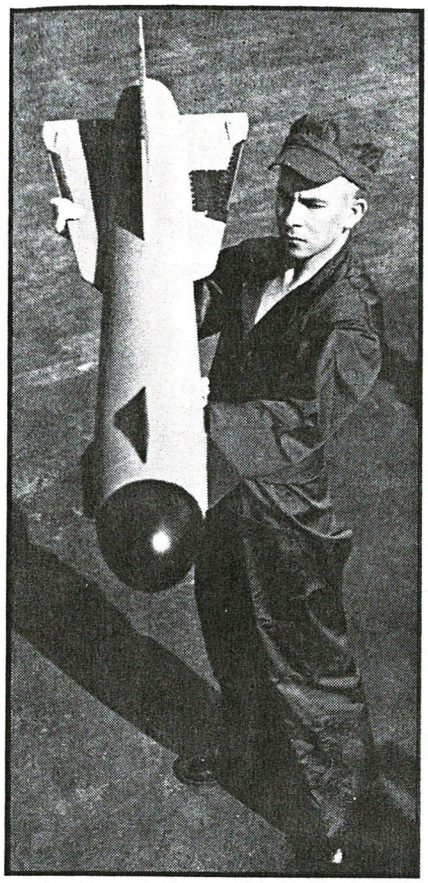
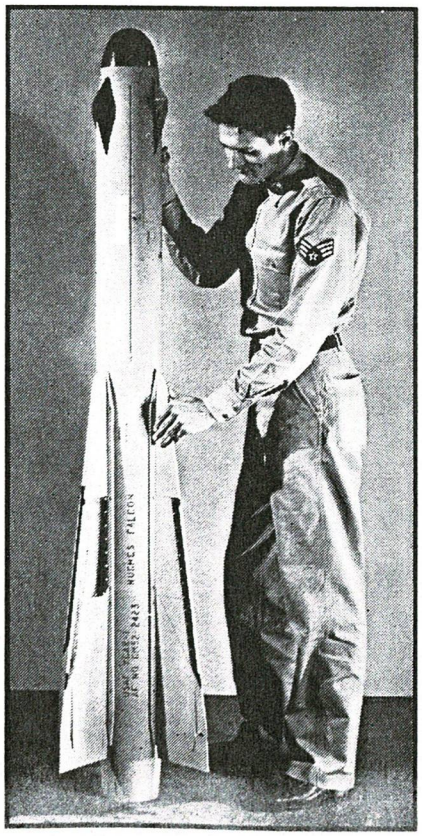


These photos give mute testimony of the compactness of this new, deadly anti-aircraft weapon. The Falcon weighs just slightly over 100 lbs. It is only six feet in length and six inches in diameter. Extensive use of plastics is made in fabricating its body and fins.



The Fighting Falcon

THIS NEW GUIDED MISSILE MAY ARM THE CF-100

FIRST DETAILS of the Hughes GAR-98 Falcon were made public in a speech in mid-March by Trevor Gardner, assistant secretary of the USAF. The GAR-98 (Guided Air Rocket) Falcon, an air-to-air guided missile designed to destroy invading bombers, is of more than academic interest in Canada, as it has been frequently mentioned as future armament for the CF-100/4. In the USAF, the first fighters to be equipped with the Falcon will be the Convair F-102 and the Northrop F-89.

Reports have indicated that when Falcons are made available to the RCAF, each CF-100 will carry six of the missles at each wingtip, for a total of 12. Such a load is quite within the carrying capabilities of the CF-100, since a Falcon weighs only slightly over 100 pounds.

Depth in Numbers: The Falcon, which was developed for the USAF by Hughes Aircraft Co., Culver City, Calif., is now in quantity production, so it will be available for operational use some time before the so-called "Velvet Glove" air-to-air missile being developed for the RCAF by the Canadian Armament Research & Development Establishment, Valcartier, P.Q. A series of air tests on the Velvet Glove are now underway at the Air Force's air weapons range at Cold Lake, Alberta. No detailed comparison between the Velvet Glove and the Falcon is possible at this time, but it is understood that the Canadian missile is considerably larger and heavier than the Hughes development.

Commenting on the development of the Falcon, USAF Assistant Secretary Gardner said: "I believe it is safe to say that the Falcon missile is one of the most important contributions to the defence of the North American continent against air attack since the development of radar.

"Air Force tests have conclusively proven that Falcon really works. It has been knocking down QB-17 and F-80 jet drones even without benefit of an explosive warhead — drones which were maneuvering in simulation of enemy bombers and which could have been carrying the hydrogen bomb. Falcon tests using an explosive warhead show that virtually every hit is a sure kill.

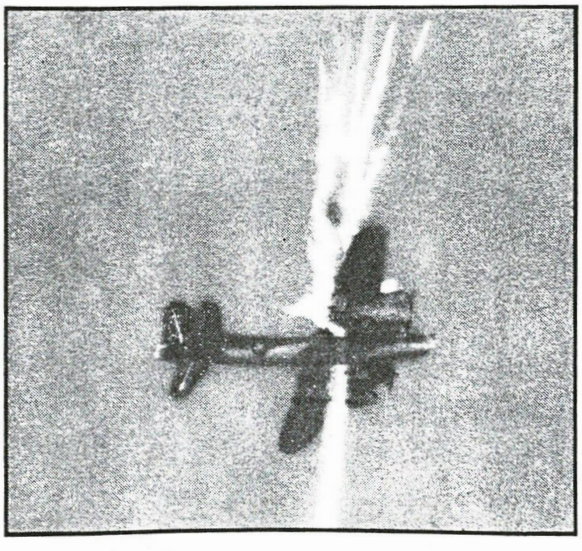
"The missile receives target information with the speed of light. It decides what to do without ever making any of the mistakes humans might make."

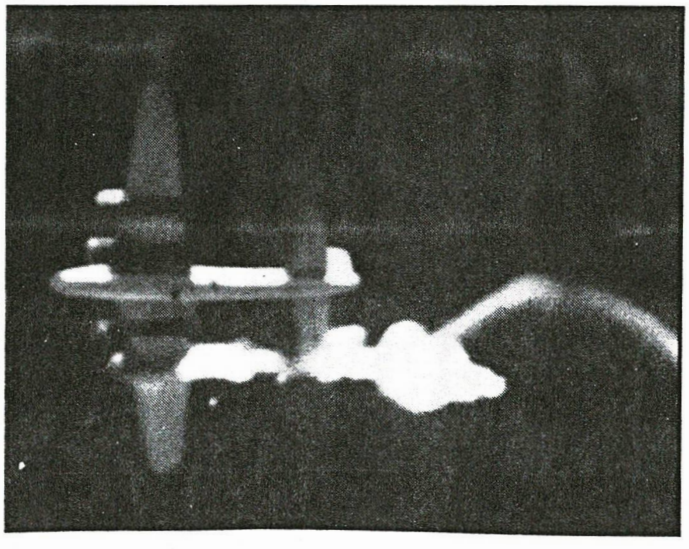
Miles Away: Mr. Gardiner said that the Falcon could be launched from an interceptor while still some miles from the target aircraft. Visual contact is not necessary, the launch aircraft being equipped with radar to guide it within missile range of the target (the CF-100/4 carries Hughes APG-40 radar, which would be suitable for this purpose). Attack procedure currently used with "Mighty Mouse" unguided rocket missiles is also used with the Falcon: the radar fire control system guides the interceptor to the proper firing position, then "locks on" the target, firing the Falcon automatically at exactly the right second. The Falcon can be launched on a climbing course from an interceptor that is far below the target.

This missile is just six feet long and six inches in diameter. Into this tiny space is packed: (1) miniaturized tracking and homing gear which includes a complete computing device for calculating the changes of course necessary to keep the Falcon on a collision course with the maneuvering target; (2) a solid-propellant rocket motor that develops a momentary peak thrust of 6,000 lbs.; (3) an explosive warhead — in actual fact, during test firings, Falcons have destroyed drone target aircraft even when not fitted with a warhead.

Initial acceleration forces are said to be in the nature of 60 G's, giving some indication of the ruggedness of the miniature electronic components of the Falcon. The extent to which these components have been miniaturized has been compared to . . . "what would be required if you compressed two television sets into a space the size of a football."

In these dramatic pictures, the effectiveness of the Falcon is demonstrated. Photo above shows the smoke trail which marked the course of one of the missiles during a demonstration, and was taken just as the missile had struck the QB-17 drone and exploded.





Closeup at lower right shows No. 4 engine afire. This aircraft disintegrated before crashing. Lower left is a Falcon without a warhead making a direct hit on a drone and passing right through amidships. Even without a warehead the Falcon strikes a crippling blow.

Guided Missiles
FOR THE FUTURE

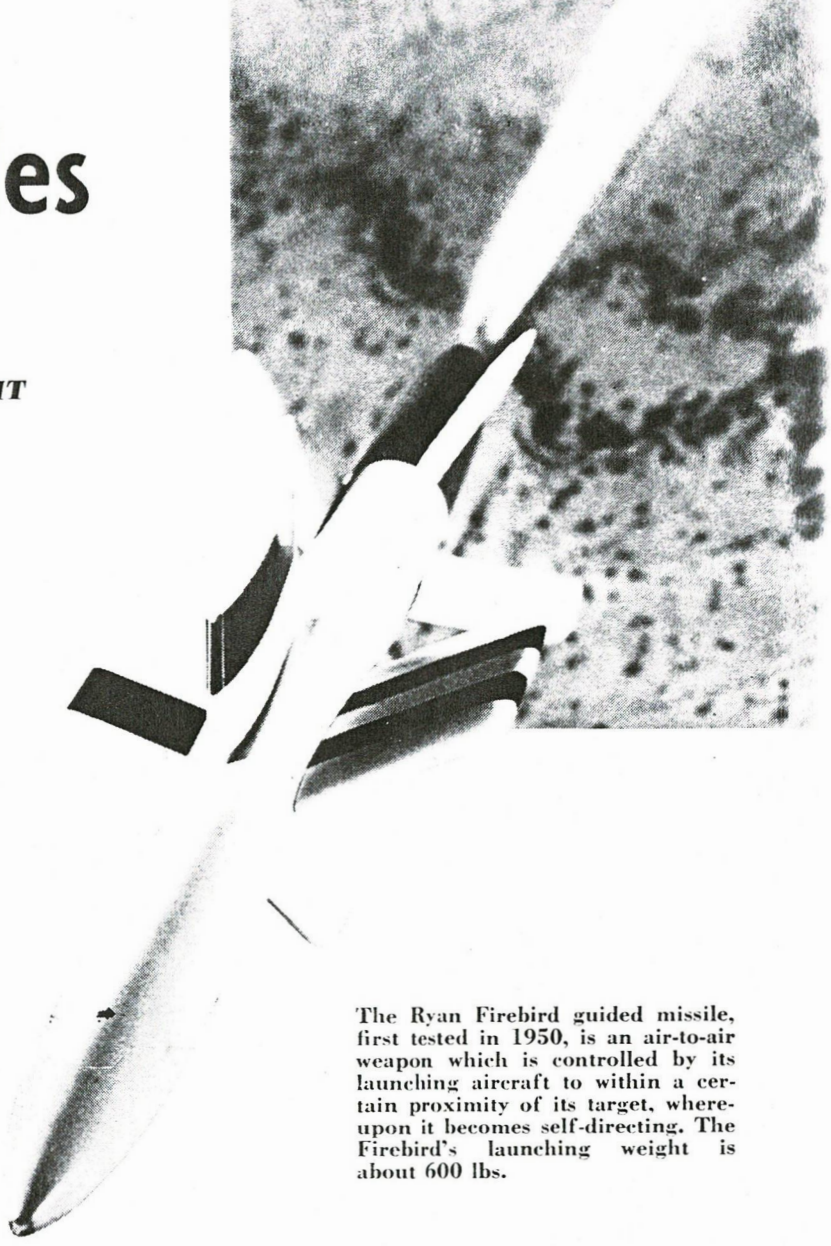
By GROUP CAPTAIN H. R. FOOTTIT

"New things are seldom considered coolly and objectively."
—*Marshal of the RAF Sir John Slessor.*

FINALLY the news filtered home. The red coats had suffered a stinging setback. This was towards the close of the eighteenth century and the British troops, during a campaign in India, had been thrown back by the massed fire of a native "rocket corps." Immediately parliament voted money for the development of this new weapon. And Sir William Congreve plunged into a program that, by 1817, produced a family of rockets having ranges from 2,000 to 3,000 yards, and carrying all the variations in artillery ammunition that were then in use.

Today, the nations of the Western World are busily following a similar feverish course. But now it is the guided missile. With the man-hours and money that are being poured into these new developments, and the rapid march of technology, there is no doubt that the missile is here to stay. Even in Canada this has been recognized. And the Defence Research Board's CARDE establishment is busy designing and developing a modest air-to-air missile, the Velvet Glove, to RCAF requirements.

Exaggerated Picture: But the whole missile picture has been clouded by exaggerated time scales, and misleading publicity pushed out by the proponents of "push button" war. Even our own missile, like all others, has its limitations. In other words, any fully developed missile, just like an adding machine, will do one job well —the job it was designed for. But it is not omnipotent and it is not infallible. Though within the channel of its particular usefulness it may be a powerful weapon. Still, there is no doubt that we in Canada, as others have done, will have to expand our missile design, development and production facilities. For the final reckoning in any future war will hinge heavily on a wide variety of specialized guided missiles.



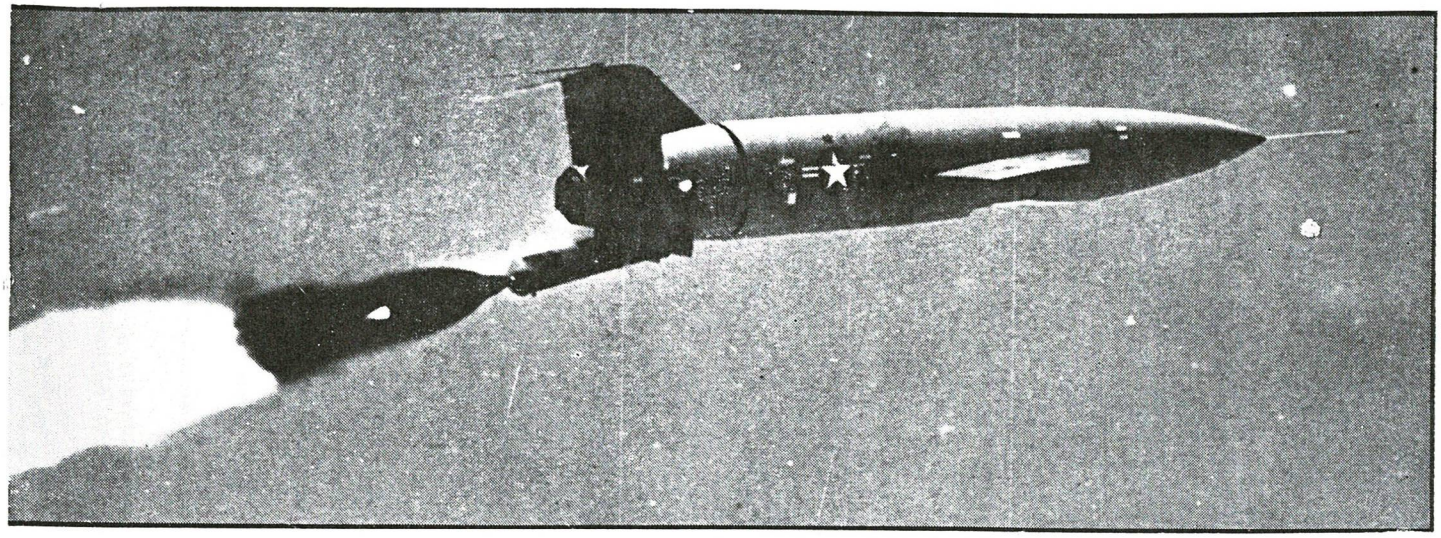
The Ryan Firebird guided missile, first tested in 1950, is an air-to-air weapon which is controlled by its launching aircraft to within a certain proximity of its target, whereupon it becomes self-directing. The Firebird's launching weight is about 600 lbs.

With the wide swath of publicity given to these weapons of our age, it is sometimes difficult to decide "what" they will do, and "when" they will do it. For example, C. C. Furnas, Director of the Cornell Aeronautical Laboratory, said recently, "No matter how complex they become, guided missiles are essentially stupid." However, he is trying to drive home the point that, in his analysis, the missile will not replace the man in battle in the next half century. But he is quite ready to admit that missiles "do many clever and wonderful things and are relatively selective in their action."

At almost the same time General Donald L. Putt, former commander of the U.S. Air Research & Development Command, told the American Rocket Society in New York that as missiles approach the peak of their development, ". . . the military airplane, as we know it now, will eventually be relegated to a mere logistical vehicle."

And Sir John Slessor has written in his book, *Strategy for the West*, "At least some manned fighters will be with us for many years to come, and I cannot visualize the disappearance of air crews from the air forces of the world in the foreseeable future."

Matter of Viewpoint: Undoubtedly all these eminent experts are right. It all depends on the viewpoint. If we compare the electronic "brain" of a missile system, with the slow but powerful and compact human, as Dr. Furnas did, then missiles are indeed stupid, and will undoubtedly remain



USAF's Martin Matador is classed as a surface - to - surface/air - to - surface guided missile and is now in operational service as a pilotless jet bomber. One is being displayed at this year's CITF.

so. As one neuropsychiatrist, Warren McCullouch, has opined, "If a calculator were built to fully simulate the nerve connections of the human brain, it would require a skyscraper to house it, the power of Niagara Falls to run it, and all the waters of the Niagara to cool it."

On the other hand, General Putt has peered ahead and moved a long way down the time scale. His offensive and defensive air forces are organized into missile squadrons. But he hasn't got rid of the human being. He has only relegated him to a ground position where he can still put a guiding hand on the controls of these powerful weapons. Sir John Slessor, however, has taken an intermediate stand. He has part of his human material on the ground controlling missiles squadrons and part in the air in the familiar fighter.

Thus we can see that everyone is really saying the same thing: "Powerful guided missiles are coming. Their exact timing in the future cannot be pinpointed. Yet as they do come, they will gradually change the whole mode of war. All these missiles will have limitations. They won't replace the human being as the prime fighting force, they will only relegate the human brain to another position in the scheme of things." And when we sit back and contemplate it, this is exactly what the longbow, the gun, the cannon, the tank, and the airplane have done in all bygone wars. They have merely changed the face of war, while man, the brain behind the mechanism, has merely repositioned himself to make the best use of these products of his own ingenuity.

Slow Development: To visualize the various complications connected with these missiles of the future it is necessary to pigeon hole them into technical and operational categories. From the technical side, as we have seen, the unguided, ballistics rocket, suffered through nearly 150 years of desultory development after Congreve's work. Then, in World War II it came back with a vengeance. Man-carried bazookas, firing small rockets, decimated German tanks; Hawker "Typhoons" with under-wing rocket installations blasted German road traffic; while the Germans put some pre-set guidance into a 46 foot liquid rocket missile and hammered London with their infamous V-2s.

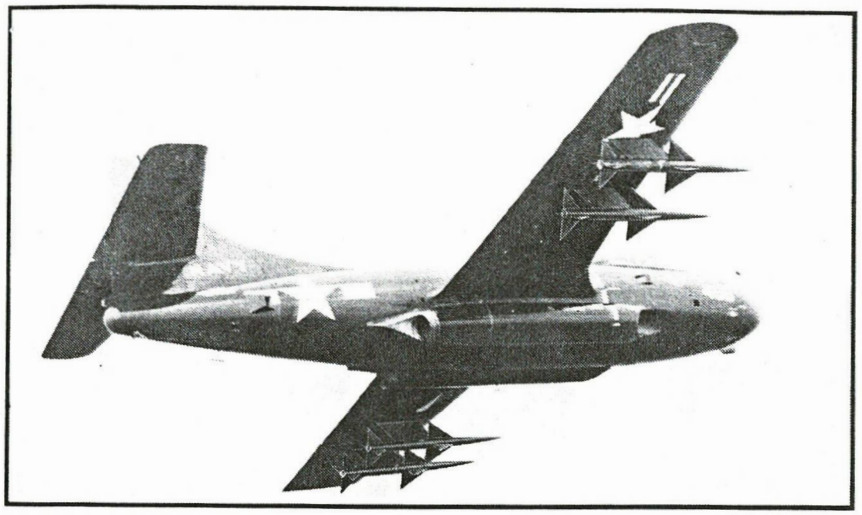
While this pre-war rocket development was proceeding apace, the British, Americans, Germans and others, had carefully tried out pilotless airplanes. Using a radio-controlled auto pilot they had successfully taken and landed such craft. Some of this work was even going on during World War I. But it was not until after the last war that the full impact of adding guidance to ballistic or winged missiles really struck home. And once it did, the missiles race was on.

Today, between these two technical extremes, the guided rocket and the guided pilotless airplane, there are all manner of missiles that are coming into the Allied arsenals, or being tested on the stands, or are still on the drawing boards. And each of these technical configurations has been designed for a set operational role. Neglecting homing torpedoes, and other maritime guided weapons, these missiles are made as air-to-air, air-to-surface, surface-to-air, and surface to-surface weapons.

Complex Requirement: To generalize the operational aspects, while keeping in mind all the possible technical configurations, it is apparent that the missile launcher may be fixed or moving, depending on whether the missile is ground or air fired, and the target may be fixed or moving, depending on whether it is a vehicle or a static installation. And between the attacker and the target there is realms of three-dimensional space. To make matters more complex, the target may even have some invisible electronic defensive net spread around it, that may confuse and misdirect the missile so it explodes harmlessly a safe distance away.

It is obvious then, with all these variables in the missile equation, there will never be just one omnipotent guided missile in the military arsenal, but a whole air force of missiles—each designed to be set off from a specific launcher to cope with a specific target, and each designed to carry out its task within certain limits of range, target manoeuverability, and the like.

The Martin Matador, which now stands guard in Europe as a surface-to-surface tactical missile (and essentially a pilotless bomber), the Hughes Falcon, a guided air-to-air rocket, and the Nike, a guided anti-aircraft rocket,



A NAVAL DEVELOPMENT is the USN's Sparrow air-to-air guided missile, shown here under the wings of a Douglas F3D Skynight. Companies associated with this project include Douglas, Sperry and Raytheon Mfg. Co. The Sparrow is rocket propelled and employs beam guidance with terminal homing.

are some of the first fledglings of this new air power, and just a few of the variations that will eventually be forthcoming.

Designed for the Job: Each of these missiles, like all others, has been designed to do a set job, and it can only operate effectively if the job falls within its scope. First of all, there are limitations on range. Any missile of a fixed size and power will only go as far as its fuel will carry it, and fast missiles are notoriously hungry for fuel. Once the fuel tanks are dry, or the powder has burnt out, it loses a measure of its effectiveness. With no further thrust, it can only manoeuver within the limits imposed by its momentum. If it is aimed at a fixed surface target, this may be inconsequential. But if it is aimed at a moving target, gravity, drag and target manoeuverability take their toll so all the guidance in the world may not get it to strike home.

Moreover, fixed guidance systems themselves lose power as they reach out through space, and missile effectiveness starts to slump. Or if the guidance is part and parcel of the missile itself, a moving target may skip out of range, to one side or another, and the missile wanders hopelessly until it falls to earth. There are limits to the angle of vision of even a radar eye.

Missiles, like airplanes, are also limited in manoeuverability. They may be built to withstand, say, 15 "g," to keep the structure weight down and so reduce the size and power required. Yet a manoeuvering target, or even a fixed one under certain conditions, may cause the guidance system to attempt a last minute correction, that is beyond the missile's capability. The result is a miss.

The Race is On: Air Commodore C. L. Annis, of the RCAF's Air Defence Command, recently noted that, "The race for emergence as the most practical intercontinental vehicle next to appear is between the very high speed and altitude unmanned bomber, and the still higher speed and altitude, unmanned intercontinental ballistic missile" This stress on altitude brings up another factor. The higher we send our missiles, the less air there is. And the less air there is, the less stabilizing force there is to bear on the missile and keep it unerringly to its course. The missile, then, may tumble end over end, in the upper reaches of the sky, and only straighten out when it again hits the sobering effect of the earth's air mass.

Guidance, under such erratic flight conditions, is no mean problem. And even the German's V-2 missile, with its pre-set guidance mechanism, had variations in course as it righted itself during its return to the atmosphere after tumbling through outer space.

Add to all these limitations, and many others, the effects of possible enemy countermeasures that have been designed to throw the missile off course, and the end result is a question mark in accuracy. Thus the missile may not be infallible, even in the set piece battle that it was designed to fight. Yet we must turn the page and ask ourselves, "What other weapon do we have that is absolutely infallible?" And the answer, of course, is "None."

It is abundantly clear, then, that as missile design data becomes more readily available, as designs are perfected through continued development, and as reliability of the finished product reaches new heights the missile will take its place, slowly but surely, in the stockpile of future military weapons. Already we in Canada have started to scratch the surface of this new business. We are designing and building our own missile at CARDE, and we have put test installations on CF-100 and Sabre aircraft.

No Precedents: But this is just a bare start. R. D. Richmond, Chief Development Engineer for Canadair Limited, has been studying the impact of missiles on the Canadian aircraft industry. Says Richmond, "Canadian industry in general only recently became aware of some of the problems encountered with guided missiles. We, as well as other companies, have, for the past few years, been gradually accumulating some experience with them. In many cases we have found that these missiles bring up problems which are devoid of any precedent, and it has been necessary to adopt a 'creep before you walk' philosophy to ensure avoiding any basic errors in design."

To illustrate how far this cautious approach has to be carried, Richmond points out that a missile is only part of a complete and complex system. Take just the seemingly simple case of test equipment. "It is now accepted practice," Richmond says, "to support each missile program, both during the development and production phases, with a large amount of complex, custom-made test equipment. The function and application of this equipment is initially predicted to handle some of the more obviously critical items. However, as experience is gained, the emphasis may shift considerably. This in turn causes a chain reaction of new and redesigned test equipment."

(Continued on page 157)

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VISCOUNT DELIVERY

(Continued from page 29)

sprawling Narsarssuak Air Force Base. Giant USAF bowsers refuelled TGN while we posed for pictures beneath a sign which read "Welcome to Sunny Southern Greenland." Sunny it certainly was.

Refuelling completed, we left Bluie at mid-day, taking off downhill and out once again down the fjord to the sea, where we set course for Goose Bay, intending Seven Islands as our alternate. The first leg of the track is to Cape Harrison and we quickly climbed up to 24,000 feet.

Again the interior of the Viscount is bathed in streaming sunlight, pouring in through the large windows. Greenland's icy mountains are still visible from 70 miles away while far beneath us a few isolated icebergs slowly drift southwards in the direction of the shipping lanes.

Direct Flight: With some excitement, Scotty, who had been working hard with his computer, announces that he had collected favorable tail winds that might enable us to make Montreal direct, cutting out the Goose refuelling stop. At first Peter hesitates, deferring a decision until we can get a better check on our fuel state, but at 11:30 there is no doubt and Peter decides to fly direct to Montreal.

Eventually Cape Harrison comes into sight dead ahead, and beyond the Cape are Labrador's snow-covered barren lands. The triangle of Goose's runways passes 24,000 feet below our nose. We fly the airway to Seven Islands—still over snow-covered forest—on along the broad sweep of the St. Lawrence, past Quebec, south to Rougemount. The fan marker winks over the beacon and we are cleared into Dorval. Over Montreal, giving some of us our first glimpse of a North American city, and there straight ahead is Dorval. We take a wide sweep around and touch down at 17:05 GMT, 12:05 local time. As we taxi to a halt a group of TCA officials walk forward and come aboard. TCA has received its sixth Vickers Viscount.

GUIDED MISSILES

(Continued from page 30)

It is therefore apparent that the design, development and production of missiles systems requires the backing of a skilled engineering team. It will take us time to build up this team in Canada so that it can adequately bring forth these vital weapons for our armed services.

For we must recognize that, in spite of their limitations, missiles will be the spearhead of any future war. In the air force alone we will have men, and we will have airplanes. But for both to do an effective job, we must have missiles. To time our Canadian industrial program—which will stretch into years—so that there is a gradual feeding in of top rate missile systems will require cool and objective thought. This is no easy task. For, as Sir John Slessor has said, new things, such as missiles are seldom considered in such an atmosphere.

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