression, was speeded up in 1936. Early in that year the technical training and army co-



operation schools were moved to Trenton from Camp Borden, and the flying training and air armament schools followed them in June 1937. Three new specialist schools were formed to give instruction in navigation and seaplane flying, wireless and storekeeping. At the same time, stations and bases on both coasts were further developed and improved.

During 1938 three Commands were formed—Western, Eastern, and Air Training Commands, located respectively at Vancouver, Halifax, and Toronto. In December of this year, too, the title of "Senior Air Officer" was changed to "Chief of the Air Staff." Its holder was now responsible directly to the Minister of National Defence for the control and administration of the R.C.A.F.

The effect of these changes was to place the Air Force on the same footing as the Navy and the Army, and all powers previously exercised by District Officers Commanding, Military Districts, in relation to the R.C.A.F. were transferred to the respective Air Commands.

1939 to the Present Day

The history of the R.C.A.F. during the recent war years is too well known, at least in its broader aspects, to warrant recapitulation here. The following facts and figures, however, may be of interest.

From its tiny force of 4,000 men at the outbreak of war, the R.C.A.F. expanded to over 206,000 by the end of 1943 and held fourth place among the Air Forces of the United Nations. It developed and administered the great British Commonwealth Air Training Plan which produced 131,553 trained airmen for the British and Dominion Air Forces. At home the R.C.A.F. put over forty squadrons into the field. These squadrons, in addition to guarding our coasts and sharing in the Aleutian operations, played a very important part in Co-operation with Coastal Command and the British, Canadian, and American Navies in the hard-fought battle of the Atlantic.

Overseas, the R.C.A.F. contributed forty-eight squadrons for service with the several Commands of the R.A.F. Fourteen of these units formed a special R.C.A.F. Group (No. 6) in Bomber Command; fourteen others constituted four Wings in the Second Tactical Air Force. Other squadrons flew with Coastal Command over the North Sea, the Bay of Biscay and the Atlantic, fought with the Desert Air Force from Alamein to Treviso, patrolled over the Indian Ocean, and carried supplies to our armies in North-Western Europe and Burma.

In addition to the personnel of these units at home and abroad, great numbers of Canadians served in R.A.F. formations in every theatre of war. The R.C.A.F. suffered 18,463 casualties in killed, presumed dead, and missings. It won over 8,948 awards for gallantry.

With the end of the War, retraction naturally occurred. However, it was short-lived. The R.C.A.F., the strength of which stands now at approximately 13,000, is rapidly once more becoming a fully operational air force. Training, both ground and air, is in full swing. Air Transport Command is carrying out regular scheduled flights to and fro across the Atlantic and the length and breadth of Canada. Two squadrons are fully occupied in photographic survey, and R.C.A.F. aircraft are constantly busy with Magnetic Pole exploration, geodetic survey, magnetic airborne detector operations, and the like.

Eight Auxiliary Squadrons are now activated, and more are in process of formation, while almost 14,800 Air Cadets are receiving carefully organized training in 175 squadrons located in all parts of the country.

(The second article in this series, "Early Sub-Arctic Operations," will appear in next month's issue.")

The ROYAL CANADIAN AIR CADETS

by A. MACDONALD

THE EIGHTH YEAR

FRESH FROM THE BUSIEST SUMMER in a brief but eventful history, Canada's junior Air Force—the Royal Canadian Air Cadets—has just commenced its eighth training year. Across the Dominion some 175 squadrons, supervised jointly by the R.C.A.F. and the Air Cadet League of Canada, are enrolling new cadets, issuing uniforms, and planning a full year of instruction on the fourteen important aeronautical subjects included in the latest syllabus of training.

It is a fairly safe bet that the coming year will be one of solid accomplishment, for the Air Cadet League now ranks among Canada's leading agencies in the field of aviation and citizenship training. In the words of Air Marshal Robert S. Leckie, C.B., D.S.O., D.S.C., D.F.C., retired Chief the Air Staff:

"Because the Air Cadet League appeals to youths' natural interest in aeronautics, I would not be surprised to see it grow into one of the greatest youth movements of our times."

THE PAST SUMMER

Events of the past summer add weight to the Air Marshal's statement. In the short space of two months (July and August) the R.C.A.F. and the League co-operated on the following impressive list of projects:

A total of 225 senior cadets received flying instruction under scholarships awarded by the R.C.A.F. Thirty-two member clubs of the Royal Canadian Flying Clubs Association participated in the scheme which gave each cadet 17 hours in the air and 50 hours of ground instruction.

Almost 6,000 Air Cadets attended R.C.A.F. summer camps at Summerside, Aylmer, Gimli and Patricia Bay where, in addition to attending classes and participating in organized sports, they received familiarization flights in Service aircraft.

Twenty-five top-seeded cadets flew the Atlantic in a R.C.A.F. "North Star" to spend three weeks in Britain, while a similar group of British A.T.C. cadets were sightseeing in Canada. Another 24 cadets toured the United States as part of an exchange plan which brought 24 U.S. Civil Air Patrol cadets to this country.

In August, an Air Cadet drill team, selected from squadrons in Montreal and Ottawa, travelled to the International Aviation Exposition, New York. In the presence of more than 130,000 spectators, they defeated a U.S. team to win the General Beau Trophy, emblematic of international drill supremacy.

The close of the summer schedule was marked, appropriately enough, by the entry of 32 former Air Cadets into the newly opened Canadian Services Colleges at Royal Roads, B.C. and at R.M.C., Kingston. League scholarships were awarded to 12 of these successful candidates, whose four-year course will prepare them for positions of leadership in the R.C.A.F. or careers in all branches of engineering.

INTERNATIONAL GOODWILL

Probably the most newsworthy of the above-mentioned projects was the second annual exchange of Air Cadets. This scheme, aimed at promoting goodwill among young people, was inaugurated last year when 46

Canadian and British cadets toured each others' countries for three weeks. The U.S. Civil Air Patrol entered the picture for the first time in 1948, and there is a good possibility that additional countries will participate next year.

A particularly gratifying aspect of the international "get acquainted" programme was the remarkable flood of publicity it produced on behalf



Cadets leaving 10 Repair Depot, Calgary, for a two-week tour of U.S.A.F. bases, aircraft factories, and other places of interest in the United States.

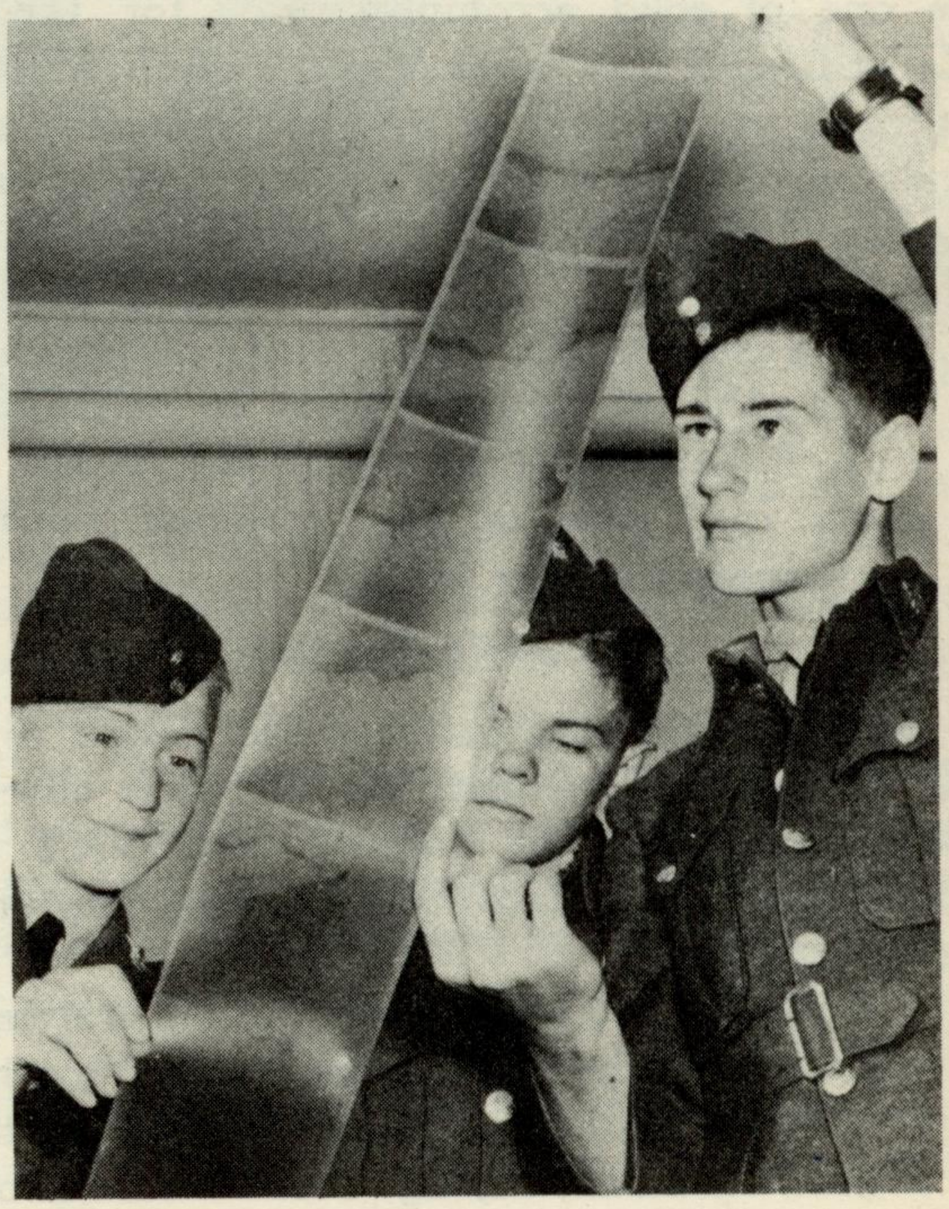
of the R.C.A.F. and the League. In many centres the visiting cadets received the full treatment—press, radio, and newsreels. What it all added up to, of course, was even greater public interest in the League, the R.C.A.F., and aviation generally.

CADET FLYING TRAINING

Another item worthy of special note is the Air Cadet flying training programme. First introduced in 1946, the scheme has thus far permitted 598 Air Cadets to reach the solo stage. Training is paid for by the Department of National Defence, with the League and the flying clubs co-operating on such matters as transportation, billeting, selection of cadets, etc. Each course lasts four weeks, and most clubs award additional scholarships under which top students may go on to private pilots' license standard. In addition to this Service-sponsored course, many squadrons have arranged for deserving cadets to take regular flying lessons at nearby flying clubs or commercial schools.

Although accurate statistics are not available, it is estimated that more than 1,000 Air Cadets have taken flying training since 1945. The majority of these are now well advanced along the path to a private license and several have already earned limited commercial licenses.

At a time when flying safety is demanding much attention in the aeronautical press, it is considered significant that not a single Air Cadet



Cadets study a roll of processed aerial film during lesson on air photography.



Lord Tedder inspecting Royal Canadian Air Cadets at Halton, England

has been involved in a serious flying accident—this despite the many thousands of flying hours accumulated by Air Cadets since the movement was formed in 1941. Futhermore, the coveted Webster Trophy, awarded annually to the best amateur pilot in Canada, was won in 1947 by a former Air Cadet: Charles W. Wilson of Vancouver.

THE FUTURE

When the Air Cadet League was first formed, its primary aim was to produce pre-trained recruits for a fighting Air Force. Since 1945, however, the training has been directed towards the development of better Canadian citizens, regardless of whether or not they intended to enlist in the R.C.A.F.

Despite this, many graduate cadets select a Service career. At the present time, 25% of all serving airmen are former cadets while one out of every three recruits to enter the R.C.A.F. in recent months has had the advantage of Air Cadet training.

According to Regular Force instructors (who should know), this form of pre-training is of great value to a young airman, a point which was borne out by the good showing of seventeen graduate Air Cadets who attended the R.C.N./R.C.A.F. College, Royal Roads, last year.

And what of the future?

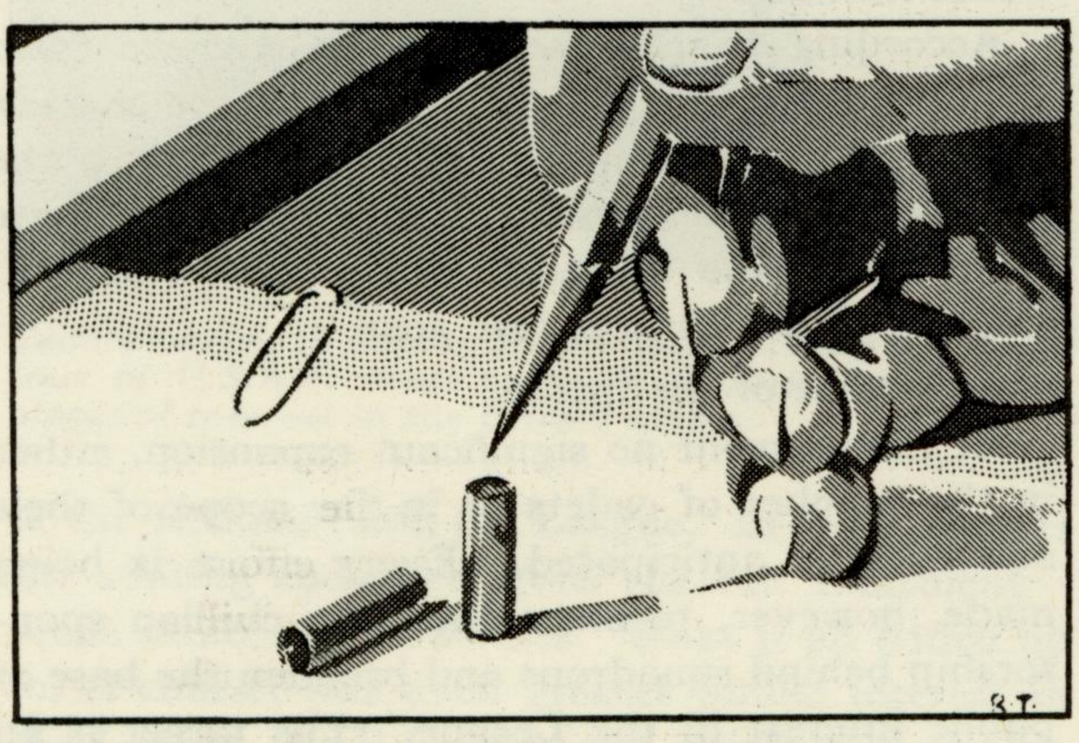
At the moment no significant expansion, either in the number of cadets or in the scope of their activities, is anticipated. Every effort is being made, however, to strengthen the civilian sponsorship behind squadrons and broaden the base of public interest in the League. The target is an attractive and well-organized training programme, strong community support for the squadrons, and waiting lists of young Canadians anxious to take their places in the ranks of the Royal Canadian Air Cadets.

THE TRANSISTOR

(Reprinted from "Electronics" by courtesy of McGraw-Hill Publishing Co. Inc.)

A NEW DEVICE, operating on an entirely new principle and capable of many functions of the electronic vacuum tube, but having neither an evacuated envelope nor a hot cathode, was announced early in July by scientists of the Bell Telephone Laboratories. Known as a TRANSISTOR (TRANSfer resISTOR), the device is essentially a triode form of the well known germanium crystal diode.

In its present experimental form the Transistor is a metal cylinder 3/16 inch in diameter and 5/8 inch long, as shown in Fig. 1. Inside the cylinder, Fig. 2A, is a block of germanium soldered to a metal disc to which it makes low resistance contact and that grounds it to the cylinder. Two 2-mil tungsten wires make contact with the upper face of the germanium at points about 0.002 inch apart.



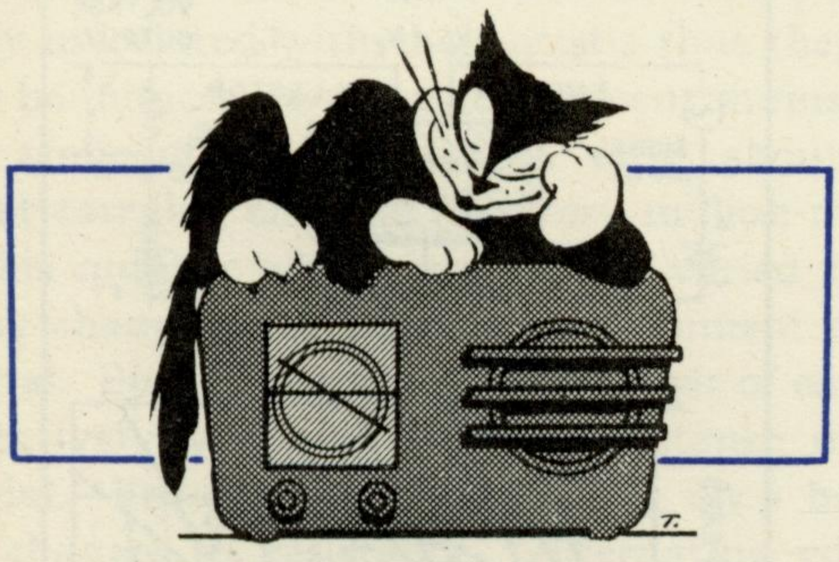
Contained in a small metal cylinder, the Transistor consists of two extremely fine wires whose points rest on a small square of a semi-conductor.

An input signal, Fig. 2B, in series with a small positive bias voltage, is applied between the grounded face and the input cat whisker (emitter). A large negative bias voltage is applied between ground and the output (collector) point contact. The output signal appears across a load resistor in series with the negative bias. In this manner a power gain of 100 (20 db) is obtained between input and output of a Transistor. The terminal characteristics of an experimental Transistor are shown in Fig. 2C (see the *Phys. Rev.* p. 230, July 15, 1948.) This is an early unit having a gain of about 15 db. The characteristics are typical of later units having an average gain of 20 db.

Because of its unique properties, the Transistor is destined to have far-reaching effects on the technology of electronics and will undoubtedly replace conventional electron tubes in a wide range of applications. The Transistor requires no heater or filament power and uses the power supplied by its bias sources with high efficiency. Under typical operating conditions it draws only 0.1 watt from the bias sources (about a tenth the power consumed by a flashlight bulb) and delivers 25 milliwatts of useful output, thus having an overall efficiency of 25 percent.

The Transistor is smaller than a subminiature vacuum tube. It seems likely to have a useful life of many thousands of hours because of its simple, sturdy construction. Where portability and low battery drain are essential, as in hearing aids and personalized radios, the Transistor appears ideal. In equipment using large numbers of amplifiers, large-scale computers being an extreme example, the absence of a heater makes it possible to place many Transistors in confined space without creating difficulties in heat dissipation.

Although cost factors have not been thoroughly explored, Transistors should be no more costly to manufacture at present than the 1N34 (high back-voltage) germanium diode, which lists for replacement at $1.20 and is obtainable in large lots by equipment manufacturers at $0.53 apiece. These prices are slightly higher than the prices of a corresponding vacuum diode (6H6). However, present costs of crystal diodes are not representative of inherent costs. The industry has spent about 40 years mechanizing production of vacuum tubes and has written off engineering and plant costs over that time. If crystal devices (diodes and Transistors) prove as successful in practice as they now appear to be, they too will be put into mechanized production and their cost reduced. Ultimately they should be cheaper than comparable vacuum tubes because of their simplicity and because they do not require evacuation, which is the most difficult step in producing vacuum tubes.



There are limitations to the use of Transistors in their present state of development. The power output is restricted to about 25 milliwatts per unit, or 50 mw from a push-pull stage. A Transistor capable of developing several watts output does not seem feasible at present. Parallel operation of two or more units is possible, however, and could be used to increase the power to a load several fold. The upper frequency of operation is limited to about 10 megacycles by transit time within the germanium. Thus the Transistor is at present useful at audio, video, and the lower radio frequencies, but is unsuited to vhf and uhf applications. Furthermore, the noise generated within a Transistor is appreciably greater than that produced in vacuum triodes.

If the requirements of an application for which the properties of Transistors are suitable justify their cost when they first become commercially available, there remains a temporary obstacle to their immediate use, namely engineering this new device into the circuit. One of the principal problems requiring development is matching the input and output impedances of the Transistor to the circuit. The input impedance of the Transistor is low because the bias in the input circuit causes current to flow in the forward direction through the point contact of the emitter. On the other hand, the output impedance of the Transistor is about a hundred times higher than the input impedance because its bias causes current to flow in the reverse direction through the point contact of the collector. These impedance levels are the opposite of those for vacuum tubes and require a new approach to the coupling circuits between amplifier stages. Intensive work on this problem is underway. The Transistor thus opens new fields for clever design and inventive talent.

ILLUSTRATIVE APPLICATIONS

In announcing the Transistor, BTL scientists demonstrated several typical electronic devices in which it was used. A booster amplifier for telephony illustrated its application to voice-frequency amplification. A similar video amplifier was also demonstrated. Its low power-supply drain makes it suitable for telephone and television repeater service. In fact, it requires no more power than that usually available at a subscriber's set from the central office batteries that are connected to the line. Use of a Transistor as an oscillator showed the versatility of the unit. Use in a radio receiver for the standard broadcast band illustrated its practicality.

The radio receiver contained no tubes. It consisted of a broad-band r-f amplifier, a tuned r-f stage, local oscillator, mixer, three stages of i-f, second detector, and four stages of a-f amplification, the last being push-pull. A total of 11 Transistors were used in the amplifier stages, with 2 germanium diodes for the mixer and detector

stages, and 2 selenium rectifiers for the power supply. The receiver brought in local stations, delivering 25 mw of audio power to its loudspeaker.

At low power levels crystal diodes and triodes, in conjunction with printed circuits, make possible the extension of electronic techniques. Existing equipment can be made more compact. Transistors, having no filament, are operative the instant power is applied.

RESEARCH BACKGROUND

Research work in semiconductor materials began at least 24 years ago. Germanium and other semiconductors have been used as rectifiers because of their unilateral conductivity. These employ a single point contact; the input and output circuits are not separated. The two-contact arrangement is the practical outcome of a long programme of scientific research on semiconductors.

Although investigation of semiconductors at BTL dates back a number of years, with the end of the war a concentrated basic research programme was undertaken. Groups in the Physics Department were reorganized. Additional personnel were taken on, particularly theoretical specialists. The groups consisted of paper-work men and laboratory experimentalists who could pass problems from office desk to lab bench and back as the programme unfolded. The fact that pure research paid off relatively quickly, in so spectacular a way, is testimony to the ability of the men who carried out the programme and to the facilities with which they worked.

The group on semiconductors, led by William Shockley, one of this country's leading solid-state physicists, was seeking answers to three basic questions: (1) physically, what is a semiconductor, (2) how does its physical nature produce its observed properties, and (3) how does the fabrication and processing of the material affect its physical nature? Among the semiconductors studied were silicon, copper oxide, and germanium.

A great deal of empirical information had been amassed on these substances during their use, particularly as detectors in microwave equipment ("Crystal Rectifiers," H. C. Torrey and C. A. Whitmer, McGraw-Hill, 1948). In particular it was known that their resistivities were determined chiefly by impurities, and furthermore that their resistivities could be varied over wide ranges by applying various external influences (light in the case of photocells, electric potential in the case of rectifiers and detectors, or temperature in the case of Thermistors).

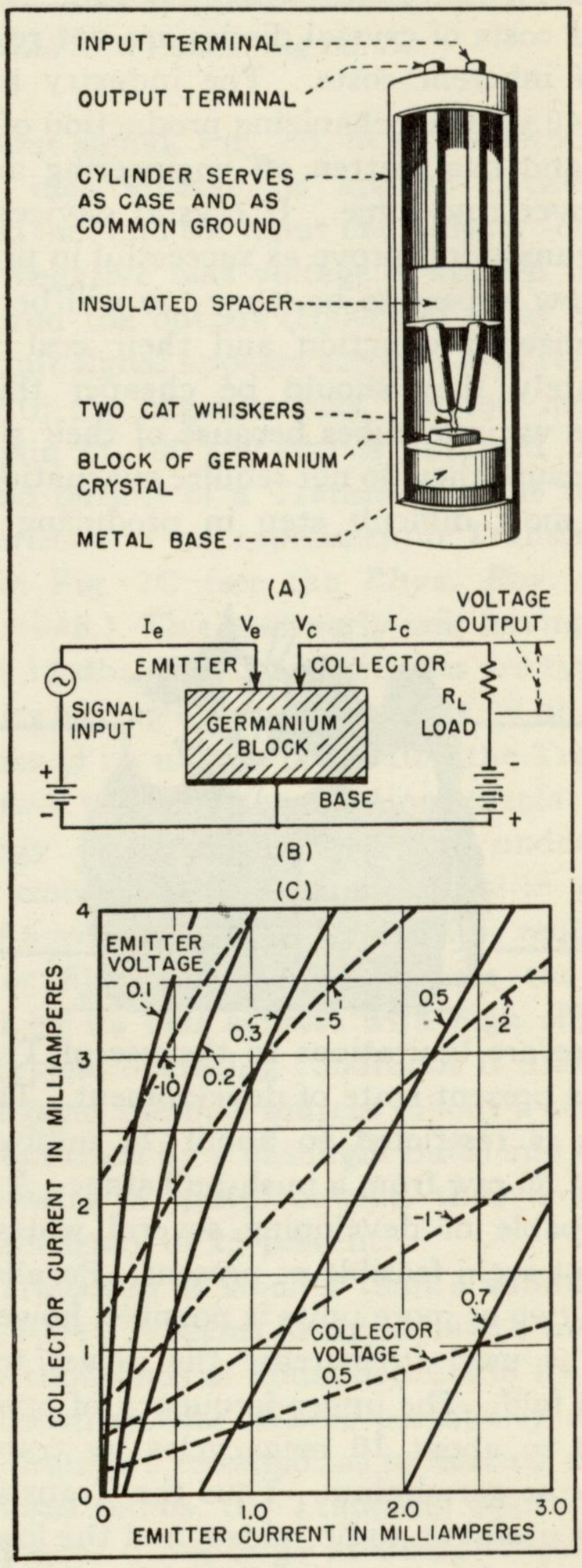


FIG. 2—Crysal triode (A) consists of two cat whiskers connected to separate input and output circuits (B) to give characteristics (C) that produce high amplification

THEORY OF CONDUCTION

Modern physics has developed a detailed concept of the construction of matter and consequently an understanding of the mechanism of conduction. In metals there is approximately one free electron that can be used for carrying current for every atom; in insulators there are practically no free electrons. By free electrons is meant electrons so loosely associated with their atoms that they can easily be induced to move to adjacent atoms.

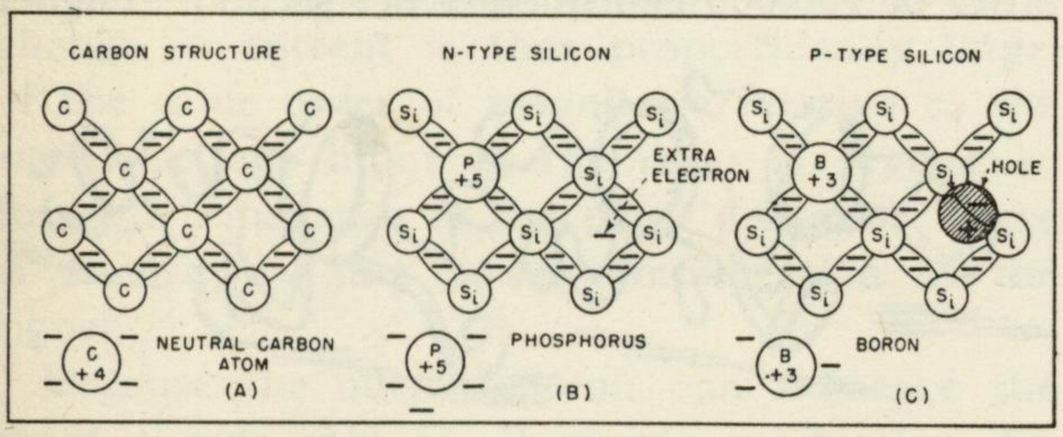


FIG. 3—Conduction within a semiconductor depends on the interatomic bonds formed by the electrons. Current flow in a pure semiconductor is difficult to produce (A). If an impurity having an excess electron (B) is added then that electron can carry current. On the other hand, if the impurity lacks the required number of electrons for the bonds (C) the hole thus created also makes conduction possible

In semiconductors there is only about one current-carrying electron for every million atoms, but this number of carriers can be varied 1,000-fold by changing the physical environment of the material. Such a change in the number of carriers is effectively a change in the resistance of the material. For example, light falling on a barrier layer changes its resistance. Alternating voltage applied to a selenium rectifier or a germanium diode changes its resistance so that current flows predominantly in one direction. Likewise, a high potential applied externally (without making contact) to a semiconductor should change its resistivity. Using a sheet of germanium as one plate of a capacitor, Shockley and his colleagues measured the change in resistance produced by changing the voltage across the capacitor. The change in resistance was much smaller than anticipated in the light of prevailing theory. Conclusion: something wrong with theory. So John Bardeen, a theoretical physicist in the group, devised a theory of surface states that would account for the measured change as well as for older known effects unexplained by previous theories.

To review the old theory for a moment, it was known that conduction in semiconductors could take place by two mechanisms, operating either separately or simultaneously. In some types of semiconductors the electrons, as usual, moved under the influence of applied voltages and thus provided a current flow. Such semiconductors are called N-type because conduction is by negative (electron) charges. In other types of semiconductors, in which there is a deficiency of electrons, the current flow consists of the movement of virtual positive charges (images of electrons) that are actually empty places from which electrons have been removed. Such semiconductors are called P-type because conduction appears to be by positive charges, are shown in Fig. 3.

The two types of conduction had been identified with impurities. For example, as shown in Fig. 3B, silicon alloyed with a minute percentage of phosphorus is an N-type (electronic) conductor. Physically, the effect is explained by the fact that phosphorus has five valence electrons. Four of these form bonds with the four valence electrons in a silicon atom (thus binding the atoms together), leaving one electron free for carrying current.

If the impurity is boron (Fig. 3C), which has only three valence electrons, there is one incomplete bond between each boron and its neighboring silicon atom, leaving a hole in the structure. Because the percentage of boron impurity is very low, not many silicon atoms are so bound. Hence the hole in the bond of one silicon atom with a boron atom can be filled with an electron from an adjacent silicon atom under the influence of an external electric field. However, this action leaves a hole from which the electron came. This hole is free to be passed from atom to atom and hence to carry current. Whereas a negative electron will migrate from a negative region toward a positive region when voltage is applied, a hole will migrate from a positive region to a negative one. (In P-type—hole—conductors the electrons would have no place to go if it were not for the hole, so, although the electrons do move when current



flows, it is the presence of the hole that makes their motion possible. Thus, to physicists, conduction is by (owing to the presence of) holes. Such action takes place in germanium.

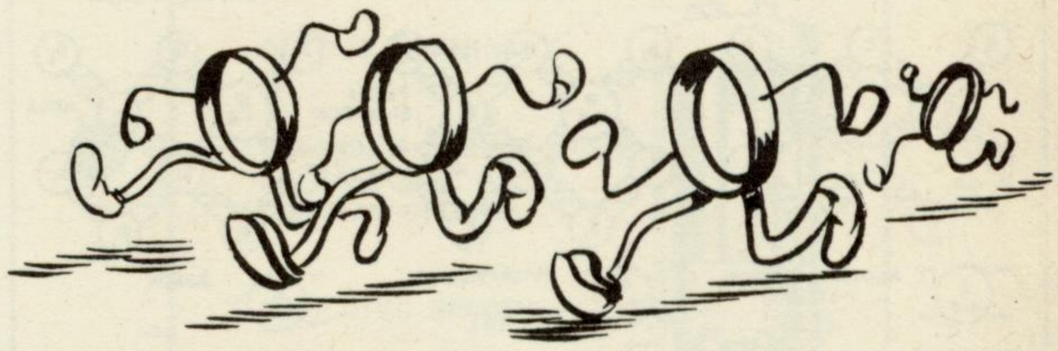
The new theory suggested new experiments, which, when performed, called for refinements in the theory. While W. H. Brattain and John Bardeen were following up the consequences of the refined theory of surface states they invented the Transistor. With it they discovered a surface layer having peculiar characteristics.

To account for these characteristics, they postulated and later showed by experiment that there is a thin layer of electrons at the surface of germanium. This surface layer would prevent the penetration into the body of the semiconductor of an externally applied field and thus account for the smallness of the changes in resistance observed in the capacitor experiment. The field created by these surface electrons causes the formation of holes in the adjacent material, and these holes conduct current. The conducting layer may be caused by an excess of impurities near the surface such as boron that accept electrons into bonds and thus create holes, or by a space-charge barrier layer. Between this P-type layer and the N-interior is a rectifying barrier.

When a single point contact is made, the surface layer determines the conductivity for reverse currents or small forward currents. For large forward currents there is an increase in the concentration of carriers (electrons and holes). In either case (forward or reverse current) a large part of the current is carried by the surface conducting layer within an area of interaction very close to the point. Within this area the conductivity, which is mainly by holes, is much greater than elsewhere in the semiconductor. The second point contact for the Transistor is added within this area of interaction.

TRANSISTOR CHARACTERISTICS

In a Transistor, the positive point contact causes the release of holes in the surface layer of the germanium, which is prepared in a similar manner to a high back-voltage rectifier. These holes spread away from the point, flowing in all directions along the surface (but not into the body of the semiconductor). The holes reach the other contact point 0.005 cm away, in less than a ten-millionth of a second. This is the transit time that limits present performance to frequencies below about ten megacycles. From this observation, it is estimated that the holes travel at the order of 100,000 centimeters per second. Higher



applied potentials and smaller spacings, as used in vacuum tubes to increase high-frequency performance, may reduce this transit time. That there are holes capable of moving from 10 to 100 times this speed is known from estimates of their thermal velocities.

The negative bias applied to the collector causes a very small current to flow from the germanium in the absence of hole conduction produced by the emitter. When the positive bias is applied to the input, however, holes are attracted to the output point contact, which is biased negatively, and these are absorbed, thus increasing the current in the output circuit. Variations in the input current change the number of holes released toward the collector and thus vary the output current proportionately. The Transistor circuit thus closely resembles a grounded-grid triode circuit.

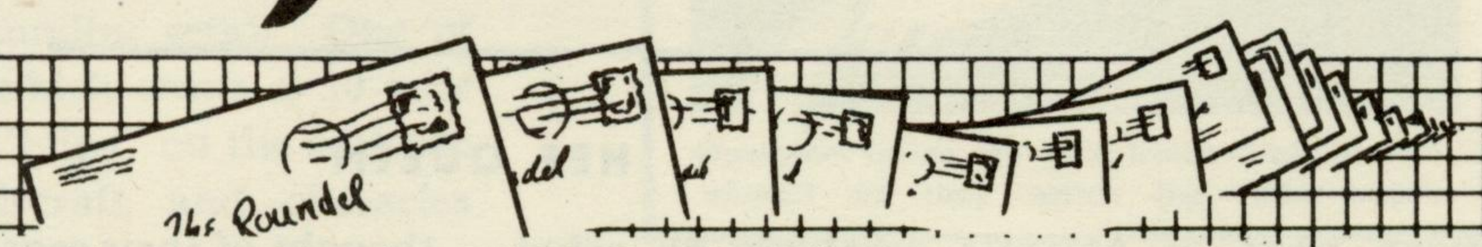
In a grounded-grid vacuum triode the current from the cathode is controlled chiefly by the potential between it and the grid (ground); the plate potential has little effect. In the Transistor the positive bias (about 1 volt) of the emitter (cathode) causes a small current to flow into the semiconductor. The negative bias (up to 50 volts) of the collector (anode) is made large enough so that it withdraws about the same current (a few milliamperes) from the semiconductor. While the collector is a poor emitter of electrons, it is a good collector of holes. A variation of the number of holes in the surface around the two point contacts is produced by changes in the input voltage of the

emitter. This variation changes the current (carried by holes) to the collector by a factor of from one to two times the change in emitter current, depending on the operating bias. Furthermore, this change in current flows in the high impedance of the output circuit, of the order of 10,000 to 100,000 ohms. The voltage change produced in this high-impedance circuit by the change in current is thus proportionally large, of the same order of magnitude relative to the signal voltage input as the ratio of reverse to forward impedance of the point contact. There is a corresponding power amplification of the signal.

Because the output circuit can influence the input circuit only by electronic conduction, for which the surface resistance is high, there is little coupling from output to input, and the circuits, one of low impedance (low power) and one of high impedance (high power), are properly isolated for use in unilateral amplification.

The d-c characteristics of a typical experimental Transistor, Fig. 2C, show the interrelation of the four variables, the two currents and the two voltages. If two are specified the other two are determined. The effect depicted by these characteristics shows that, in addition to the forward amplifying action, the collector current lowers the potential of the surface in the vicinity of the emitter in proportion to the collector current times a constant internal resistance, and thus increases the effective bias on the emitter. This describes the nature of the back coupling that exists. Under certain operating conditions this coupling, which represents positive feedback, can cause instability. Thus, although the principle of operation is vastly different, the Transistor has the properties of vacuum tube amplifiers in many respects.—D.G.F. and F.H.R.

A Letter from CENTRALIA



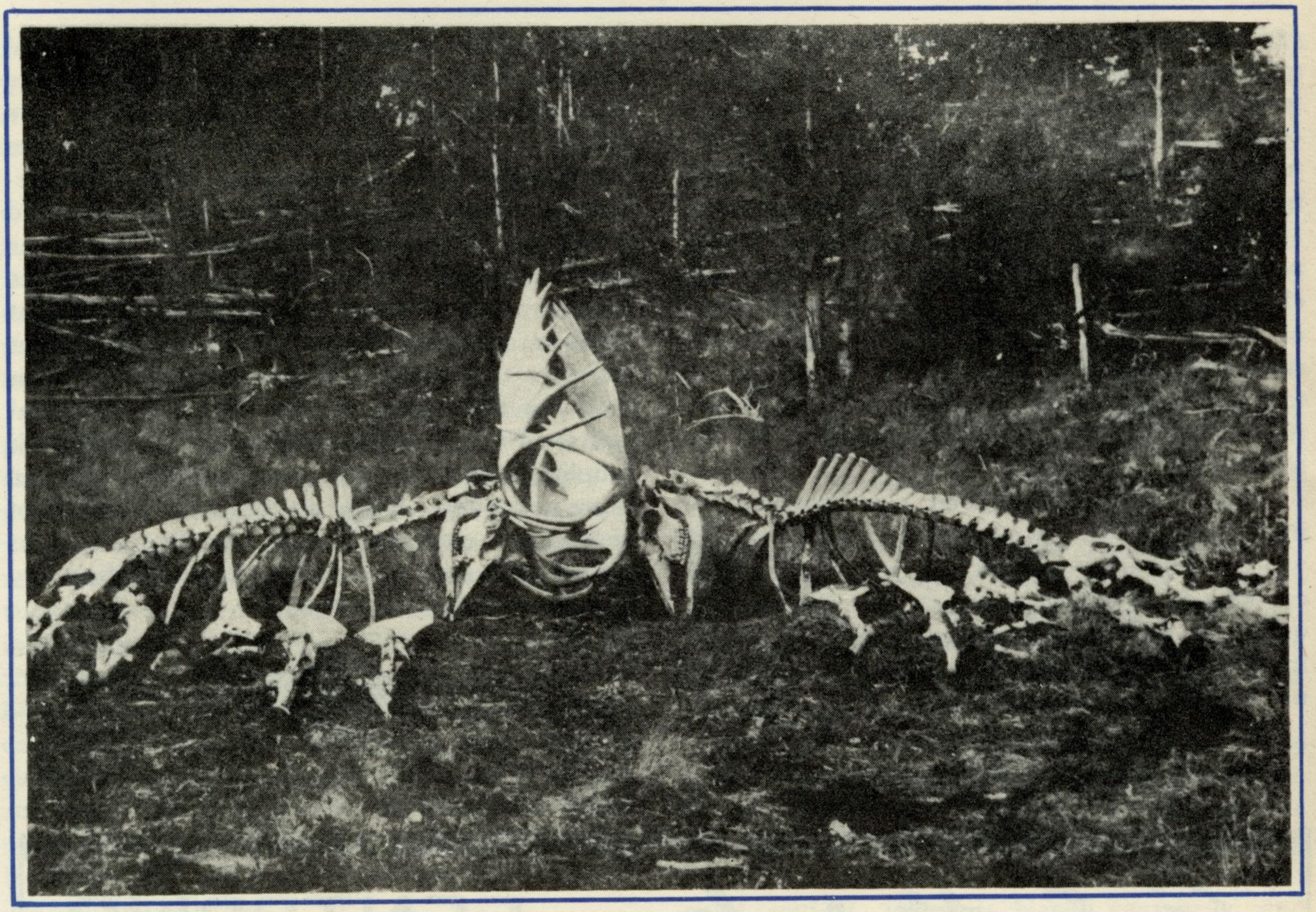
Dear Editor:

I wish to speak on behalf of my friends—LAC's Lewis, Higgins, and Fraser—and myself. All of us are ex-RAF personnel who joined the RCAF in London, England, this year. We wish to express our gratitude to the people of Canada with whom we have come in contact since our arrival in this country—and in particular to the men stationed at Centralia, who have shown towards us a friendliness which we have come to recognize as part of the spirit of the Service.

As ex-RAF personnel, we have a natural feeling of comradeship with the RCAF, developed during the stress of the recent war; but we would like to give voice through your magazine to our appreciation of the kindness we have everywhere encountered.

We are proud to belong to a Service whose traditions, we feel, are equal to the best traditions of the RAF. We shall endeavour to uphold them.

LAC C. HEWITT



CHERCHEZ LA FEMME

The above photograph, an unusual record of a mating-season tragedy, was taken on the North West Staging Route

HEP QUEEN

In these days of Atlantic crossings by robot Skymasters the radio-controlled Tiger Moths (known as Queen Bees) with which we played before the war seem pretty small beer. Nevertheless, they did a lot of useful work; not all of which went entirely according to plan. Once a R.A.F. test pilot took off in a Queen Bee for a test flight after an engine change. By arrangement, he switched on to ground control once airborne. The Q.B. immediately dived at the airfield, beat up the mess, slow-rolled at nought feet and, after climbing again, repeated the whole programme. The pilot cut out ground control, landed, and stormed over to the radio hut to tell them what he thought of their sense of humour. He found they'd all gone to tea—but ever after turned the story in his favour by alleging that they'd left the Queen Bee tuned in to an Italian station broadcasting dance music!

Another Queen Bee was once plying up and down the Channel giving gunnery practice to one of His Majesty's cruisers. The A.A. crews were not in good form, and after a third fly-past toward the misty horizon one gun commander turned half apologetically to a R.A.F. liaison officer and remarked that it was pretty poor shooting to-day. "Just as well," he was told. "That was Jersey Airways."

(By courtesy of "The Air Reserve Gazette")

GCA RADAR

by RONALD A. KEITH

(Reprinted by courtesy of "Canadian Aviation")

THE RADAR BLIND LANDING SYSTEM known as Ground Control Approach or GCA has been adopted by the Royal Canadian Air Force. Trial GCA equipment has been in operation at Edmonton under American supervision since November, 1947. Now, the R.C.A.F. has acquired six of these mobile installations from the U.S.A.F. and has organized a school for training ground operators and technicians at Dorval.

Tentative plans indicate that the R.C.A.F. GCA equipment will be in operation at Edmonton, Rivers, Churchill, Centralia, Rockcliffe and Dorval.

The GCA mobile equipment is arranged compactly in a 23-ton truck trailer which, when in operating position, is parked at a 96-degree angle to and 500 ft. from the centre of the live runway.

It consists of two functionally independent radar systems (plus two standby sets). One of these is the search system which scans a 30-mile radius and paints luminous "blips" on the cathode ray scope to represent aircraft and obstacles within its range.

The search scope is used to direct air traffic within the control area and to guide approaching aircraft into the circuit.

As the aircraft turns on its final approach, the precision radar operator takes over. The precision equipment scans the approach path, one antenna sweeping horizontally through a 20-degree arc to locate the aircraft in azimuth. The other antenna sweeps vertically to locate the aircraft in elevation. At the same time, range is read directly from the scope as indicated in the accompanying diagram.

With this constant three-dimensional indication, accurate to plus or minus 10 ft., the operator can direct the pilot by voice radio down the approach path. Fixed distance and azimuth markers near the end of the runway show up on the expanded precision scope, giving the operator specific reference points.



Operators inside the GCA trailer "talk down" aircraft as they watch the radar scopes.

The merits of GCA as compared with the Instrument Landing System (now installed at a number of Canadian airports by the Dept. of Transport) have been the subject of considerable debate.

Civilian agencies, generally, have favoured ILS. It leaves the blind approach in the hands of the pilot who flies a sloping approach beam according to the needles on the cockpit instrument. The ILS system has been favoured by the Civil Aeronautics Administration in the U.S. and has been recommended by ICAO for international standardization.

On the other hand, the military services, notably the U.S. Army and Navy, and the RAF have preferred GCA. Against the civilian pilots' reluctance to hand over control to a ground operator, the Services set up an impressive testimonial based on their experience with GCA.

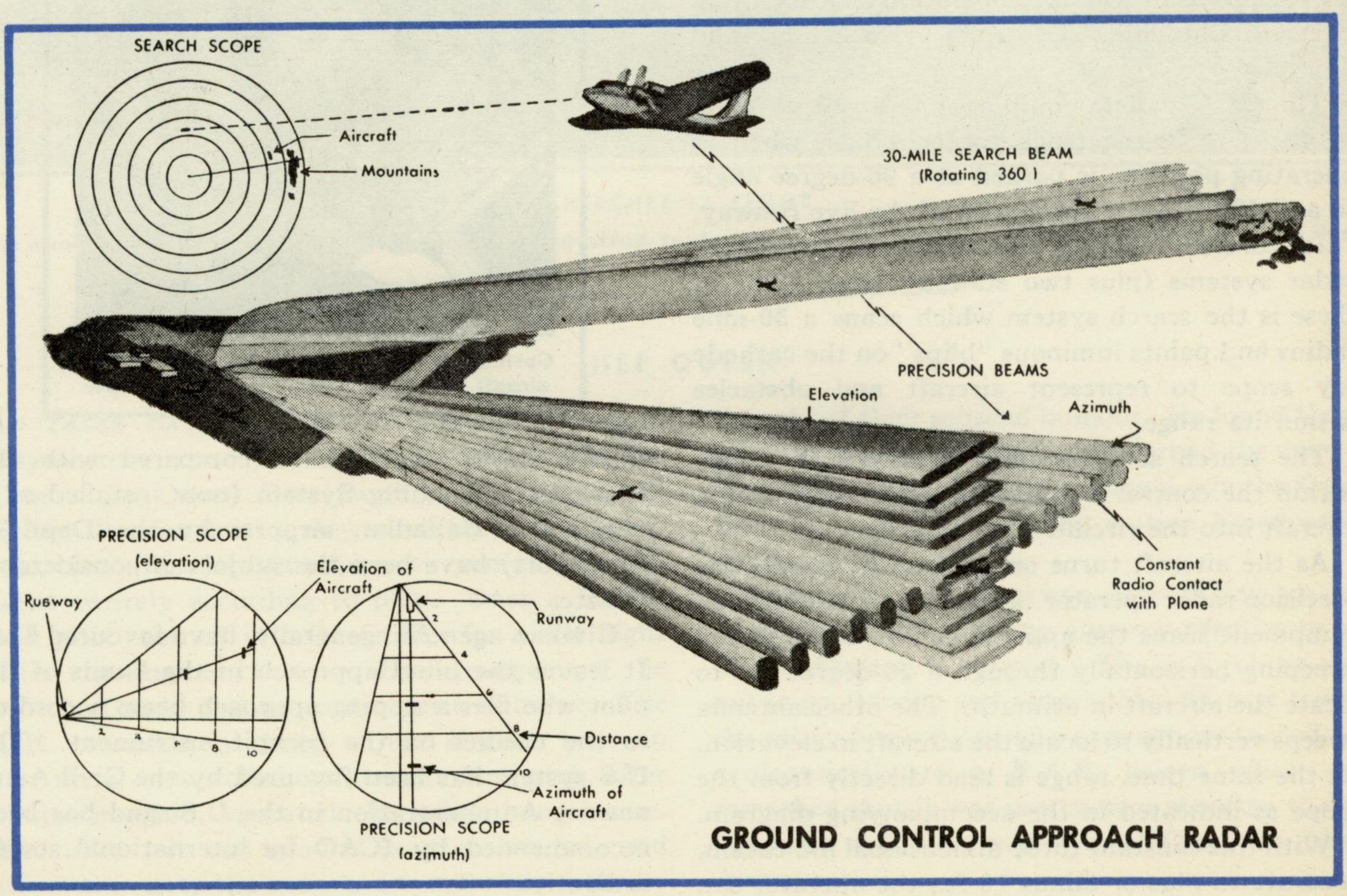
Since December, 1942, when the first complete blind landing was made with GCA, a vast amount of experience has been acquired. The U.S. Navy field at Patuxent, Md., guided 27 aircraft to landings with GCA during one brief period when the ceiling was under 200 ft. and visibility varied from zero to a quarter mile. The Navy has reported 469 operational "saves" (when landings could not otherwise have been made) with GCA. They claim the field has never been closed for weather since GCA was installed.

The U.S. Army airways communication system claimed 2,847 GCA landings under otherwise impossible weather conditions during a 15-month period.

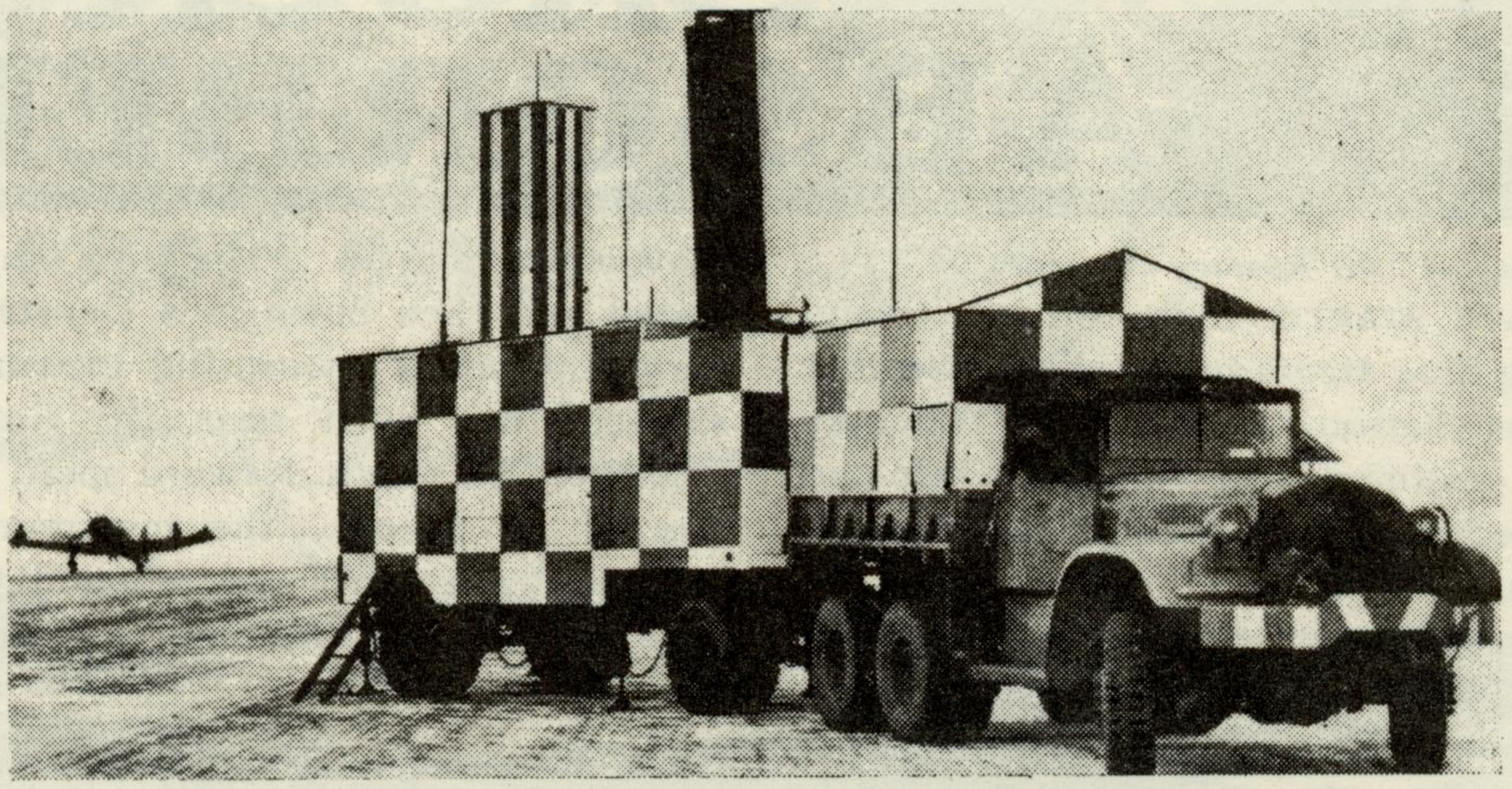
At the Indianapolis Experimental Station of the CAA, the AAF undertook a series of tests with airline pilots, CAA pilots and various categories of military pilots. Each pilot made two ILS approaches and two radar-controlled approaches in a C-54. According to the findings, of 75 pilots quizzed, 70 stated preference for GCA.

Credit for the successful application of radar to blind landing is given to Dr. Luis Alvarez, then with the MIT Radiation Laboratory, who was awarded the 1946 Collier Trophy for the greatest achievement in aviation in America on the strength of this achievement.

At first, in 1941, radar was dicredited as a landing system because of distortion at ground level. The British developed a dipole antenna which eliminated this distortion, however, and Alvarez used this to complete the first GCA set in January, 1942. Two years later the first production model was turned over to the AAF.



GROUND CONTROL APPROACH RADAR



The GCA mobile unit which is in operation at Edmonton.

Meantime, the original experimental unit had been sent to England on a British warship. It was demonstrated successfully in combat conditions to AAF and RAF personnel, then was turned over to the RAF Coastal Command.

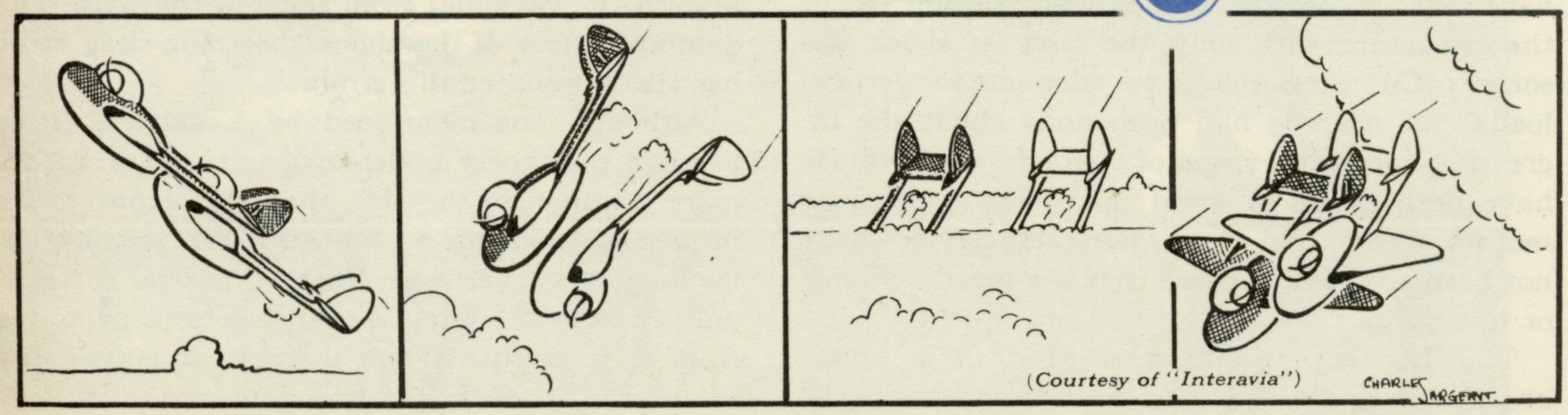
The AAF still has four GCA units operating in Europe, three in the North Atlantic, three in Alaska and 11 in the Pacific. Numerous AAF bases in the United States are using GCA on a 24-hour shift basis.

During its brief history, Ground Control Approach radar already has undergone considerable modification and improvement. Much of this development has been done by the engineers of Gillfillan Bros. Inc. of Los Angeles (who make the AAF equipment) and the Bendix Radio Division of Bendix Aviation Corporation (who supply the U. S. Navy).

Originally the GCA equipment required five operators. This has been reduced to two, one for the search and one for the precision scopes. A further modification, particularly for civilian use, will allow remote installation of the scopes in the control tower where they can be operated by one man.

While still in the future, further modifications promise to extend the usefulness of GCA. Teleran, for instance, will provide the pilot with a visual indication of his position in respect to other traffic and in relation to the approach.

It is expected that the GCA school of the RCAF will have two or three years' assignment in training the ground operators and maintenance personnel to man existing equipment in Canada.

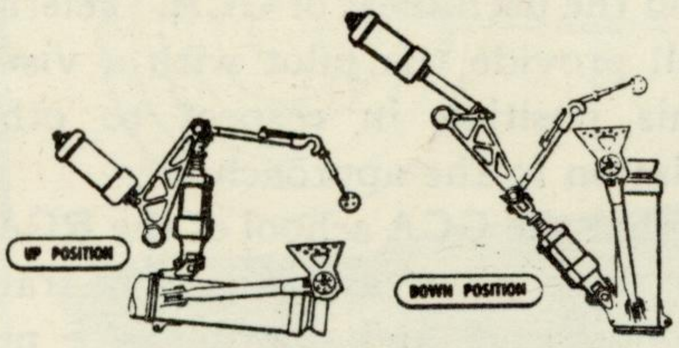


Springing the SHOCK ABSORBER

(Courtesy of "Air Reserve Gazette")

LOCKHEEDS HAVE STARTED to fit, retrospectively, shock-absorbing drag struts to the shock-absorber legs of the Constellation. At first sight this may sound like the pessimist who wore both belt and braces, but a second glance shows how common-sense is the idea.

A couple of years ago it was realised that thirty per cent of U.S.A.A.F. aircraft failures were undercarriage ones. This despite the fact that it was felt that the strength requirements were ample for all direct loads, even from heavy landings. The Lockheed Company were given the job of sorting out the mystery, and J. F. McBrearty, one of the engineers, came to the conclusion that excessive loads were being generated in *normal* landings. It could not be inherent weakness in tire, strut, or structure, nor could it be fatigue. Mr. McBrearty's conclusion was that the heavy loading came from the excessive drag when the wheels were speeded up at first touch down.

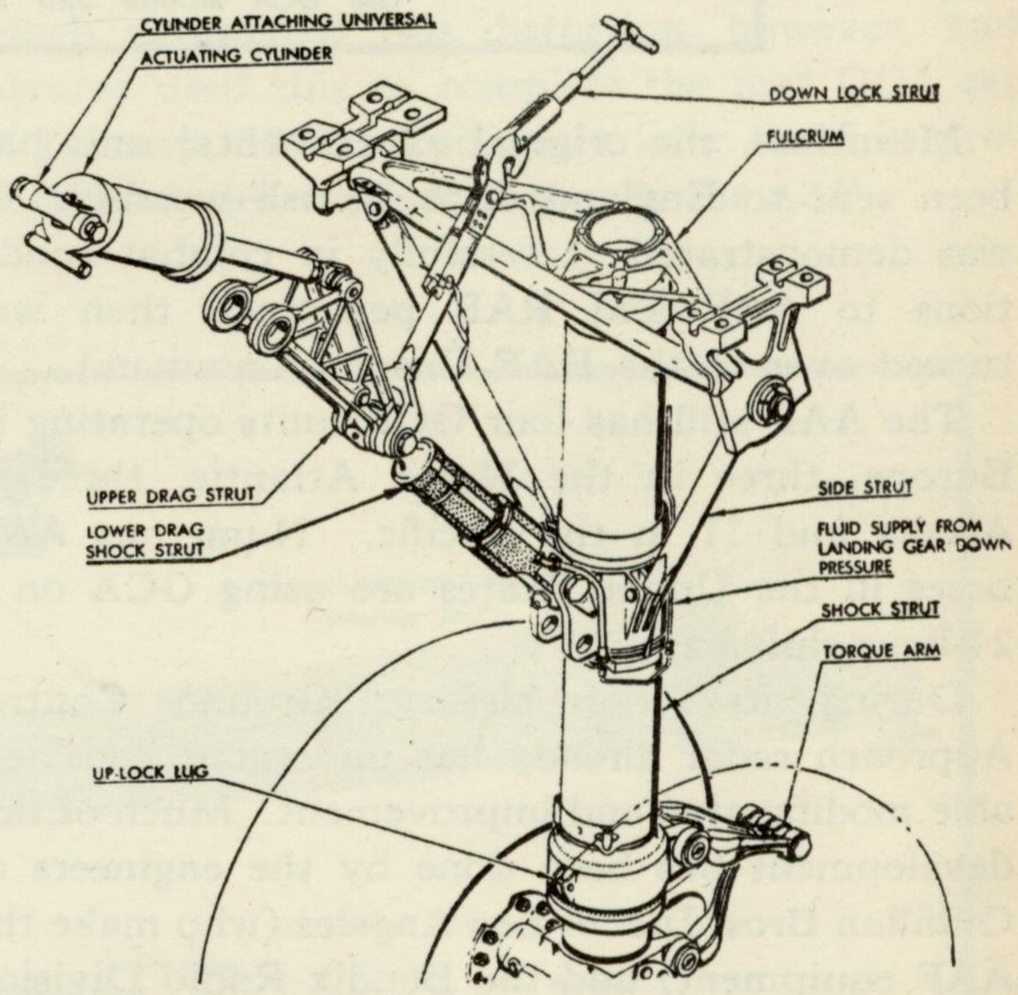


Geometrical layout of the Lockheed undercarriage retracted and extended.

Anyone who has heard the screech, and seen and smelt the smoke from the tires of an aeroplane touching down on a runway at a hundred miles an hour must realise the sudden load transmitted to the structure with only the tires as shock absorbers. Compression legs are adequate for vertical loads, but nothing had been done about the increasing horizontal speed of contact. Some efforts have been made to speed up wheels by electric motors, or by wind vanes, but these devices have not been adopted, because they are mostly clumsy or heavy.

The Lockheed solution was to fit a shock absorber drag strut to allow the wheels a backward movement of 6 in. The unit was first ground tested and then flown in a Constellation with a very full set of measuring instruments. Tests showed that even near the limiting landing condition, 95 m.p.h. forward speed and a vertical one of 10 ft./sec., the maximum loads were reduced by a third and rebound to less than a quarter—and that familiar first jolt was greatly eased.

Perspective view of the Constellation main leg, showing the new shock-absorbing drag strut shaded.



A contributory cause of undercarriage failure was thought to be due to resonant vibration from uneven runways and from skids in the wet. The damping effect of the shock-absorbing drag strut has also eliminated this strain.

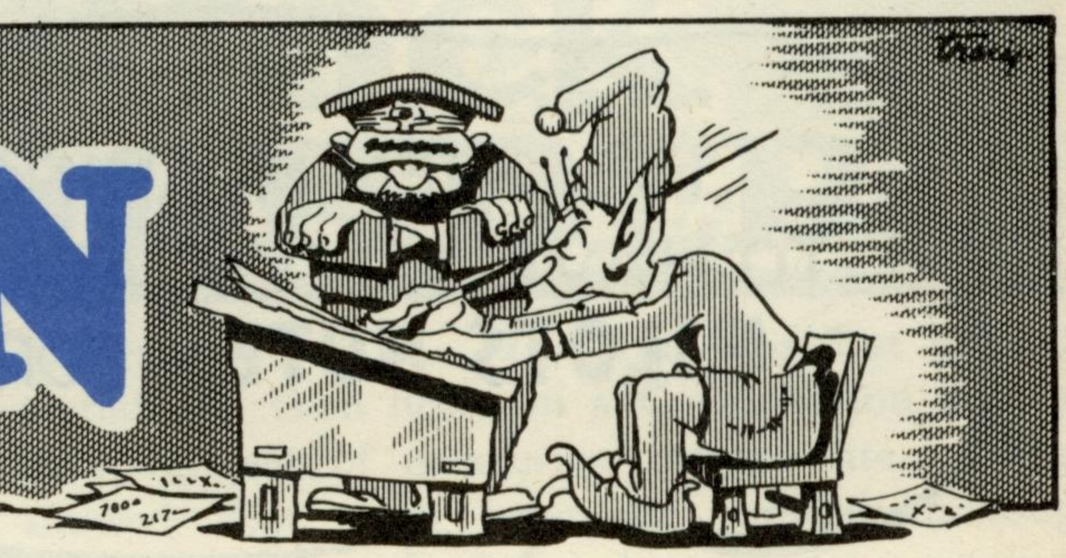
Although not mentioned by Lockheeds, it is possible that these undercarriage troubles, rather more common in the U.S. than this country, are in part at least due to the American predilection for long cantilever legs. Such units tend to bend, only minutely, but nevertheless this detracts from their smooth shock-absorbing qualities and causes the type of vibration mentioned.

kay tracy

I'VE BEEN MEANING TO HAVE A LOOK AT THESE **PILOT'S NOTES** FOR AGES!

ACCIDENT PREVENTION

A TEST FOR THE GOBLIN



In order to judge the present-day standards of British jet engines, a de Havilland Goblin 2 was recently subjected to one of the most severe tests yet attempted with any engine, either of the reciprocating or gas-turbine type. The tests, which lasted from July 8 to August 5, were done at the request of Sir Alec Coryton, K.B.E., C.B., M.V.O., D.S.C., Controller of Supplies (Air) at the Ministry of Supply, who selected a schedule that would simulate the worst war-time operating conditions for fighters and with little or no attention between flights. The programme provided the equivalent of 234 combat flights, each of 65 minutes duration with ten-minute intervals, and the Goblin was picked haphazardly from a production batch.

On the test bed the engine was run on simulated interception flights, composed of 1½ minutes start and ground idling at 3,000 r.p.m.; 5 minutes taxi-ing at 5,000 r.p.m., including three accelerations from 3,000 to 7,000 r.p.m.; 1½ minutes at the take-off condition of 10,200 r.p.m.; 5 minutes maximum climbing at 9,700 r.p.m.; 35 minutes maximum cruising at 8,700 r.p.m.; 5 minutes combat at 10,200 r.p.m.; 7 minutes descent at 7,000 r.p.m.; and 5 minutes further taxi-ing. With a ten-minute stop, this schedule gives a total time of 1 hour 15 minutes. This was repeated day after day, and the test was fully observed and recorded throughout the whole period.

During this very severe test the Goblin had 1,404 accelerations from 3,000 to 7,000 r.p.m., and 468 periods of running at maximum speed and output (10,200 r.p.m., and 3,130 lb. static thrust); 234 of these full-power runs were of 1½ minutes duration and the remainder 5 minutes—almost six hours of harsh treatment. In addition, 25½ hours were run at maximum climbing power at 9,700 r.p.m., and 2,600 lb. s.t., and 136 hours at maximum cruising power.

During the test, in which 81,000 gallons of paraffin and 28 gallons of oil were consumed, the Goblin received no maintenance whatsoever, and retained its performance to the end. The success of the test, equivalent to almost a month's field operation without servicing, under conditions which are not likely to be encountered even under the most strenuous combat conditions, should more than justify the choice of both the Goblin and its mount, the Vampire, by the Air Forces of Great Britain, Canada, Sweden, Norway and Switzerland.

(Courtesy of "The Aeroplane")

Answers to Quizz on page 9

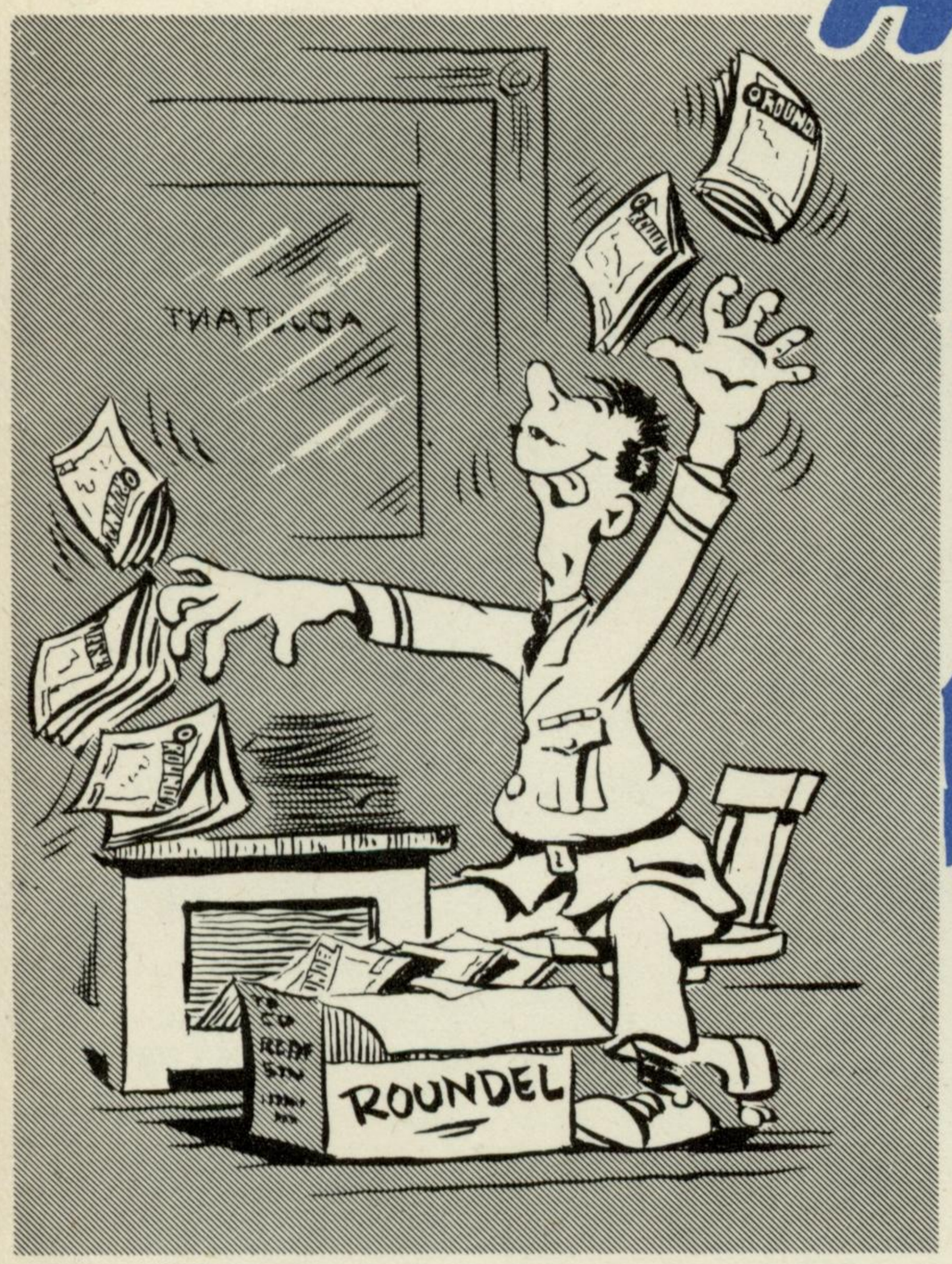
387	YAK-7B	452	Seafire 17
390	YAK-9	453	Beaufighter 10
397	LA-5	460	Meteor 4
445	Firebrand 5	461	Mig 9
447	F8F-1 Bearcat	463	York
448	Constellation	464	Auster

Answers to problem picture on page 27

1. Operator is welding without goggles.
2. Welding tanks are too close to the work being done.
3. The excelsior is a nice fire hazard.
4. That rug lying on the work shouldn't be there either.

How many more errors did *you* find?

A PLEA TO THE ADJUTANT



Distribution of *The Roundel* should be regarded as a problem in tactics. Copies of it should not be scattered abroad with gay abandon, nor, on the other hand, should they be hoarded like a miser's gold. They should be planted with system and cunning in every place (except one) where a few minutes' leisure may suggest their perusal.



and a hint to the READER

Contributions to "The Roundel" should be sent to:

The EDITOR "The ROUNDEL"
Room 2540, DND Bldg. A
Ottawa, Ont.

The ROUNDEL