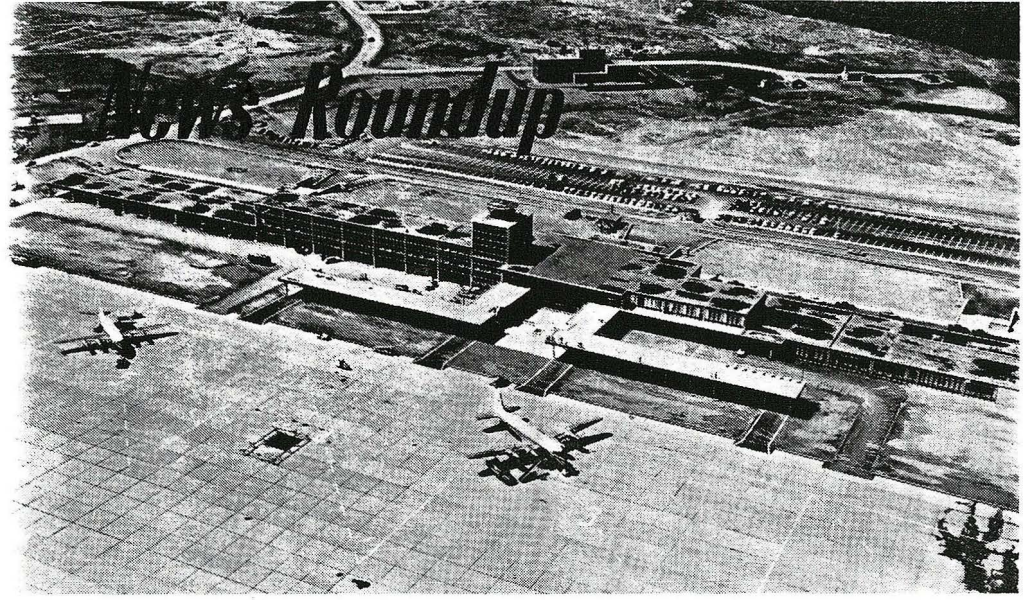


THE HANDSOME NEW TERMINAL at Halifax International Airport is shown in this Department of Transport photo. Building at upper left is new Fairey Aviation hangar. The 165,000 sq. ft. $4.5 million terminal houses the most modern passenger facilities as well as all essential DoT services.

Simulated Checks

According to a recent COPA report to its members, the DoT is considering permitting semi-annual Instrument rating checks to be taken in flight simulators or Link trainers. At present, a check flight must be made in the company of a DoT inspector.

COPA says that not only is the DoT short of instrument check pilots, but that many operators at major terminals have been complaining that check flights interfere with regular arrivals and departures of scheduled flights. If the proposed plan to use Link or simulators were adopted, the number of check flights would be reduced by about half.

Black Brant II

The DRB this year will launch Canada's greatest rocket research program — 12 to 15 firings from Fort Churchill between now and July 1961.

The rockets will be used to test solid propellants developed by the Board's establishment at Valcartier, Que., and for upper atmosphere research. In some cases, both purposes will be served at the same time. Three of the rockets will be used to study a newly-discovered phenomenon causing communications blackouts — polar cap absorption of solar rays.

Dr. A. H. Zimmerman, DRB chairman, said he is very hopeful that the rocket — known as Black Brant II — will become a standard research tool not only for Canada but for other countries as well. The Board may be able to sell it to the U.S., for one.

Dr. Zimmerman said the Canadian program is complementary to that of the U.S. and Russia and will fit into the U.S. family of research rockets.

"The U.S. and Russia have left the upper atmosphere behind and gone right into space. This has left a tremendous number of problems in near space which have to be solved. This is the area in which we have been and will be making a real contribution."

Canadian research in the upper atmosphere is mainly concerned with phenomena which affect northern communications such as aurora, solar flares and cosmic rays.

A Canadian satellite to study the top layer of the ionosphere will be launched by a U.S. rocket from California some time between November 1961, and March 1962.

The history of the Black Brant is one of continuous success so far. Twenty-five feet long and 17 inches in diameter, it was developed by the Valcartier establishments. It has had 15 successful static tests and four successful launchings out of four tries from Fort Churchill last year.

The new Black Brants will attain altitudes of about 150 miles with instrument payloads of some 150 pounds. The solid propellant enables them to be fired immediately a solar flare or auroral display is detected.

Dr. Zimmerman indicated that the Black Brant may be in use for some five years or more as a research tool.

Cranbrook Night Facilities

Night landings of aircraft at Cranbrook, B.C., are now possible. Vastly improved regularity of service will result.

The DoT has turned over to the city a $13,700 low intensity lighting system along the length of the runway.

Auto Parts for A/C

The DoT has approved the purchase from auto supply houses for use in aircraft without release notes, of parts for aircraft starters, solenoids, generators and similar equipment, which are in common with parts used in corresponding automobile equipment. However, the parts concerned must be obtained in sealed factory containers.

Muirhead Literature

Two new product catalogues, "Muirhead Control Synchros" and "Muirhead Servomotors", are now available from Muirhead Instruments Ltd., 677 Erie St., Stratford, Ont.

New Aero Course

An important addition to aeronautical education facilities in Canada has been made by the Province of Ontario's Ryerson Institute of Technology, which is now offering a three-year course in aeronautical technology.

Ryerson says that the course qualifies graduates for positions as research & development technologists, stress analysts, aerodynamic and flight testers, aerial surveyers, design draftsmen, inspectors, and technical sales representatives. Graduates of the Toronto Institute will also be eligible for commissions in the RCAF.

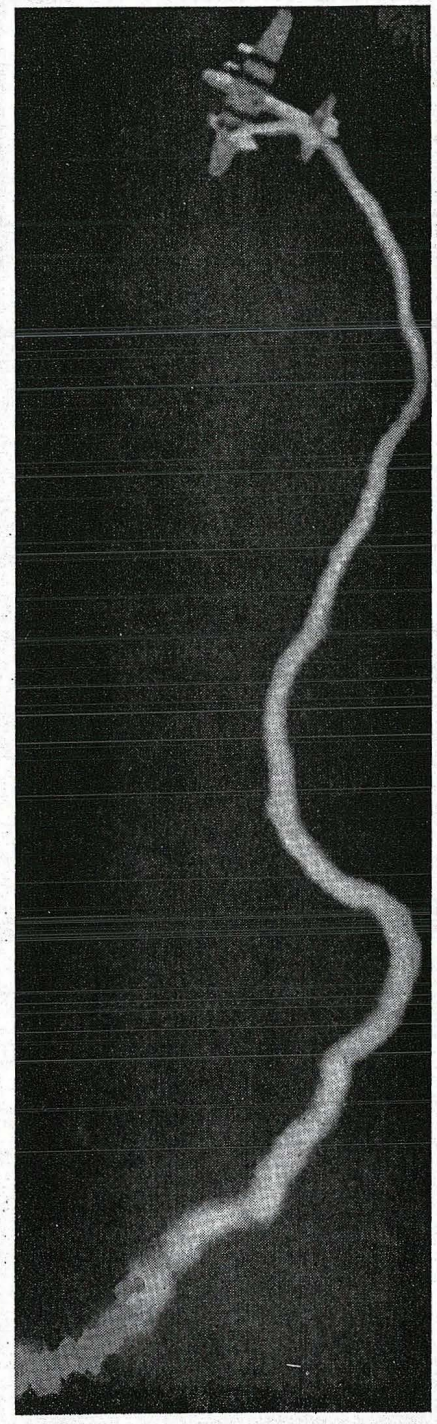
Aeronautical Technology students take a common first year with all other Ryerson students of technology and a common second year with students of Mechanical and Metallurgical Technology. Aeronautical specialization begins in the third year, and new laboratories for this specialization became available at the beginning of the 1960 term this month.

Subjects studied during the year of specialization include mechanics of materials & machines, aeronautical design, applied thermodynamics, mechanics of flight, meteorology, and mechanics of fluids.

The Aeronautical Technology department is headed by G. Nicholson,

CANADIAN AVIATION JUNE 1953

NEW GUIDED



FALCON air-to-air missile, a guided aircraft rocket developed by Hughes Aircraft for the USAF. It's ability to manoeuvre is shown at left with a direct hit on a radio controlled B-17.

... open an era

By Dick LaCoste
Washington Correspondent

In the atomic or thermonuclear war of tomorrow electronics is the key to survival. It is the brain of both the offensive and defensive weapons of tomorrow.

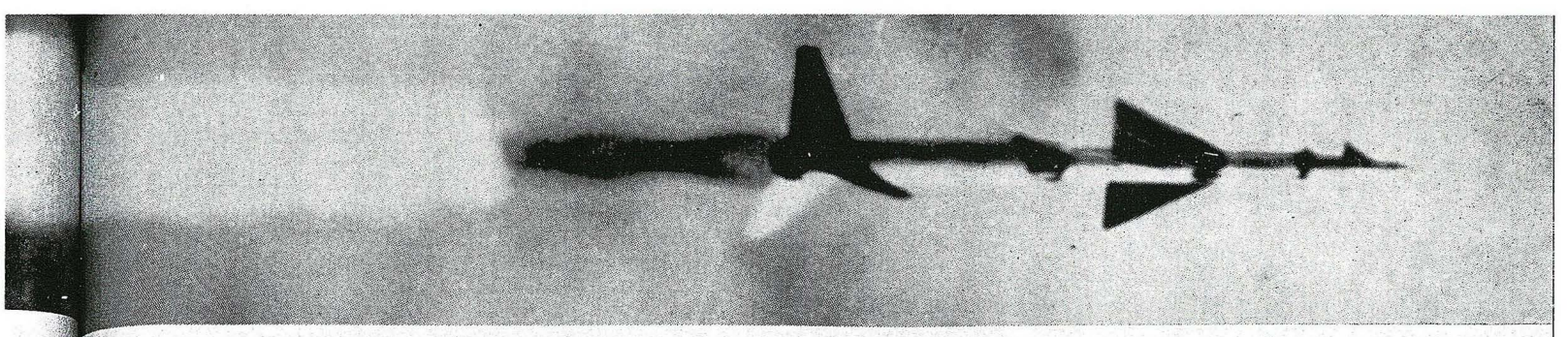
Because only electronics provide the answer to an effective continental defense of North America, Canada and the United States are exerting every effort to bring electronic weapons and warning systems to maturity.

▸ **Industry Effort** — This means almost 60% to 75% of the aircraft industry's efforts are being concentrated on the last piloted supersonic aircraft (such as the Avro Canada CF-105) and the ultimate guided missiles.

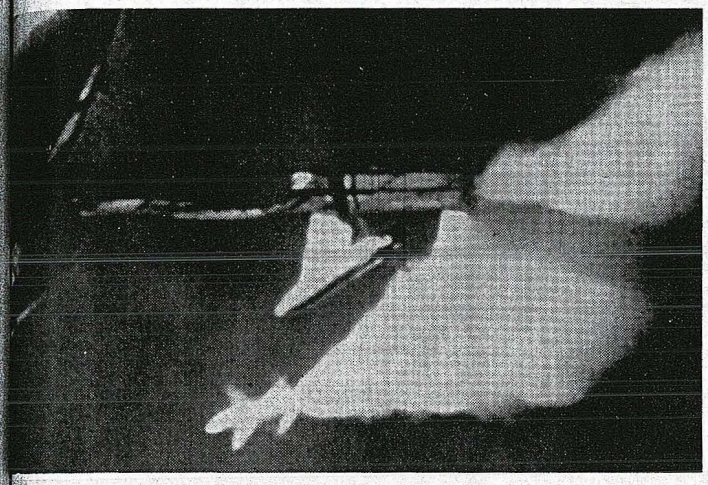
Sparked by the Defense Reasearch Board, Canadian industry—Avro, de Havilland, Canadair, Westinghouse and others—is racing against time to bring electronic guiding, tracking and firing system to operational efficiency.

▸ **Velvet Glove.** Canada's major efforts are being concentrated on air-to-air missiles to be carried aloft by the CF-100's and CF-105. A small number have been developed by Canadian Arsenals at Valcartier, Que., in co-operation with private industry. Named the Velvet Glove missiles they are undergoing tests at Cold Lake, Alberta, proving grounds.

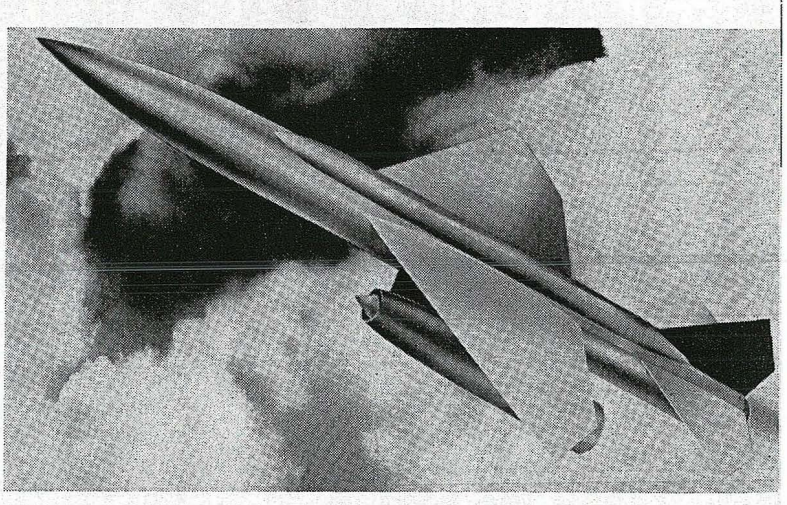
But this is only the beginning in Canada. Air-to-ground and anti-submarine missiles are also under development. Much consideration is also being given to taking on production of some of the U. S. and British missiles.



MISSILES . . .



SPARROW air-to-air missile shown being launched from a plane. It is produced for the U. S. Navy by Sperry.



BOMARC F-99 USAF pilotless interceptor being developed by Boeing marks the end of piloted interceptor fighter era. (Official USAF Photo.)

of electronics warfare

Now, the U. S. Department of Defense has three weapons that could spell the difference between defeat and victory for both Canada and the U. S. in any all-out war.

● **Atlas.** First, there's Atlas, an intercontinental missile. This super Air Force weapon is scheduled to speed to target some 5,000 miles away from a U. S. base at 10,000 miles per hour. Scientists say it will strike within a 20-mile circle of the target. Armed with an atomic or hydrogen warhead, such accuracy is sufficient for military success.

● **Nike.** Second, there's the Army's Nike, a ground-to-air missile. Right now the Nike can outmanoeuvre the fastest fighters and bombers.

● **Falcon.** This air-to-air guided missile is in quantity production for operational use by the U. S. Air Force. It is launched from a piloted aircraft and is equipped with self homing devices to find the target itself to live up to its description of the only air-to-air missile with a "brain."

The success of this weapon has raised the possibility that it could be produced in Canada under license. It would be suited to both the CF-100 and CF-105 being developed for supersonic long-range interception.

▸ **System Types.** The U. S. features four basic types of missiles: surface-to-air or anti-aircraft; air-to-air or plane-launched; air-to-surface or plane bombing; and surface-to-surface or from one ground area to another.

Like any other weapon, missiles must be guided to target. The guidance system — the brains of the missiles which lead them to target —is what makes them different from conventional weapons.

Some of these systems include the beam-riding type which follows an electronic or light beam toward a target; the homing type—self explanatory; the command guidance type which is directed from ground, ship or plane; and the automatic navigation type which can be sent to target in a dozen different ways.

An aside should be added here on preset missiles. These are not true guided missiles. Missiles of this type have their own propulsion systems. Once they are launched, their course cannot be changed.

For defense, the U. S. is banking on two missiles. The first is the miraculous Falcon. That "bird" is charged with the mission of knocking down "enemy bombers, carrying the hydrogen bomb long before they reach their targets." The Falcon is

an air-to-air electronically-guided missile.

The second missile is the Nike, a surface-to-air missile. Affectionately known as the "homing bird," the Nike is an anti-aircraft weapon.

Third in the U. S. missile bag of armaments is the Atlas, an Intercontinental Ballistics Missile (IBM). Strictly speaking, the Atlas is not a true guided missile. It is aimed like a bullet from a gun.

The Atlas presumably would be launched from bases in this country or Canada to home in enemy territory. To this offensive phase of war would be added the punishing power of rough, tough, cigar-chewing General Curtis LeMay's Strategic Air Command.

▸ **Air-to-Air.** Conceived in 1947, produced and developed by the Hughes Aircraft Co., the fantastic Falcon theoretically is capable of destroying enemy aircraft carrying hydrogen bombs before they reach Canada and the U. S.

There's little doubt interceptor planes in Canada, Alaska, Greenland, Iceland, and other arctic areas soon will be equipped with the Falcon.

The Falcon can be launched from well beyond the reach of an enemy bomber's defense. It can be launched on a climbing course from an interceptor that is far below the enemy bomber, thus saving time that the interceptor would need to gain the bomber's altitude.

It has an extremely high probability of "kill," even against manoeuvring targets, especially when it is considered that a small interceptor can carry and launch a considerable number of Falcons.

Once the target has been pointed out to it the missile's electronic brain will steer it to anticipate and strike that target no matter how the bomber manoeuvres.

▸ **Surface-to-Air.** The liquid-fueled Army Nike is fitted with a booster rocket which gives it the initial blast-off. Approximately 20 feet long and one foot in diameter, the Nike is fitted with two sets of fins for guidance and steering.

What makes the Nike valuable is that it can operate regardless of weather conditions and visibility. Launching sites are now being installed near large industrial cities and military centers.

Inside the Nike's aerodynamic body is an explosive warhead, a rocket propulsion unit, and guidance equipment.

As the target approaches the range of the weapon, the control mechanisms, stabilization and navigational gear are checked. At this time, certain safety mechanisms are disengaged. When the target crosses Nike's distant and invisible deadline, the missile fires.

With a roaring whoosh it strikes out to meet the enemy. Within seconds the missile has pushed past the sonic barrier. Then, while in supersonic flight, the Nike propels itself smoothly on its own rocket engine as it searches for its prey. Seconds later the Nike and the enemy meet. Both are blasted to bits.

▸ **Intercontinental War.** As of late March, 1955, the most fearful weapon in the U. S. arsenal was **Atlas**, the Intercontinental Ballistics Missile.

Two others—the **Navajo** and the **Snark** — are competitive with the Atlas. But military men call the Atlas the "true decisive weapon." They say, in effect, we shall have arrived at the age of push-button warfare when the Atlas is fully operational.

Right now the Atlas is moving out of the design range. Perhaps as many as six versions will be built. Currently envisioned, however, is a two-stage or stage-and-a-half rocket weighing 15-plus tons capable of flying 600 miles above the earth at 20 times the speed of sound.

What pleases Air Force officials about Atlas is that it's not a true guided missile. It's aimed — like a bullet. Another satisfying thought is that there is no known defense against the Atlas and similar missiles. —The fact that the Atlas has no guidance mechanism; that it cannot be sidetracked or befuddled by electronics; that it could carry a hydrogen warhead more than 5,000 miles and strike within 20 miles of target makes it a true decisive weapon. The 20-mile margin of error means little. Destruction would be complete.

The Snark, on the other hand, by no means is out of the running. Built by Northrup for the Air Force, the jet-powered pilotless plane also has intercontinental range — some 5,000 miles. Actually, the Snark has flown. But it is not in quantity production.

Measuring about 30 feet long, the Snark snakes to target at just under the speed of sound. Since its ceiling is about 50,000 feet, it could be "caught" by enemy jets. That's its shortcoming.

The third IBM with promise is North American's Navajo. A true guided missile, the Navajo is a ram jet. It is guided to target by the stars. Scheduled to fly at from 60,000 to 80,000 feet, the missile will attain speeds of slightly less than three times the speed of sound.

Runway barrier trials will be conducted using a CF-100 Canuck at RCAF station Uplands near Ottawa. The barrier is an accident prevention device placed at the end of runway, designed to bring jet aircraft to a stop should the aircraft lose its brakes on landing, overshoot the runway on a flame-out landing, or lose its power on take-off. Runway barriers have been used by the USAF for such jet aircraft as the T-33, F-86, and F-84. The Canuck, weighing more than 17 tons, will be the heaviest fighter used to date, to test runway barriers.

* * *

De Havilland Aircraft of England has started a sales campaign on the Heron "Executive Special"—de luxe variant of its Heron Series 2 executive version. It has accommodations for six passengers in a divided cabin with a forward lounge.

* * *

Canadian Steel Improvement has printed a booklet entitled "The Forging Process." It describes drop and press forging methods and equipment, outlines production steps, discusses the design of forging dies, and covers the characteristics of forgings and various forging materials. Standard tolerances for impression die forgings are also given in table form.

For a free copy of "The Forging Process," write to Canadian Steel Improvement Limited, Horner and Second Avenues, Etobicoke, Ont.

* * *

Exceptional Service Award, highest honor the U.S.A.F. accords a civilian, was presented to **Lawrence D. Bell,** one of the nation's aviation pioneers.

For more than 43 years Lawrence D. Bell, who founded the company bearing his name, has worked for military and peacetime aeronautical progress.

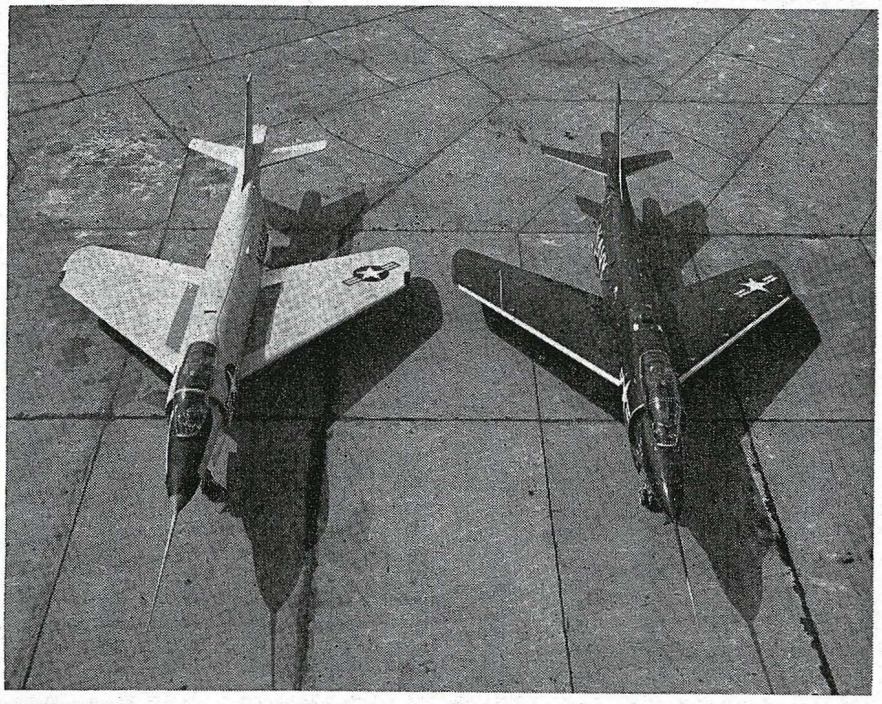
* * *

Canada has started into the first phase of guided missile production. Defense Minister Campney said that an order has been placed, presumably for the **Velvet Glove,** but would not disclose to whom the order has been placed.

* * *

Helicopters flying from an Arctic patrol vessel of the Royal Canadian Navy have carried out a highly successful airlift operation in support of the DEW Line project in Canada's far north.

As a part of the DEW Line survey operations, it was necessary for the Labrador to set up a navigational control station on an Arctic island.



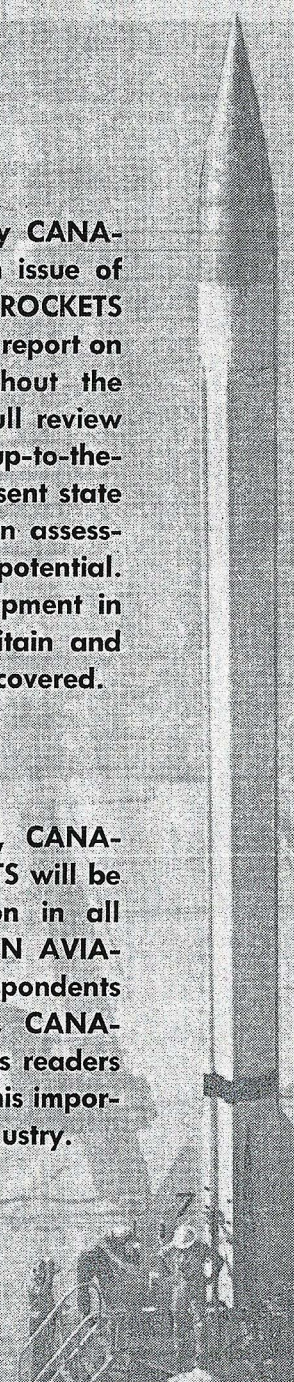
NEW DEMON: McDonnell's F3H-2N with large wings and Allison J71 with afterburner resulted in better performances.

MARCH 1958 ANNUAL

Canadian MISSILES and ROCKETS

Serving the Astronautics Industry

INCORPORATING A DIRECTORY OF SOURCES OF SUPPLY



To be published annually by CANADIAN AVIATION, the March issue of CANADIAN MISSILES AND ROCKETS will contain a comprehensive report on missile development throughout the world. Included will be a full review of Canadian projects, with up-to-the-minute evaluation of the present state of the art in Canada and an assessment of future development potential. Current research and development in the United States, Great Britain and other countries will be fully covered.

Commencing in April 1958, CANADIAN MISSILES AND ROCKETS will be carried as a regular section in all monthly issues of CANADIAN AVIATION. Through special correspondents and staff prepared articles, CANADIAN AVIATION will keep its readers abreast of developments in this important facet of the aviation industry.

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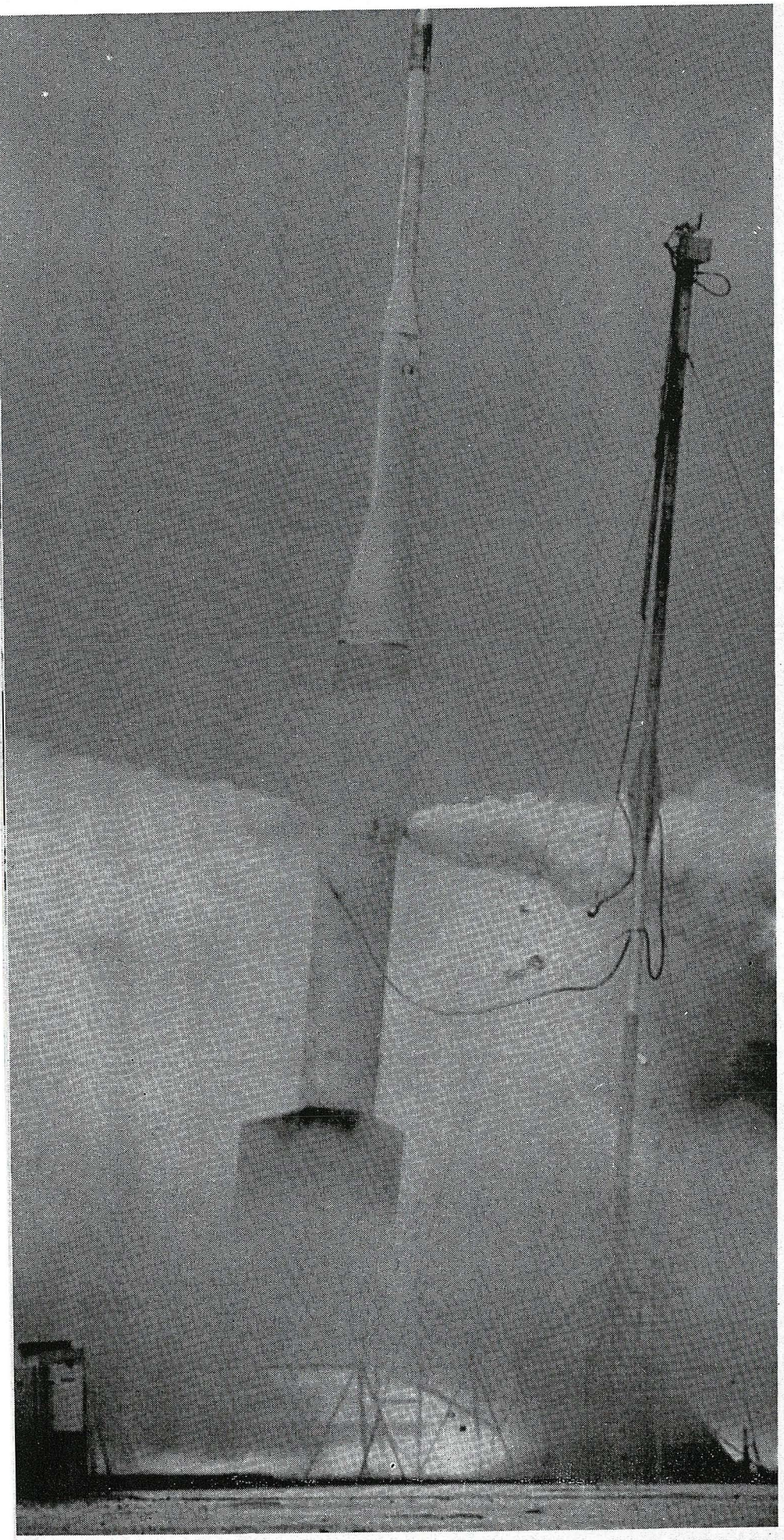

U.S. Bid

By Dick LaCoste

CAPE CANAVERAL, Florida—Activity is reaching fever heat on this sand-swept peninsula jutting out into the Atlantic on the east coast of Florida. Activity for peace—and for war. Activity for human survival.

For this is the home of the U. S. Air Force Missile Test Centre. The setting where weapons of the future are being checked, tested, tempered.

From here also, from a concrete launching pad set in the sand, the first artificial earth satellite, project Vanguard, will be rocketed into space.

Why has this innocuous mission taken on such signal significance? Simply because its launching paves the way for the most formidable weapon yet envisaged: the hydrogen-tipped intercontinental ballistic missile.

The pace has inevitably quickened. Competition between east and west to be first to launch an earth satellite is keen. Recent Soviet announcements of the launching of an intercontinental missile have added fuel to the fire. Indications are that Vanguard will be launched next month.

And Cape Canaveral has been closed to newsmen.

It was on July 29, 1955, that the White House announced the U. S. would attempt to launch an orbital artificial satellite. The announcement foreshadowed the era of the ICBM.

In fact, the launching of the unmanned orbital earth satellite is a mere forerunner of a later reconnaissance vehicle. Both are preliminary to the firing of the ICBM on its 5,500-6,000-mile aerial journey. Such a weapon could cross the Atlantic in 15 to 20 minutes—30 at most.

The Ultimate Weapon?

It has been labelled "the ultimate weapon." But miliary men don't consider the ICBM any more an ultimate weapon than was the first A-bomb or H-bomb, the airplane, machine gun, rifle, bow and arrow, or flinted bludgeon.

The day is fast dawning when the ICBMs will be in production and operational. Military men and scientists are now looking forward to defense against the 15,000-18,000 m.p.h. hydrogen-headed missile.

ICBM nose cones are tested on this X-17 research missile to probe heat problems of re-entering earth's atmosphere.

For Missile Supremacy

Maj. Gen. Bernard A. Schriever, the USAF's Air Research and Development Command ballistic missiles chief, stated on August 23 that defense against the ICBM is theoretically possible. In fact, the tall, slender, 47-year-old, German-born missileman underscored his awareness of the difficulties of the anti-missile problem. Further, he revealed that his organization contained an "anti-anti" section, hard at work on ways to circumvent the anti-ICBM.

Successful U. S. Launch

On August 23, general Schriever revealed that a three-stage ICBM solid rocket missile had traveled at 15,000 m.p.h. It was launched from ARDC's Cape Canaveral. The remark went almost unnoticed in the U. S. press.

Three days later, the daily press scrambled for more details when the Soviets claimed they had an ICBM that could "hit any spot on the globe."

The successful U. S. launch announced on August 23 followed a failure some two months earlier. On June 11, the giant-size Atlas prototype plummeted ignobly into the Atlantic after a launch from the Cape.

On that fatal morning of its first test firing, the big bullet had to be destroyed after soaring to an estimated 5,000-10,000 feet. Reports are that malfunctioning of the rocket motors caused the Atlas to oscillate after launch. When the range safety officer pushed the "destruct" button, the 95-foot missile wavered like a winged bird, then plunged into the Atlantic.

U. S. scientists and engineers are running a race against time. What they are seeking is a technological breakthrough to produce a **practical** ICBM —**first.**

But they are worried.

On August 26, the Soviets announced they had fired a "multi-stage ballistic missile" which "covered a huge distance in a brief time" and "had landed in the target area."

"Crash" Development

Let's consider the five thermonuclear weapons that have been placed on a "crash" basis by the U. S. Two are ICBMs—Atlas and Titan, both Air Force weapons. Other three are intermediate range ballistic missiles (IRBMs). Thor belonging to the Air Force; Jupiter (Army) and Polaris (Navy). As of September, the U. S. ICBM effort centres around three projects. But only one of them is a true ballistic missile—the Atlas.

U. S. and Canadian scientists and engineers are running a race against time. They are seeking to produce a practical intercontinental 5-6000-mile ballistic missile — first.

Indications are that the Russians will have the ICBM early in 1960, or before. Strength was added to this belief by the reports last month of successful Russian launching of an ICBM.

Western hopes are pinned on two thermonuclear ICBM weapons being developed by the U. S. on a "crash" basis, Atlas and Titan.

Atlas towers something under 95 feet from its concrete launching pad at Cape Canaveral. Gross take-off weight is from 100 to 120 tons. It will, like its predecessor the earth satellite, lift almost straight in the air, slowly at first, like an elevator. At about 20 miles, a servomechanism detaches the first unit of the three-stage rocket and the second-stage unit takes over.

Some time before the big bullet reaches 300 miles above the earth, the second-stage jettisons and the payload —or warhead—is naked and exposed. Estimated at about 30 feet in length and some four feet in diameter, the warhead skyrockets upward to its 600-800-mile apogee. Then, traveling at about 18,000 m.p.h., it re-enters the earth's atmosphere and, like a catastropic meteor, bursts over the target.

Scientists say we will literally have arrived at the age of push-button warfare when the Atlas becomes fully operational. Then the problem will be the anti-missile missile, the anti-anti missile missile, et cetera, et cetera!

Counting The Cost

Twelve years in the making, Atlas had cost more than $500-million when the last figures were released January, 1957. More than 100,000 persons—including the nation's top scientists, chemists, engineers and technicians—are devoting full time to the project. As many as 100 test versions may be launched from the Cape.

After the original costs are redlined, each Atlas, minus the blunt-shaped, ceramics, thermonuclear - tipped warhead, will cost about $1-million.

Designers are setting their sights on accuracy at two-tenths of one per cent. For an ICBM traveling a distance of 5,500 miles, that means coming within ten miles of the target.

ICBMs like the Atlas are not considered true guided missiles. They are pre-set. Guidance data is fed into the weapon before takeoff. Theoretically, it will travel on a predetermined course in a set direction for a set distance. Then it will explode. Such a missile, naturally, cannot be radar-guided.

In order to get distance out of an ICBM, it must be fired high into the atmosphere. As the rocket gets high into space, there is no possibility of control because the control surfaces have no air to push against.

Slower, jet-propelled missiles **can** be controlled to a lareg extent. Their mechanism can check their course periodically by the stars. Errors then can be corrected.

The direction of the stars is fixed in space. In the jet-propelled type of missile, a gyrocompass controls the missile's direction. The gyro takes automatic readings of the positions of the stars. But gyros have a tendency to drift off their original settings after a while. A reading of the star sights

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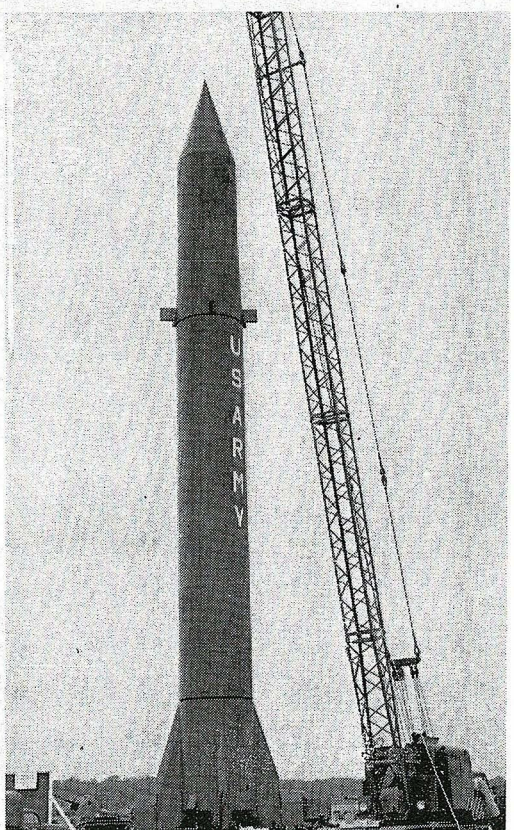
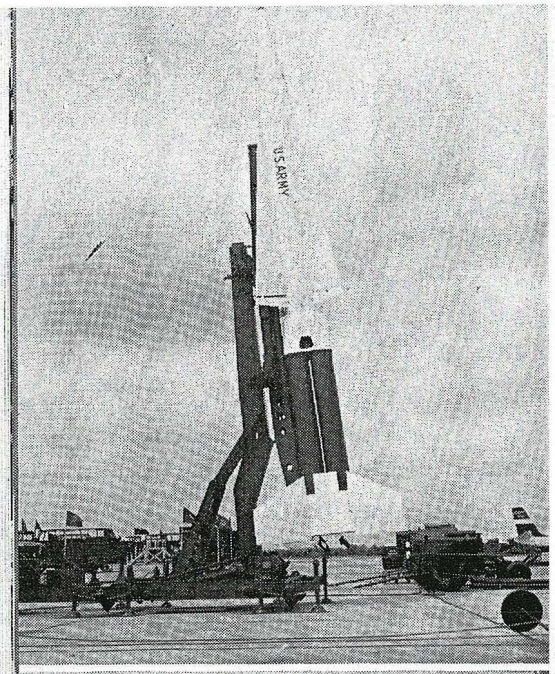
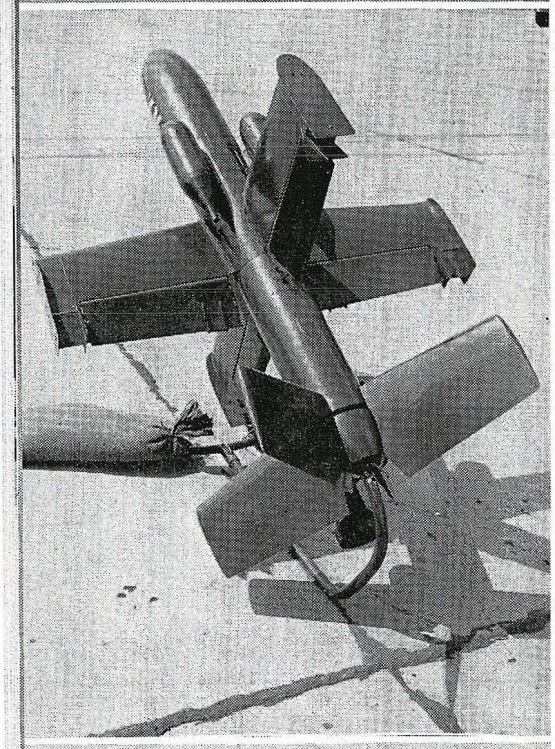
POISED below is the U. S. Army's Redstone surface to surface missile, which is now in production. Range: 300 miles.







corrects this and turns the missile on course.

One shortcoming is that the celestial system will not work on cloudy nights. Scientists are attempting to perfect a mechanism that can be guided from time to time without checking on the stars. Then, when the missile breaks through the clouds, the course can be checked and corrections made.

Decisive Atlas

The fact that Atlas has no guidance mechanism means that it cannot be sidetracked or befuddled by electronics. Married to a hydrogen warhead it speeds to targets more than 5,000 miles away, and strikes within 10-20 miles of a pinpointed target. These facts make it temporarily a truly decisive weapon.

The 10-20-mile margin of error matters little. Destruction would be complete.

Little has been heard lately of the Titan ICBM. This tandem, two-stage, long-range missile will also mount a hydrogen warhead. The Martin Company, prime contractor, is completing manufacturing facilities at Denver, Colorado. The company received an initial contract of $358-million for the project.

Titan is a more sophisticated missile than its bigger brother, the Atlas. Although well advanced, the Titan is about one year behind the Atlas.

Late in 1955, the USAF decided to develop the Thor IRBM on a "crash" basis. Douglas Airplane Co. was awarded a contract for $67.5 million. The U. S. Navy joined forces with the army in working on the Jupiter IRBM. Missilemen believe that the U. S. Department of Defense will evaluate both IRBMs, then give genesis late this year to another weapon incorporating the best features of both.

Both missiles were fired from the Cape late in August. Army stated after firing Jupiter that it could go into production in 30 days.

The surface-to-air Nike is the U. S. Army's first supersonic anti-aircraft guided missile designed to intercept and destroy enemy targets regardless of evasive action. Two versions are in operation, the Nike-Ajax and the Nike-Hercules. The Hercules has about three times the range of Ajax. Both are expected eventually to be atomic-equipped.

U. S. Army and Air Force are competing for ICBM defense responsibility. Army has developed Nike-Zeus, a 100-200 mile anti-ICBM missile contracted by Douglas and Bell Laboratories. Air Force has countered with Wizard, reported to be a more sophisticated weapon with long-range possibilities. Conflict will be settled by the Pentagon's Weapon System Evaluation Group.

For the destruction of low-flying aircraft and short-range missiles, the Army has developed the Hawk surface-to-air missile. Some 16 feet long and only 14 inches in diameter, the Hawk is deployed on a triple launcher. With this arrangement, three weapons can be fired in rapid order against low-flying aircraft or tactical missiles. Prime contractor for the Hawk, which is in the final development stage, is Raytheon Manufacturing Company.

Hawk will be installed first at sites in the Baltimore-Washington and New York City areas. The missile will likely replace, or at least complement, the Nike chain of defenses. Highly supersonic, Hawk has a range of 15 or more miles slant trajectory.

Shaping up as two of the Army's best small surface-to-surface missiles to replace artillery are Dart and Lacrosse. Dart is a tank buster only five feet long and 8 inches in diameter. Guidance is by a wire control system. Impulses fed through the trailing wire direct the weapon to target with a high degree of accuracy and at a speed of well over 900 feet per second.

The Dart is in production and should be operational soon.

Lacrosse measures 20 feet in length with a diameter of 20½ inches. An all-weather missile, it is in quantity production by the Martin Company. It is designed to destroy enemy strongpoints in the field, supplementing air and artillery attack. Is launched from a standard Army truck. Range is estimated to be about 15-20 miles.

Army Heavyweight

Honest John is heavyweight among the Army's surface-to-surface missiles. Weighs 6,000 pounds and is 27 feet long with a diameter of 30 inches. An anemometer measures velocity of surface winds that affect the initial flight of the missile. The launcher is again mounted on the chassis of a standard Army truck. Range is 30 miles.

Little John, small brother to Honest John, is only 12 feet long with a diameter of 12 inches. Stressing high mobility, the little rocket is the ideal atomic missile for the airborne infantryman.

A possible successor to the U. S. Army's 100-mile Corporal is the 75-mile Sergeant tactical missile.

FOR THE ARMY: Nike Hercules ground to air missile at top has range of about 70 miles. Centre: Dart anti-tank missile. Below: the Lacrosse surface to surface weapon with a range of 15 to 20 miles.

Last fall, army fired a three-stage improved Redstone that skyrocketed a 150-pound warhead 600 miles high and 3,400 miles from launch. The vehicle was experimental and unguided but is now in production.

The U.S. Navy bullpup air-to-surface tactical missile is designed for light attack aircraft. Featuring movable canard control surfaces, the 11-foot, 600-pound, solid-propellant rocket is being produced at Martin's Orlando, Florida plant.

Dual Sidewinder

Originally a Navy missile, the Sidewinder will also be assigned to the "F" series of Air Force aircraft. It is already in operational use by the Western Pacific fleet. An infrared homing missile, the 9-foot Sidewinder is reported to have a 7 to 10 "kill" ratio.

Two other operational Navy missiles are the Zuni and Sparrow 1. The former is a combination air-to-air and air-to-surface weapon and is attached to fighter aircraft wings in clusters of four. At least five models of the Sparrow are in existence. Both Atlantic and Pacific fleets are, or soon will be, armed with this supersonic anti-aircraft and anti-missile missile.

The Navy ramjet-powered Talos can be launched against enemy ships and land targets, and also functions in an interceptor role. Already in use on one cruiser, the beam-riding Talos can be fitted with either conventional or nuclear warheads.

The air force has perhaps the most deadly short-range missile of all, the new infrared-guided Hughes Falcon GAR-2A. This has destroyed a score of Matadors, from five to seven QF80 drone fighters, a few drone bombers, and many balloons and parachutes. It is 6½ feet long, 6½ inches in diameter and weighs a little more than 120 pounds.

The supersonic Falcon is being used on the Convair F-102 and McDonnell F-101B interceptors. It can be fired singly or in clusters of up to six at a distance of more than five miles to target.

Boeing's Bomarc is scheduled to be one of the Air Defense Command's most important long-range supersonic watchdogs. Capable of reaching Mach 2.5 and an altitude of 60,000 feet, the 200-mile missile is homed to target by ground radar. It is now scheduled for mass production.

Rascal For Hustler

Bell's GAM-63 Rascal, a rocket-powered air-to-surface guided canard-configurated missile, is due to be assigned to Strategic Air Command's B-47 manned bomber squadrons this month. Can also be carried by the supersonic B-58 Hustler and aboard the B-52.

But the air force recently announced a multi-million dollar contract to North American Aviation, Inc., Los Angeles for a yet unnamed long-range air-to-surface missile to be launched from intercontinental bombers, supposedly to replace Rascal.

Martin's Matador is scheduled to replace manned bombers in certain areas. It was the first land-based type of missile to become operational overseas. Several squadrons are deployed in Germany. The pilotless jet Matador can carry an atomic warhead about 500 miles.

In less than a year, Northrop's SM-62 Snark intercontinental pilotless bomber is scheduled to be assigned to SAC.

Designed for a range of about 5,000 miles, the 69-foot long, 42-foot wingspan Snark heads for the target at just subsonic speed. Snark won the Air Force nod over the Navajo. Latter has been canceled.

The operational Douglas MB-1 spells out new "kill" capabilities for the F-106A fighters of U. S. Air Defense Command. Now known as the Genie, the air-to-air atomic-warheaded missile was fire-tested from an F-89J Scorpion last July.

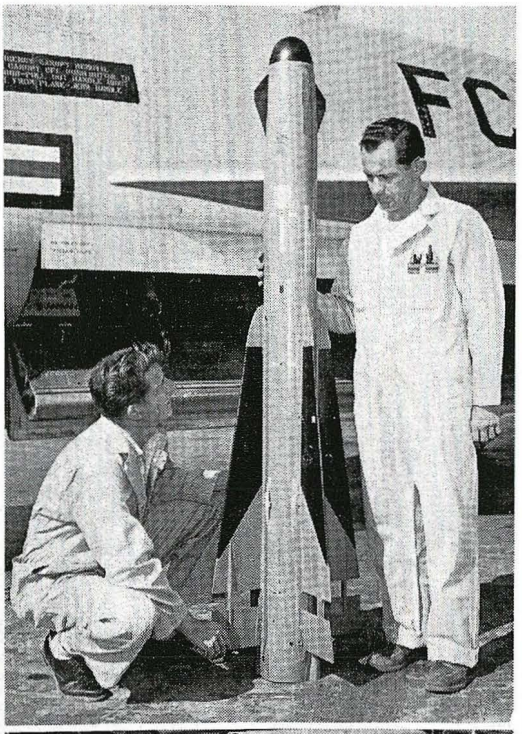
New air-to-air missile in the development and production stage is the Fairchild Goose. This is a diversionary drone. Launched from the B-52 or the Hustler, it is designed as a decoy to attract intercepting enemy planes or missiles away from the bomber strike force. It is about 20 feet long with a span of 13 feet, and will have a velocity of Mach 1.25.

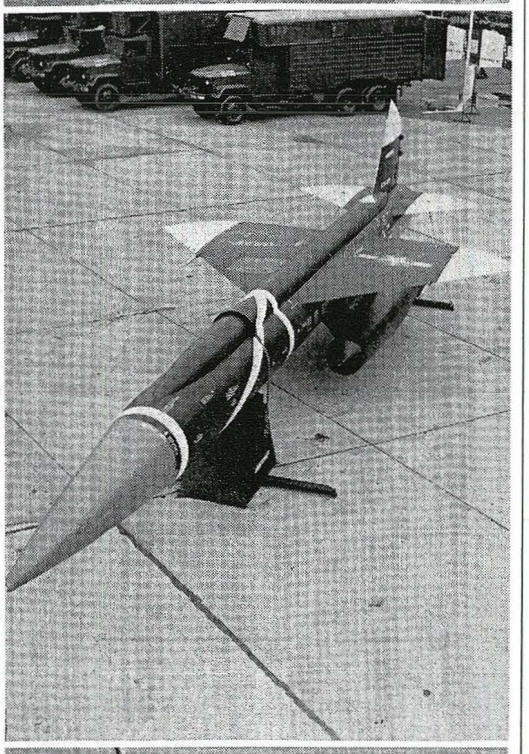
All in all, U. S. military men feel they're in good shape should an enemy strike. They're convinced of their own air supremacy. But no one will comment on how long this supremacy may last.

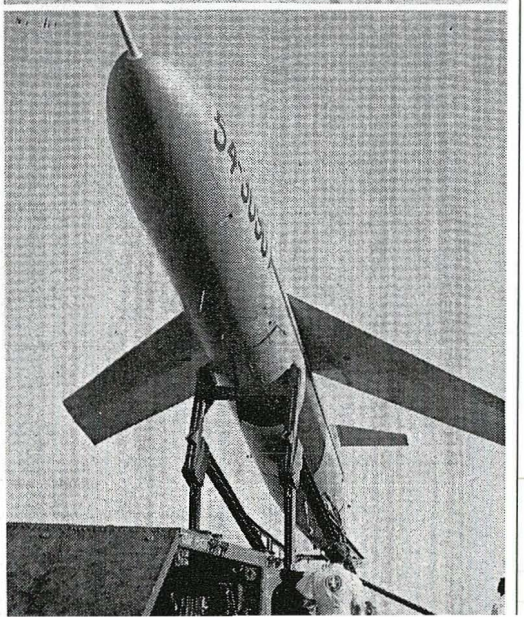
Time for defense must be calculated by Canada and the U. S. not in months or weeks or days—but in hours, even minutes.

Nuclear attack upon either would bring swift retaliation. The entire family of missiles would be launched—including Atlas in whatever shape it might be at the time.

The missile race is indeed a race for human survival.

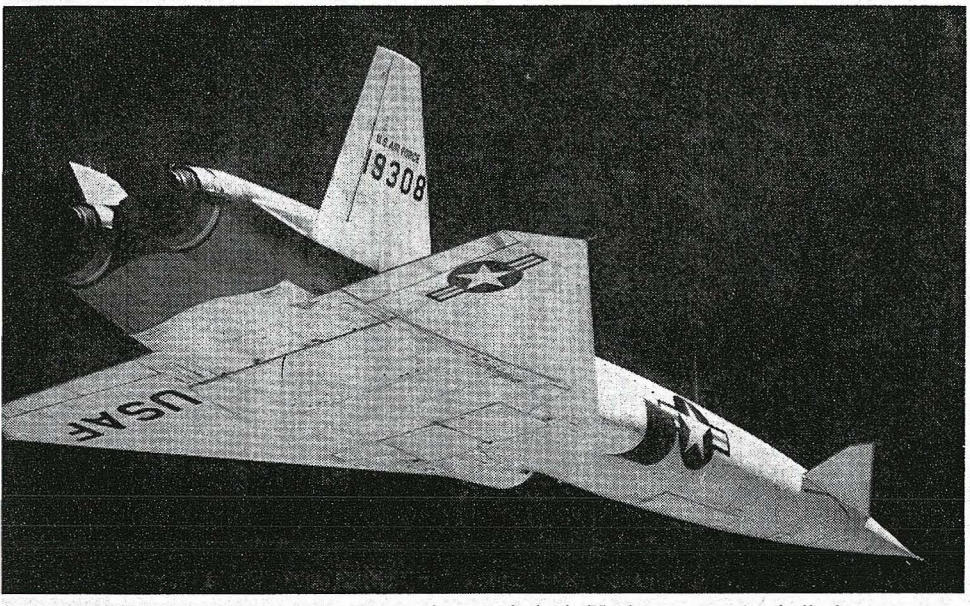






FOR THE USAF: Falcon air to air missile is at the top. Centre: Mach 2.5 Bomarc pilotless interceptor. Below: Matador surface to surface missile.

UAV ?



RECOVERABLE. North American Aviation's X-10 unmanned missile has a retractable landing gear and can be recovered for repeated use. Twin jets provide the power.

Boeing Expansion

Estimated cost of the Boeing Airplane Company's three-year plant expansion program is up to about $100 million. Earlier quotations were $73 and $90 million.

Metal Bonding

During 1956 the use of structural adhesives increased by more than 200 per cent in the U. S. This type of bonding is used widely in the construction of high speed aircraft and missiles.

DC-7C From Montreal

BOAC recently held a DC-7C demonstration flight from Malton Airport, Toronto. Flight celebrated the introduction of the DC-7C on their Montreal/London, England, route, commencing May 4. The aircraft is able to fly the route non-stop in either direction. With a maximum cruising speed of 365 mph., it is claimed to be the fastest commercial plane in use on the North Atlantic routes. Scheduled time from Montreal to London is 10 hr. 15 min.

DC-7C is equipped with weather-mapping radar. Pilot can observe conditions up to 150 miles ahead of the aircraft. As reported previously in Canadian Aviation, a DC-7C set up a trans-Atlantic record on January 31 this year. It flew from New York to London in 8 hr. 26 min., fastest time for a commercial airliner.

Last RAF Lancaster

The last RAF Lancaster went out of service recently. The machine had been used for some time by Eagle Aircraft Services Ltd. on behalf of the Air Ministry. Its duties were chiefly aerial photography, both still and movie, for experimental, research and publicity purposes. Lancasters are still in service with the RCAF on maritime reconnaissance.

Point Petre Range

Canada evaluates missiles, rockets

By Michael Helier

Canadian interest in rockets and missiles is on the up—to the tune of several hundred thousand dollars worth of equipment sunk into the hitherto top secret testing range at Point Petre, Ontario.

Government scientists and engineers who conducted newsmen around the range in its first public viewing recently, carefully parried questions about the Velvet Glove and Sparrow guided missiles. But they did go so far as to confide that Velvet Glove, Ottawa's $24,000,000 white elephant discarded as an air-to-air missile for the RCAF when it decided it was out of date, had not been entirely dropped. Research work was still going on and data compiled would be used in assessing foreign missiles in which Canada may be interested.

▸ **Top Secret.** Sparrow though was still strictly top secret and only the vaguest references were made to it. The impression was that much of the testing at Point Petre was being applied to the Sparrow.

R. F. Chinnick, a senior government engineer, speaking as frankly as he could under his security veil, said:

"When Canada purchases a guided missile from another nation we have to test it very thoroughly and measure its trajection, deviation, thrust speed and other factors against what we have already established.

"Our research also covers possible modifications to weapons for the Canadian services. An air-to-air guided missile from the U. S. (as the Sparrow is) may well have to have different mountings for RCAF planes. A different position could affect the rocket's effectiveness. Climatic conditions and effect on equipment are also tested and charted here."

The data compiling equipment at the range, which can only be estimated as worth "several hundred thousand dollars," was laid out for as detailed inspection as anyone cared to give it.

▸ **Tracking Radar.** The No. 1 item, the existence of which until a few weeks ago was known only to a very few people, was the MPQ-18 precision tracking radar, valued at $500,000. It has a maximum range of 230 miles and can track an approaching guided missile coming in at between 2,000 and 3,000 miles an hour. In demonstration the set picked up a bird flying 2½ miles out over Lake Ontario, and a wave flickering four miles away.

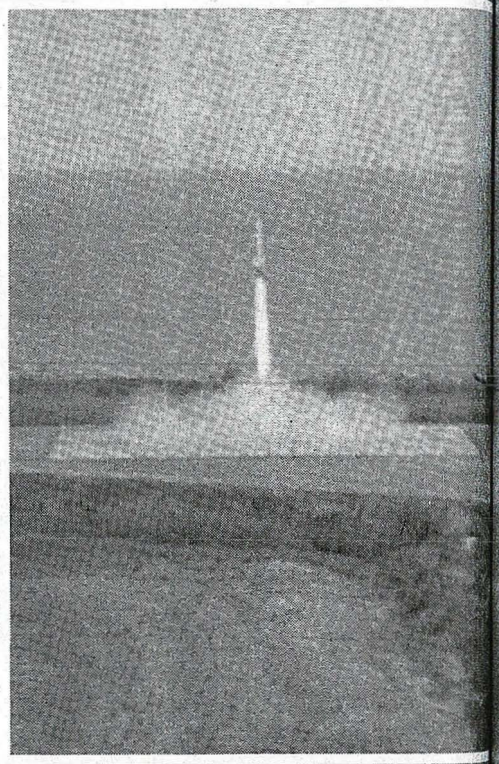
A data display rack near the MPQ-18 photographed the radar findings and recorded the exact time and date at the rate of twenty 35mm frames a second.

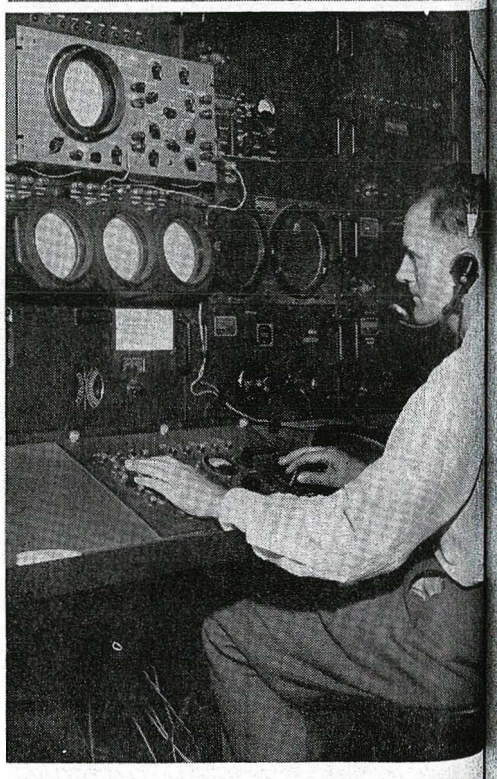
Sound signals given off from a test rocket in flight are picked up, translated and recorded on a telemetry ground station. The signals detail stress, temperature and acceleration.

▸ **Army Development.** The station is a new device developed and constructed by the Canadian Army Research Developmental Establishment at Valcartier, Que. The sound waves are collected from a two-inch piece of steel and are fed into a machine on the rocket. The machine transfers them into electrical waves which are transmitted back to the station.

An experimental missile was fired from the range's mobile launching platform. It was strictly a show deal and engineers confided later that the missile was really "only a child's overgrown skyrocket," costing about $250 and measuring a mere 12 feet in length. It climbed 7,000 feet into the sky at the rate of 1,500 feet per second.

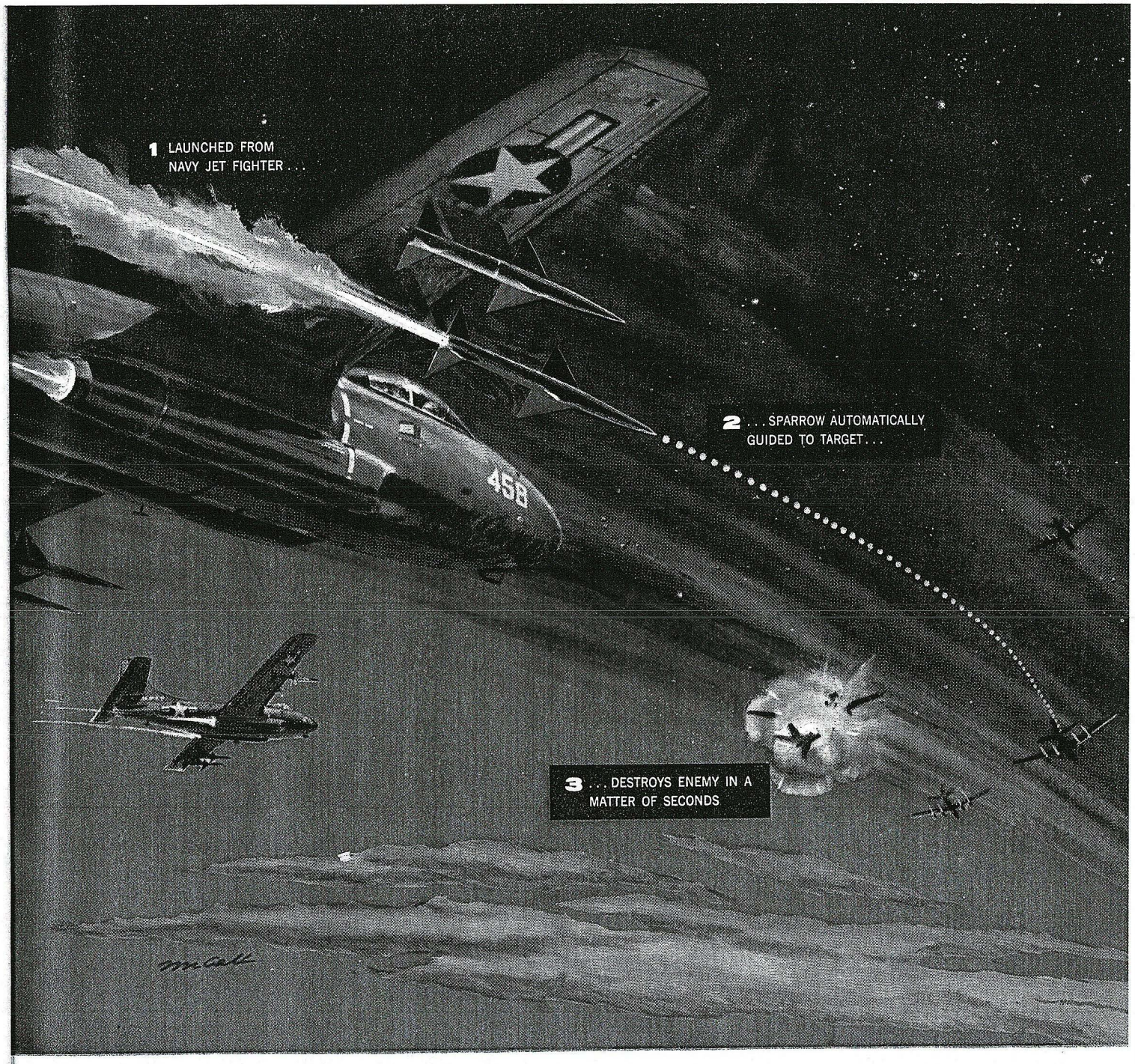
Although not very significant as a missile, it was the first rocket firing at Point Petre witnessed by persons not holding a high security clearance.





ROCKET RANGE. Unveiled recently for newsmen, the hitherto secret rocket range at Pointe Petre, Ont., is being used by Canadian scientists to evaluate guided missiles which may be built in this country. Top, a demonstration rocket is set up on the mobile launching platform. Centre, from a distance the "overgrown skyrocket" looks like the real thing. Bottom, $500,000 worth of precision radar tracking gear, capable of picking up a missile travelling thousands of miles an hour.

Oct 1956



Carrier Based Jets to have Radar Guided Missiles

NAVY'S AIR-TO-AIR SPARROW 1 IN PRODUCTION

THE STORY BEHIND THE STORY:

■ On May 12, newspapers from coast to coast carried headlines like the ones above, announcing the Navy's newest weapon of defense—Sparrow I—and the beginning of volume production for operational use in the fleets.

■ Ahead of these headlines were 7 years of intensive cooperative effort shared by the Navy's Bureau of Aeronautics and Sperry.

■ Originally designated project HOT SHOT, Sparrow began back in 1947 when the Bureau of Aeronautics assigned to Sperry the full responsibility of creating an entirely new air-to-air missile system. It had to be light and compact – so multiple units could be carried by fighter-type jets. It had to be deadly accurate – capable of outmaneuvering the swiftest bombers an enemy could produce. And it had to be practical—suitable for large-scale production.

■ The rocket-powered, radar-guided Sparrow I, coming off the production lines here and at the new Sperry Farragut plant in Bristol, Tennessee, meets these requirements—and more. It embodies the proved features of more than 100 different missiles designed, constructed and tested during a 7-year period – and the finest brains of an organization that has devoted more than 40 years creating and manufacturing automatic flight control and fire control systems.

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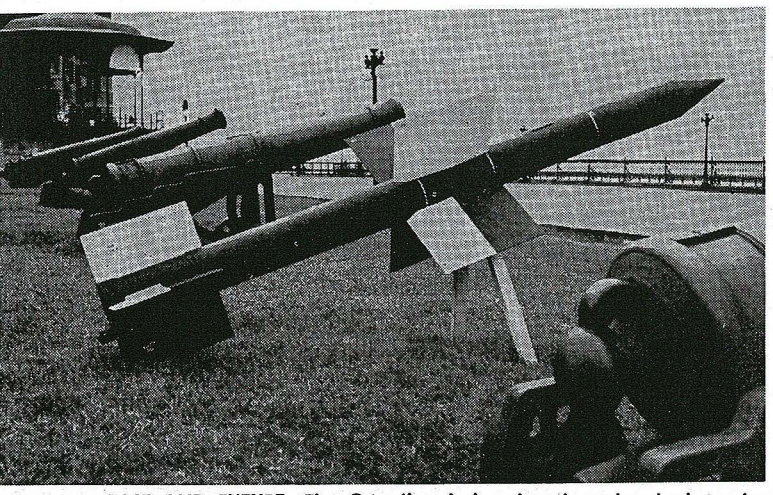

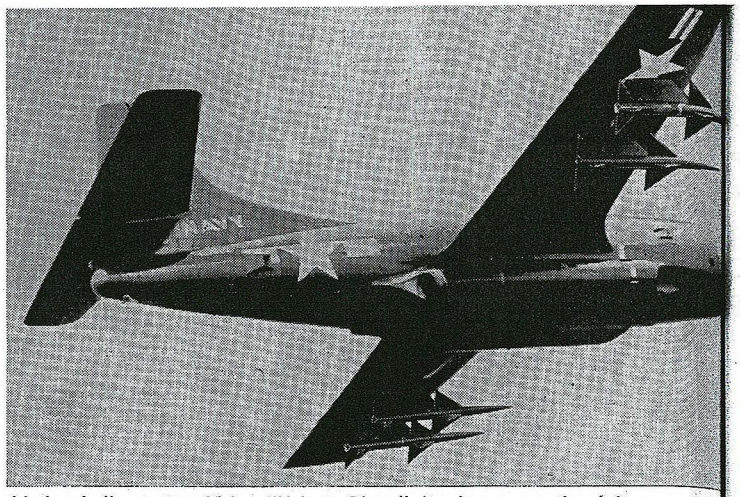

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July 56

Missiles

(Continued from page 76)

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- Other firms, such as Avro Aircraft, de Havilland Aircraft, Fairy Aviation, Computing Devices of Canada, etc., have experience in various fields of the design and test of components—and there are many other small firms anxiously awaiting the starter's gun.

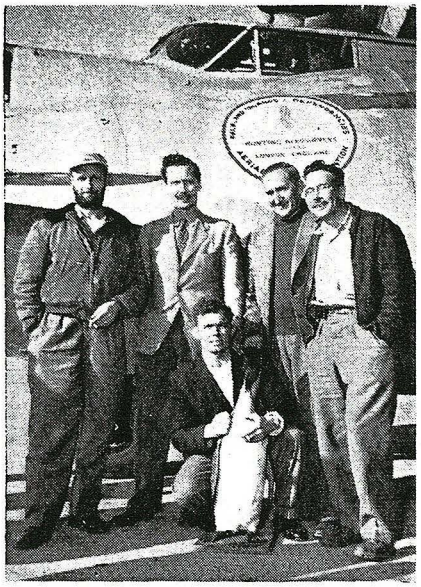
This year Canada is increasing spending on missiles from $52,000,000 to $79,000,000. Much as this may seem, the United States is now spending more on missiles than Canada has for her entire Defence Budget.

This is the future.

* * *

Battle Surveillance

A system which will permit battlefield surveillance up to 200 miles behind enemy lines is said to be under development by the U. S. Army. The surveillance units would be all-weather drones.



BACK from the Antarctic are photographic Survey Canso crew, left to right, Jim Greenshields, pilot, Oshawa, Harry Lewis, navigator, England; Lew Terry, 2nd pilot, Toronto; George Burwell, England; Mike Mugford, engineer, Toronto.

Missile Master

The U. S. Army recently took the wraps off the first electronic system designed specifically to control and co-ordinate use of Nike anti-aircraft missile batteries and other advanced weapons.

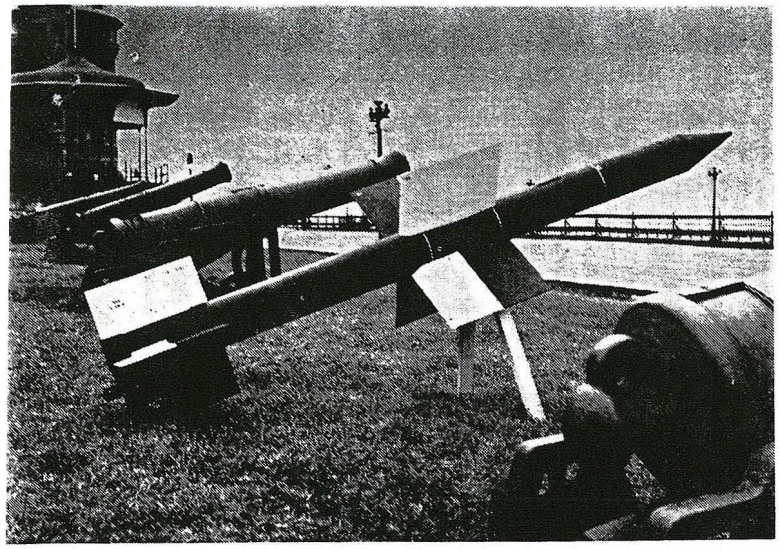
Designated the Missile Master, the system is the product of research and development by the Martin Company and the Army.

Work on this type of system was started in 1945. By 1950 a forerunner of the present unit had been designed.

Missile Master is said to tie together all elements of anti-aircraft missile defense from target detection to target destruction. Each system consists primarily of an automatic data communications network, and of automatic data processing and display equipment.

Army officials say that experiments with the system at Ford Meade, and other related tests and investigations, have amply demonstrated the ability of Missile Master to co-ordinate and control a large number of anti-aircraft batteries more effectively than ever before against a large number of aerial targets.

With the approach of hostile targets, identity and other information on targets begins coming in and is displayed on the various radar consoles in the Operations Centre and at the batteries.



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- Canadian Westinghouse provides an experienced and well recognized original design and quantity-manufacturing group covering electronics.
- Other firms, such as Avro Aircraft, de Havilland Aircraft, Fairy Aviation, Computing Devices of Canada, etc., have experience in various fields of the design and test of components—and there are many other small firms anxiously awaiting the starter's gun.

This year Canada is increasing spending on missiles from $52,000,000 to $79,000,000. Much as this may seem, the United States is now spending more on missiles than Canada has for her entire Defence Budget.

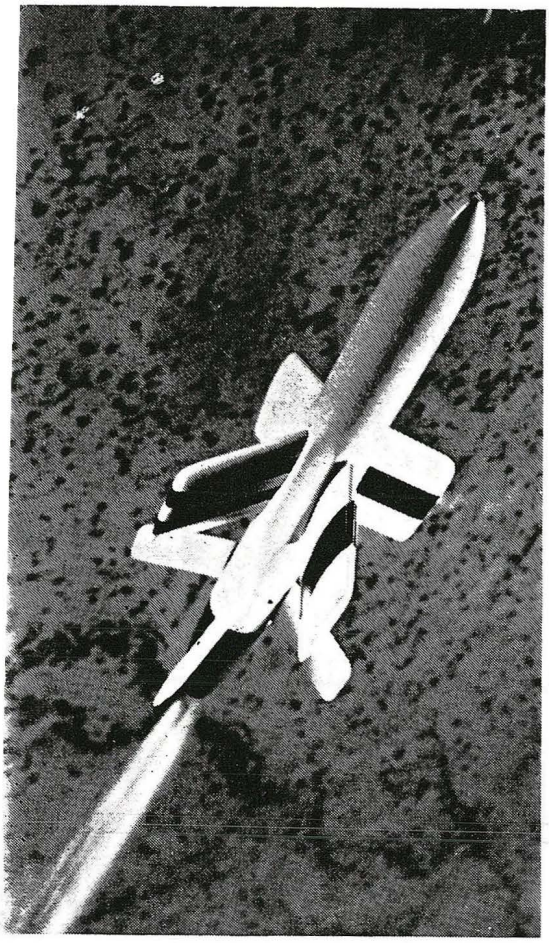
This is the future.

* * *

Battle Surveillance

A system which will permit battlefield surveillance up to 200 miles behind enemy lines is said to be under development by the U. S. Army. The surveillance units would be all-weather drones.

CANADIAN AVIATION NOV 1951



ROCKET REALITIES

WITH A SEVEN-CENTURY HISTORY AND A FANTASTIC FUTURE ROCKET EXPERIMENT IS A TOP PRIORITY PROJECT TODAY

By NORMAN S. CURREY, R.Ae.S.

THE first rocket-propelled aircraft was produced and flown by the Germans in 1940, an event which heralded the present era of rocket flight. Few realize, however, that rockets were being used more than seven centuries ago. In the year 1200 the Chinese had developed rocket-driven arrows. In the early 19th century the British were experimenting with solid-fuel rockets but these trials were abandoned when they failed to achieve accuracy and control.

Experiments in rocketry were conducted in various countries between the Napoleonic and second world wars but with no great success. Thus it was not until 1940 that the rocket began to achieve major importance.

There are many applications of rocket-power today, apart from that most commonly referred to—that of powering passenger- or pilot-carrying aircraft. They are, for instance, being used to propel a wide variety of missiles (surface to surface, surface to air, air to surface, or air to air), to give superperformance to conventional aircraft at high altitude, to rotate helicopter blades, to supply additional take-off power to large aircraft operating from short, high altitude, or hot runways, and so on.

The Bell X-1 is a typical example of an aircraft propelled purely by rocket power and already has allowed man to travel through the air at almost 1½ times the speed of sound.

It was conceived early in 1945, and made its first flight (under its own power) at Muroc Flight Test Base, California, on Dec. 9, 1946, after having been carried to altitude and dropped from a Boeing B-29 superfortress. Then on Jan. 5, 1949, it took off under its own power for the first time, and climbed to 23,000 ft. in 100 seconds!

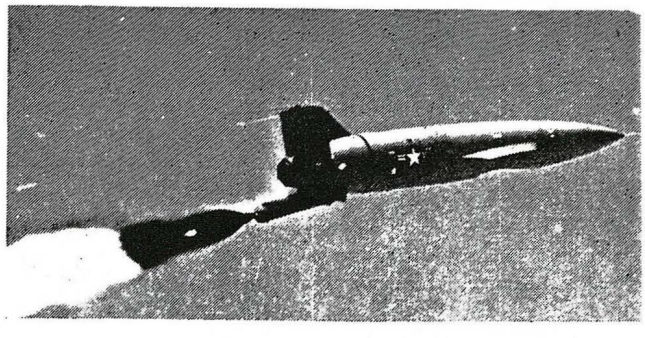
The present guided missile program makes great use of rocket power. In the United States today one may find almost every conceivable form of guided missile. There is, for instance, the "Lark," developed by the Fairchild Engine and Airplane Corp. This missile is now in quantity production for the U. S. Navy and incorporates a device which automatically guides it toward an enemy aircraft. The reliability and advanced stage of development of this rocket is proved by the fact that more than 100 hundred experimental vehicles have been fired.

The "Lark" is 14 ft. 5 in. long, and controls its flight-path by means of tail-vanes — these, incidentally, like the nose of the rocket, are made from Fiberglas, a plastic material consisting of a woven glass fibre mat impregnated with resin.

It is powered by a bi-fuel two-motor rocket using red fuming nitric acid and aniline. These are fed to the motors by means of compressed air.

For take-off, two standard JATO units are used (similar to those used on conventional aircraft), and these

ABOVE—A model of the Ryan Firebird air-to-air guided missile, a rocket-propelled fragmentation shell which "homes in" on its target by means of a radar navigational system. Actual firing tests have recently been completed in New Mexico. This missile is launched from a fighter plane and it then homes on the enemy aircraft. Initial propulsion is supplied by a booster section of the rocket which separates from the missile when expended. Flight rockets supply the force necessary for the remainder of the powered flight.



A Martin Matador pilotless bomber takes off with smoke and flame spewing from its auxiliary rocket. The first USAF squadron of these has been activated.

are jettisoned. The "main" motor then propels the rocket, the "auxiliary" motor only being used to supply extra thrust for manoeuvring.

The GAPA (Ground-to-Air Pilotless Aircraft) is a guided missile developed by Boeing. The few details available tell us that with an all-up-weight of 5,000 lb. including a 200-lb. warhead, it can fly at 2½ times the speed of sound.

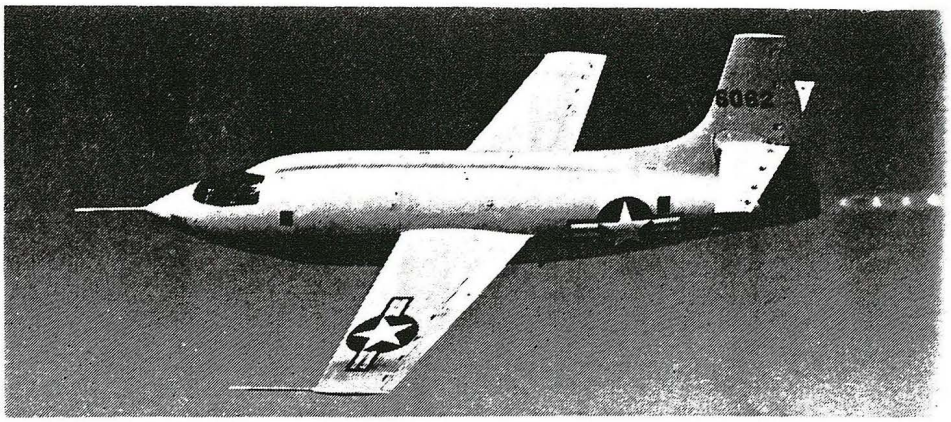
Among the so-called "air-to-air" missiles there is the "Mighty Mouse," a three-inch-diameter solid-fuel rocket, developed by the Naval Ordnance Test Station at Inyokern, Calif. The rockets are fired from an aircraft at the enemy planes, and are unguided, incorporating proximity fuses—allowing them to explode when near the enemy if they don't actually hit. The "Mighty Mouses," or perhaps "Mighty Mice," are carried in quantity by the parent aircraft and are reported to be powerful enough to destroy any known bomber with a single hit.

Another type of air-to-air missile is the rocket-propelled Ryan "Firebird," a missile which is radar-guided by the parent aircraft, and then, when near the target, will automatically direct itself toward it. If the target should be missed the rocket explodes automatically and so eliminates the possibility of damaging friendly aircraft or territory.

This rocket, developed by the Ryan Aeronautical Co. for the USAF, incorporating a bi-fuel rocket unit, is 10 ft. long and six inches in diameter.

The air-to-surface rockets; that is, those fired by aircraft at targets on the ground, can be dismissed quite rapidly, as they are usually pure and simple solid-fuel rockets of conventional design, with a warhead in the nose.

The so-called ATO units are merely units which are incorporated in present-day aircraft to allow them to take off quicker than they would otherwise. They may take the form of a battery of solid-fuel rockets, as were used on the Boeing XB-47 Stratojet, or they may be single liquid-fuel rockets, such as the de Havilland "Sprite" a unit designed originally to assist the de Havilland "Comet" jet airliner to take off from hot, high-altitude runways.



ABOVE—The Bell XS-1 rocket-propelled aircraft.

All modern rockets are operated by either solid or liquid propellants. Even the atomic power plants for rockets of the not-too-distant future differ little from the conventional liquid propellant—but more of this later.

The solid-fuel rockets derive their propulsive power through the burning of a powder; they are, in fact, large-scale versions of those used in popular fireworks.

Liquid propellants have been developed in comparatively recent years and are used in either mono-propellant or bi-propellant systems.

Typical combinations of fuel and oxidizer in use today are alcohol-liquid oxygen, gasoline-nitric acid, and aniline-nitric acid. Hydrogen peroxide is used as a liquid mono-propellant and produces thrust as a result of its decomposition.

A very common attitude found today on the subject of rocket propulsion is: "It all sounds very futuristic, but I can't see what advantages it has over present-day jet propulsion, other than speed; and surely it is far more dangerous and more expensive."

This argument is not, however, in keeping with the facts brought to light by exhaustive experiments on rockets. There are many advantages other than speed, and they seem to be quite safe.

For instance, the speed, rate of climb, and the height to which they can travel are only dependent upon the amount of rocket propellant—liquid or solid—that is carried.

The size of the complete power unit is small compared with that of any other type of power plant giving the same thrust. The fuselage (or rocket shell) can therefore be quite slender.

The weight of the complete power unit is far less than that of a comparable conventional engine.

No air intakes are required. These have always been a controversial issue in present-day aircraft design.

The thrust does not change with altitude as it does with internal combustion engine, and jet engine systems.

The operating costs should actually be less than those encountered today, when increased speed, lower engine weight, easier engine maintenance, lower initial cost, and simpler surrounding aircraft structure are taken into account.

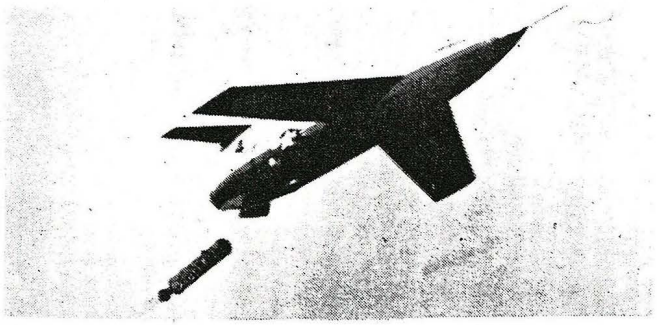
What can be said of the rockets of tomorrow?

That they will be automatically propelled is a certainty. The NEPA (Nuclear Energy for the Propulsion of Aircraft) in the U. S. has been studying such possibilities for some time now, and methods of propelling rockets by atomic power have been established. The power plant would be even simpler than those used in present rockets and would have far greater potentialities.

Basically, all that would be required in an atomic-powered rocket motor would be a tank of liquid hydrogen which would be pumped through an atomic reactor, or pile, where it would be vaporized and heated to a high temperature before escaping through the exhaust nozzle.

With this type of rocket we could think seriously of space travel.

Coming down to earth then, we can see that rockets are indeed a reality today, and have tremendous potentialities for tomorrow. Space travel is not exactly round the corner, but it is at least in sight.



After the auxiliary rocket has expended its thrust it drops automatically and the Matador pilotless bomber continues on its way. Known as the B-61, it is in production at the Martin plant, Baltimore.

Nike-Hercules

At the present time the U.S. Army's Nike Ajax missiles ring the country's major cities. In the near future the second generation of this weapons family, the Nike Hercules, will be intergrated into the continental air defence system to give the North American Air Defence Command a surface-to-air missile capable of employing a nuclear warhead.

Hercules, which at first will be teamed with the Nike Ajax and is destined to phase out the earlier missile, is larger, swifter, and a more lethal weapon which is capable of destroying entire formations of bombers at several times the range of its predecessor.

British Ramjet

A ramjet test vehicle launched at the Royal Aircraft Establishment's rocket range at Aberporth, North Wales, by the National Gas Turbine Establishment, reached an altitude of 70,000 feet in 40 seconds. It was powered by eight solid fuel rocket motors, and reached a speed of Mach 2.3. When its fuel was exhausted at 70,000 feet, it coasted to an altitude of 114,000 feet before being destroyed for reasons of range safety.

This launch was the most recent of a number which have been made with ramjet test vehicles designed and developed jointly by the NGTE and D. Napier & Son Ltd. The vehicle was an improved version of the one which set up a height record for its class two years ago.

More Firebees

A new $6¼ million contract for advanced model KDA-4 Firebee jet drone missiles has been awarded by the U.S. Navy to the Ryan Aeronautical Co. Additional funds allocated for KDA-4 spare parts will boost the total value of this contract to over $8 million. The new contract will extend Firebee production well into the latter part of 1959 and will be phased in with Ryan's present volume production of KDA-1 Firebee target drones for the Navy. and Q-2A models for the USAF.

Development of even more advanced versions of the Firebee for both USAF and USN is proceeding along with present production on current models. Ryan engineers are working on new missile compatibility programs to broaden the Firebee's usefulness with missile systems and to extend its capabilities to keep pace with the stepped up performance of new weapons.

At present, these swept-wing pilotless jet target planes are capable of 600 mph speeds and altitudes up to 50,000 feet. Air-launched, and recoverable by parachute, they are used for training crews operating the air-to-air and ground-to-air missiles of North America's air defence system.

Regulus 2

Chance Vought Aircraft Inc. recently announced the receipt of a U.S. Navy contract totalling $26 million for continued evaluation and production of its submarine-launched Regulus 2 guided missile. The contract, which puts the nuclear warhead-carrying missile into quantity production, also carried provisions for spare parts and special support equipment estimated at an additional $7.5 million.

The plus Mach 2 Regulus 2 in the final stages of an accelerated test program at Edwards AFB, Calif., will arm nuclear and conventionally-powered submarines now under construction. Fired from roving underwater satellites to targets 1,000 miles inland, Regulus 2 will give the U.S. an effective intercontinental missile capability.

Inertially guided, Regulus 2 can achieve pinpoint accuracy through a navigation system which can check its course automatically with existing landmarks close to its target and make last minute corrections accordingly. The missile is powered and guided all the way from launch to target, unlike ballistic missiles which must fall earthward in free flight like an artillery shell.

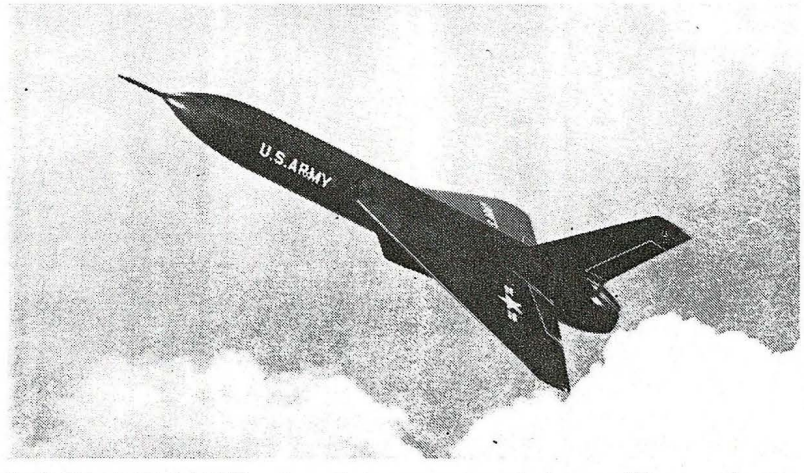
GE Contract

General Electric Co. has been awarded a $3.5 million contract for the manufacture of J-79-3A jet engines to power the U.S. Navy's Regulus 2 surface-to-surface missile. The Regulus II is being produced by Chance Vought Aircraft. The J-79 engines will be built at GE's aircraft gas turbine division in Evandale, Ohio. Delivery is scheduled for 1959.

Missile Training

The U.S. Army has announced that the training of the first of the Nike-Hercules missile battalions for Army Air Defence Command sites will begin soon at Fort Bliss Texas. The Hercules, the big brother version of the Nike Ajax, has an atomic capability and greater range, altitude and speed than the conventionally armed Ajax. Present Ajax sites will be converted to make use of the Hercules.

Meanwhile, U.S. Air Defence Command headquarters have announced the activation of the 4751st Air Defence Missile Wing at Eglin AFB, Florida. The new wing will develop and conduct a training program for the airmen who will operate Bomarc ground-to-air missile units.



SURVEILLANCE DRONE: An artist's conception of the new US Army Combat Surveillance drone now under development at the Fairchild Aircraft, Hagerstown, Maryland. This drone is being built under a $12 million contract awarded to Fairchild by the U.S. Army Signal Engineering Laboratory earlier this year.

LAUNCHING THE EXPLORER

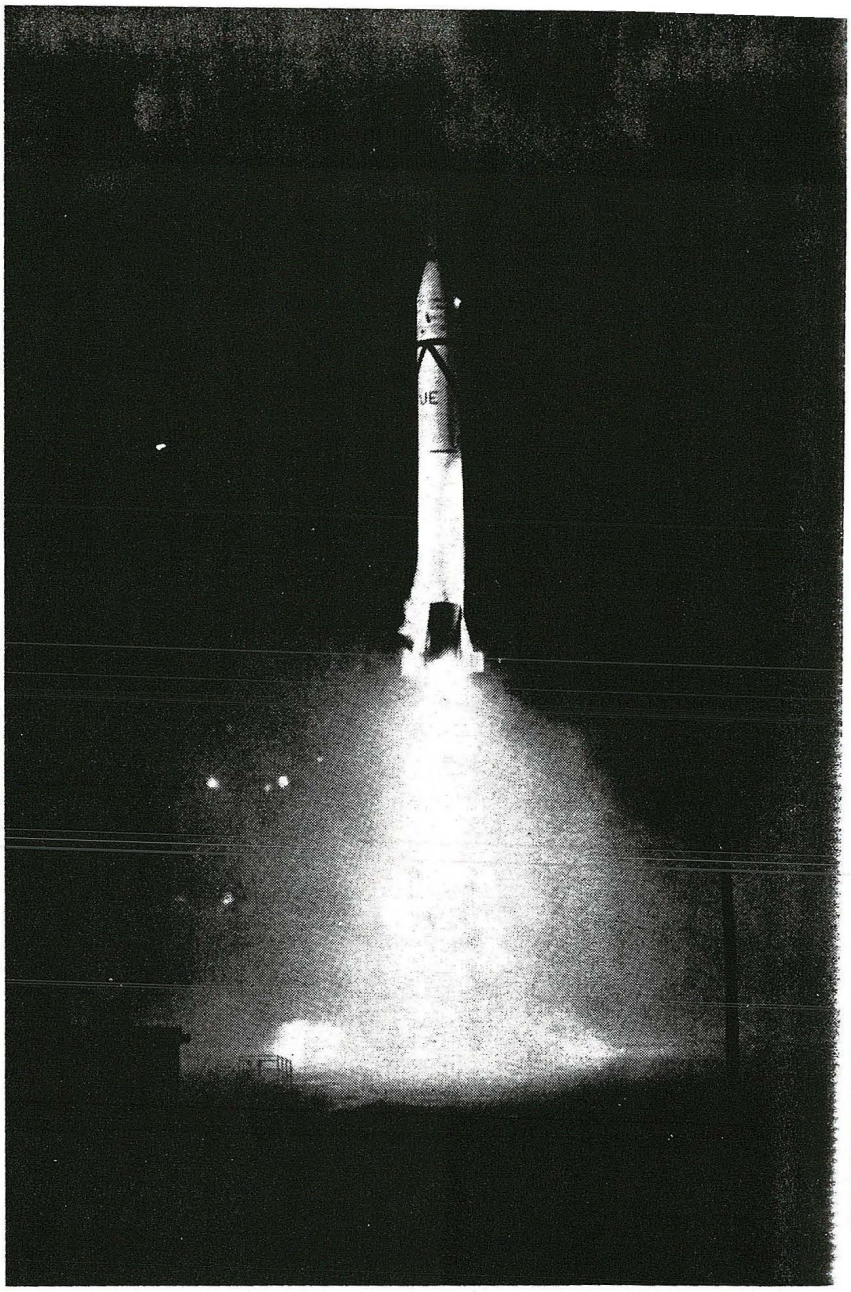
By Jupiter!

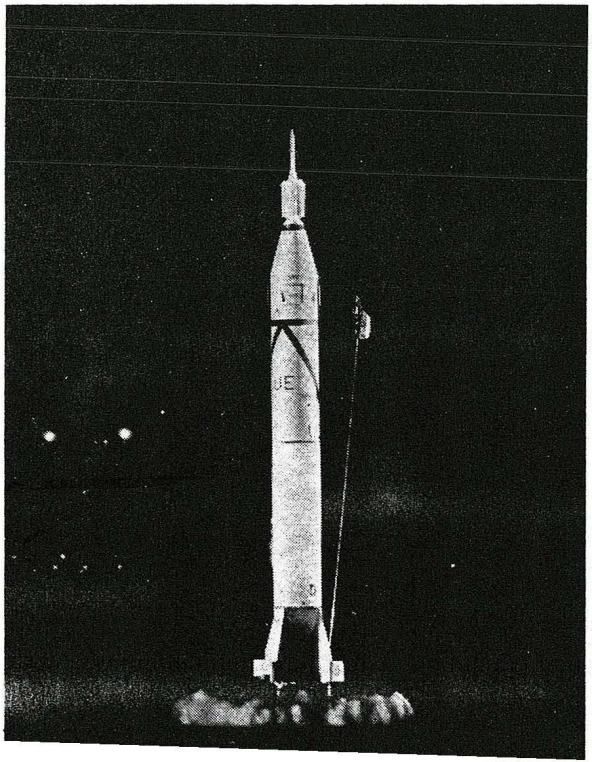
JANUARY 31, 1958, was a red letter day for the U.S. Army. At 10.48 p.m. on that date, the first Explorer satellite was put into orbit by an Army Jupiter-C rocket. The accompanying photographs show the historic launching of Explorer 1.

Since that time, Explorers 2 and 3 have also been launched by Jupiter-C rockets, though only Explorer 3 was successfully put into orbit. The fate of Explorer 2 has never been ascertained. Also since the launching of Explorer 1, the first successful USN Vanguard launching has taken place, so that there are now a total of three U.S. satellites orbiting about Earth, plus one Russian Sputnik.

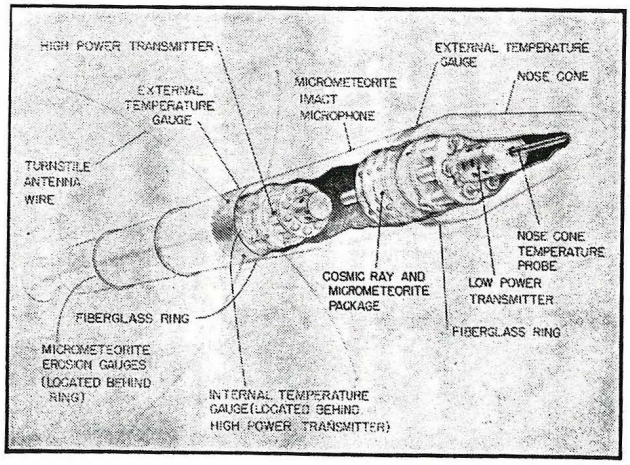
The Jupiter-C launching vehicle comprises four stages, the first of which is the Redstone ballistic missile powered by a liquid propellant engine; the other three stages all have solid propellant powerplants. The Jupiter-C was developed jointly by the U.S. Army Ballistic Missile Agency and the Jet Propulsion Laboratory of the California Institute of Technology.

Jupiter-C is approximately 70 ft. long. The final stage, plus the pointed cylindrical satellite case containing the scientific instruments is 80 ins. long, and has a nominal diameter of 6 ins. Weight of the satellite proper, 18.13 lbs.; of the final stage, 12.67 lbs. after burnout; total weight of satellite, 30.80 lbs. Payload instruments weigh about 11 lbs., exclusive of protecting steel case, which weighs 7.5 lbs.





Pictures above and lower left show the Jupiter C, launching vehicle for Explorer 1 satellite, at moment of take-off.



The 80-in.-long satellite comprises instrument section (forward) and last-stage rocket (rear). Fanning out from mid-section is antenna, made of whip-like rods.

Whither Satellitic Engineering?

Mr. F. Rose, our very own Satellite Correspondent, reports here on the proceedings at the recent sessions on the safety aspects of man-carrying earth satellite vehicles.

THE SESSION was opened by the Chairman, Dr. V. R. de la Zouche, the British delegate and originator of the balanced pressure interplanetary sphere, with a short reference to the successful launchings of the first Russian and American satellites and their history-making orbitical trajectations around the earth.

The problem was how safe would these satellites be as carriers of humans, and this depended solely on the behaviour of the protruberant eruptions on the contact surfaces of their shells, and on the resulting erotional effect on the cross-grain of their outer lamina under astro-magnetic stress. It would be imprudent to pertinate these surfaces with silicant and other carboruntive treatments. Not only would this increase the fatigue factor near the upper yielding point, but it would also have an adverse effect on the surrounding substances and increase, instead of neutralize, the heat-producing action of upper-ionospheric particles, when zero gravity is reached.

Proving the Contrary: After this brief but thought-provoking introduction, Professor I. M. A. Doppelkopf, the eminent cosmic scientist from Leipzig, rose to present his point of view. It was an old established Continental practice to look at such inter-ballistic problems from all angles and attempt to prove the contrary (by pseudo-arbitrative methods) ad absurdum. It has been clearly shown at the last annual meeting of the well-known Geotronomical Society of Saxony, that the wrought iridium shell of contra-rotating satellite casings will only stand up to intra-oscillatory movements during passage through high-density galaxies, if cold-forged in a high frequency induction refrigerator of the type originally developed by a well-known engineering plant in Pilsen for the elimination of excess froth.

There was the important problem to be considered whether satellitic projectiles, in their present state of design, should be allowed to spin in the anti-clockwise direction at the same subsonic speed as in the clockwise direction, even if dynamatically balanced with powerful internal piffle springs.

He was well aware that it had been proposed in 1956 by the former Italian scientist, Dottore Garibaldi Salami-Rotandi, who was now a naturalized citizen of the U.S.S.R. and a highly orbit plotter, that the last stage rocket should not be spun at all, but pendulated in an axial direction with increasing speed on each forward motion. To prevent chromatic turbulence with vibrating corona effects, this could be achieved by causing the projectile to move twice forward and only once reverse in each alternate propulsive cycle. The speed gain over a period of 4711 continuous space flight days should be far in excess of 3½ MACH, and the noise would most certainly be reduced to below 0.5 centri-phons, known in Germany as 6½ KRACH, which is well within the sub-sonic threshold and, therefore, will avoid cavitation.

It All Depends: At this point the Russian delegate, Mme. Bronchislava Helzinskaya, a Peace Prize winner and Professor of Astro-Phonetics at Lysenko Foundation (who suffered from a shocking cough) jumped to her feet. Scientific laboratories in the Upper Ural Mountains, where the ambient temperature conditions were semistable and therefore ideal, had proved the fallacy of using hexametric spasmometers for instantaneous acceleration measurements below the freezing point. It all depended on whether the second layer of the inner shell, especially if of crystallic structure, was provided with elongated surfaces to counteract the proto-ballistic skin-effect of infra-magnetic asteroids on the outer shell, as recently demonstrated by Dr. Sergej Sonovitch and Dr. Rasputin Blastoff in their report "Ballistic Balls in Outer Space".

Prof. A. Kliges Keppel of the Israeli delegation thanked her profusely for this valuable contribution and added that his researchers at the University of Jerusalem had found that the critical speed of stellar rockets could now be pre-regulated by means of self-governing gyroscoptic rotabulators, and his recommended anti-knock formula for the elimination of the jerk factor was...

$$H_{ip} H_{ip} = \omega_{\delta \times \mu} \sqrt{\frac{d\pi}{dp}}$$

where H_{ip} is the seahorsepower in maxibells/milifoot,

$\omega_{\delta \times \mu}$ an easy expression of the modulus of pistular expansion, and

$\sqrt{\frac{d\pi}{dp}}$ a simple method of approximating the very involved co-efficient of intrisipid locomotion after creepage has set in.

He demonstrated, with the help of a relativity slide-rule and a hyperbolic cryptogram (which gave a clear picture of the evolutic stress curve with humps in its fourth cameliar dimension) that all previous calculative methods, however deeply pre-conceived, had been in vain. In the absence of crypton or other heliotropic gases, batteries will not run down at their normal rate, and the satellitic transmitters will continue their beep signals for the whole of their isotropic half-lives instead of slowly fading into diminishing strato-sonic whistles. This was in parts confirmed in a brilliant paper recently published under the title "The Universal Void" by the Flemish scientist Hackmernisch Inkopp, published in Luxemburg in August 1957 by Berny, Busik and Bauxi.

Tops in Tracking: Dr. Dwight Fondlebee of the United States' Jonesonian Institute, who is a Canadian by birth and not only an eminent medical man, but also the originator of the Intercontinental Ballistic Track Team, pointed out that the inaccuracy in scepto-tronic measurement of the venturi flow lines on metal surfaces were not so much due to cosmo-entrophic pH reaction under magneto-hysteritic influence, but often due to simple electro - zoological micro - organisms which multiplied with fantastic speed under the radiation of Fedora Borealis.

This had recently been proved beyond doubt by the Turkish high-altitude balloonist, Dr. Kemal O. Vej-Izmir. In the stratosphere over tropical areas, particularly the sub-monsoon

(Continued on page 72)

regulatory activities. This important document is now in draft stage and will be printed as soon as possible. It will include analyses of inflight collisions and near-miss reports; gross aircraft operations trend; current rule-making with regard to weather minimums, airways floor, airport traffic patterns, high density zones, flight test areas, designation of restricted areas, military jet scramble corridors, continental control areas, off-airways high altitude operations, positive control on high altitude routes, altimetry and cruising altitudes. The Board has ordered that no effort be spared to expedite presentation of this document to the Congress."

SATELLITIC ENGINEERING

(Continued from page 42)

region of the Trikini Atolls, one had to take into account fungular growth of the pre-fossil type. Their cyclomatic development according to Prof. Kolynos Isotopalos, Director of the Oceanographic Skin-Diving Society of Athens, was accentuated by the high humiferidity, due to an abundance of marine oozing weeds (chlorophyllia osmosiensis) and the rapid propagation of hydrogenetic atomites, which appear to have been sucked up into the upper layers of the ionosphere by multi-bacillic enzyme carriers from the swamp areas of North Eastern Japan.

The Hon. Maru Mitsubihama, the Far Eastern expert on physio-emetics and Private Consultant on inter-terrestial space problems, restrained himself admirably in the face of this rather provocative refrence to his native islands. This was a great relief to all who had a closer knowledge of his country's traditions and, of what, only a few years ago, his code of honor would have compelled him to do there and then.

Inscrutable: However, with an air of inscrutable indifference, he removed his thick acetate-rimmed spectacles and, without betraying the slightest emotion, announced, that in the new Imperial Ordinance factory at Pyjama Springs—where Satellites had been coming off the production line since the middle of October — the iridium alloy shells had been superseded by bamboo-reinforced pith shells which, for the first time, used a pure form of synthetic pith (instead of the vegetable kind), which had proved the least frictitious material so far discovered, completely eliminating any surface treatment or cooling of the satellite shells, thanks to its unique auto-refrigerative properties.

The revolutionary nature of this statement caused the Chairman to call for an immediate adjournment to enable the experts to investigate this history-making solution to the problem which had stumped inter-planetary scientists everywhere, and he closed the meeting with the scholarly reminder from the Classics: "Nil desperandum—Cum pithium ad astras".

ARROW ALOFT

(Continued from page 24)

ing. The second Arrow to be built is being static tested to destruction.

Green Light: A recent news report from Ottawa states that the Defence Research Board has advised the Canadian Government that the Arrow Weapon System should have a useful life extending several years into the future. That production of the Arrow

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NEW LITERATURE

Constructive Critic

Britain's Air Survival — by Sir Roy Fedden, MBE, DSc, Hon. FRAes, Hon. FIAS (Cassell & Co. Ltd., Toronto, $2.50).

Sir Roy Fedden was responsible for the famous Bristol Series of radial piston engines, especially the high-powered sleeve-valve ones of which the Centaurus survives in production into the jet age. After he left The Bristol Aeroplane Co. in 1942, Sir Roy led important technical missions to the U.S. and to conquered Germany for the British government and he was for a time technical adviser at NATO headquarters.

As a practised and practising engineer and a man of vision Sir Roy has several times played the role of a technical Cassandra: in 1938 he warned against the German aircraft production potential, and offered a plan for bringing Britain's annual output up to 3,000 airplanes and 12,000 engines; in 1945, after leading a mission through the German aircraft plants and research establishments, he warned that the Russians (and the Americans) had absorbed the technicians and their results, while we complacently ignored them; in his 1955 lecture to The Institution of Production Engineers he warned against attempting too many and varied projects with the manpower and equipment available.

Sir Roy is a severe critic, but he is clear-sighted and, above all, he is always constructive — he never pulls down without offering something in its place. In the present volume he analyzes the British Aircraft Industry as it is and he draws the parallels. He points out how Britain won the War with obsolescent airplanes because the Germans, with revolutionary jet aircraft like the M-163 and M-262 in service had yet dissipated their resources over too many projects and had allowed political interference to cause them to switch from one to another without allowing time to consolidate research.

Again, he shows how even the colossal manpower and financial resources of the U.S. were run ragged upon far too many unco-ordinated projects until, in 1947, President Truman appointed the Finletter Air Policy Commission to enquire into the whole field. Unlike the British Parliamentary Select Committees, the Finletter Commission was given a strict time limit—and the preparatory sorting work by technicians was also strictly scheduled.

Sir Roy advocates similar treatment for the British Aircraft Industry, as well as a review of the way policies are made in the fighting services, if Britain is to survive as a first-rate air power. He advises a very high-level Air Policy Tribunal of a dozen men with spirited leadership and wide experience (outside the aircraft industry) able to deal fully with Top Secret affairs, backed by a team of specialists and supported by a secretariat. Sir Roy feels that such a Tribunal should also see that the work of the RAE, NPL, NGTE, Aeronautical Research Committee, AID and ARB is co-ordinated so that they pull together to the best advantage of British Aviation.

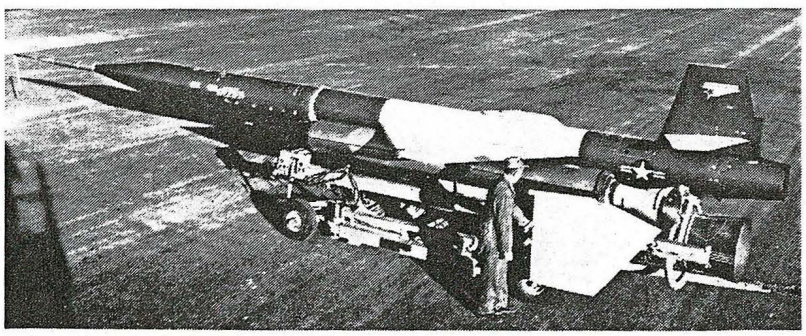
Since Sir Roy's book was prepared for the press, the Defence White Paper has cut the Aircraft Industry's projects almost to zero. In an Appendix, Sir Roy had this to say upon it: ". . . I think the proposals (in the White Paper) as regards the air emphasize what I have endeavoured to bring out in this book, namely that it is impossible for a Minister briefed by the permanent officials and advisers who have brought us to the difficult position we are in today, to provide the right blueprint for the future."

To the reviewers, Sir Roy's last word is this:

"Before we tie ourselves down to some fresh program which we may regret bitterly a year or two hence, because it is put forward without sufficient practical background and without thorough and weighty evidence by down-to-earth engineers rather than the purely scientific approach, I would advocate carefully weighing up the import of my plan of setting up an independent Commission, briefed along the lines of the American Finletter Commission of 1947, rather than this superficial survey."

This is a vigorous, yet thoughtful, book, which gives clear insight into the difficulties of the British Aircraft Industry, and points its morals statistically from recent history. Its contents can, with advantage, be viewed with other recent criticisms: the Second Report from the Select Committee on Estimates; the lecture by Air Commodore F. R. Banks to the Royal Aeronautical Society; Mr. W. E. W. Petter's, and Sir Roy's own warnings given before the Institution of Production Engineers — even the "inside story" of one company as revealed by W. A. Waterton in "The Quick and the Dead."

—J.H.S.



LOCKHEED Q-5 MISSILE: A ramjet target vehicle capable of Mach 2 cruise, has been developed to test the capabilities of North America's missile defenses. The USAF claims that test and evaluation of supersonic weapons cannot be done with WW II drone-planes. The Q-5 is recoverable by parachute; remote controlled; weighs more than 7600 lbs.; is 39 feet long and 20 inches in diameter.

Tour de Force

British Aeroplanes 1914-18 — by J. M. Bruce (McClelland & Stewart Ltd., Toronto, 742 pages, illus., $50.00).

As a schoolboy, the writer bought many 1914-18 back numbers of 'Flight' and 'The Aeroplane', even advertised for the fabulous 1919 "Jane's", in default of such a magnificent compendium as this: 742 pages, some 700 illustrations and descriptions of every known British airplane, or airplane used by the British and Dominion forces, in the first World War. What a lot is there for one's money — even

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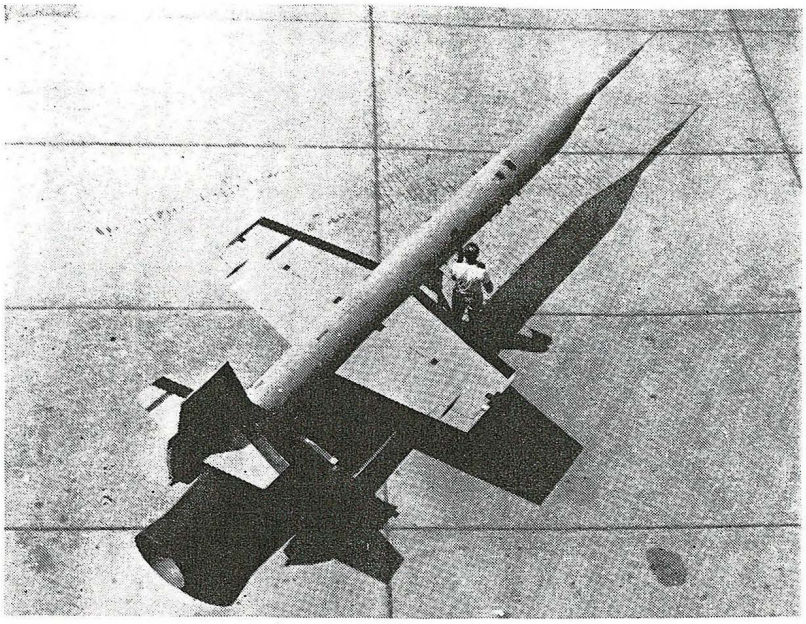


TEST VEHICLE: This is the Lockheed X-7, a supersonic test vehicle which for the past several years has been playing a major role in the development of new ramjet engines for use in missiles. The X-7 is customarily launched from a mother B-29 and after its fuel is exhausted, it is recovered by parachute. A rocket booster is used to get the X-7 up to efficient ramjet speed.

vices and stocked engine spares in connection with Capital Airlines' Dart-powered Viscounts.

Capital's recent order for 14 Comets (Avons), and the manufacture in the U.S. by Fairchild of the Fokker F-27 Friendship (Darts), will have a direct influence on the Canadian aircraft industry, according to R. M. Kendall, general manager for Rolls-Royce of Canada. The spares and service facilities that have been established at the Montreal plant to support the Dart engines now in service in the U.S. and Canada, will apply to the Avon as well.

New Orenda Computer

An IBM Type 650 high speed electronic computer that does mathematical calculations five to 100 times faster than the previously used electronic card program calculator, has been installed by Orenda Engines Ltd. The fourth of its kind in Canada, the computor will be used to work out mathematical investigations of all phases of jet engine design, including aerodynamics, performance, stressing and vibration.

It adds, multiplies, subtracts, divides; it can work trigonometry, logarithms and more complicated mathematical operations. It can store 20,000 digits at a time, and consumes 15 kilowatts of electric power which is dissipated as heat.

The complete design of a compressor blade airfoil section originally took an engineer one week using a slide rule and desk calculator. This was cut to three hours when the card program calculator became available. Now, with the new machine, the entire process takes five minutes.

Contracts Awarded

Contractors awarded business in excess of $10,000 by the Department of Defence Production during the period June 16 to July, 15, 1956, include the following. The list does not include orders placed by the Department outside Canada, or with other agencies, and increases in orders placed earlier — nor do orders classified as secret appear here.

(Names appearing in bold face are current *Aircraft* advertisers.)

Avro Aircraft Ltd., Toronto, $660,000 for repair and overhaul of airframes and airframe spares during period April 1/56—May 31/57.

Bristol Aero Engines Ltd., Montreal, $1,482,000 for repair and overhaul of aero engine components during period April 1/56—March 31/57.

Bristol Aero Engines (Western) Ltd., Vancouver, $236,000 for repair and overhaul of aero engines and engine components during period April 1/56—March 31/57.

Bristol Aero Engines (Western) Ltd., Vancouver, $198,000 for repair and overhaul of aero engine components during period April 1/56—March 31/57.

Bristol Aero Engines (Western) Ltd., Vancouver, $75,000 for aero engine spares and tools during two fiscal years ending March 31/57.

Canadian General Electric Co. Ltd., Toronto, $28,528 for radar spares for armament systems.

Canadian Pratt & Whitney Aircraft Co. Ltd., Longueuil, Que., $655,000 for repair and overhaul of aero engines and engine components during period April 1/56—March 31/57.

Canadian Pratt & Whitney Aircraft Co. Ltd., Longueuil, Que., $150,000 for repair and overhaul of helicopter airframes and airframe components during period April 1/56—March 31/57.

Canadian Pratt & Whitney Aircraft Co. Ltd., Longueuil, Que., $25,000 for aero engine spares, accessory spares and tools during period Feb. 1/56—March 31/57.

Cossor (Canada) Ltd., Halifax, $15,000, for electronic spares and test equipment during period April 1/56—March 31/57.

Curtiss-Wright of Canada Ltd., Montreal, $147,180 for aero engines and metal shipping containers.

The de Havilland Aircraft of Canada Ltd., Toronto, $25,000 for repair and overhaul of airframes and airframe components during period April 1/56—March 31/57.

Fairey Aviation Co. of Canada Ltd., Dartmouth, N.S., $220,000 for airframe spares.

Imperial Oil Ltd., Ottawa, $164,789 for aviation gasoline during period 1/56—March 31/57.

Lucas-Rotax Ltd., Town of Mount Royal, Que., $20,000 for aero engine accessories and accessories spares during period April 1/56—March 31/57.

Orenda Engines Ltd., Toronto, $9,400,000 for repair and overhaul of gas turbine aero engines and engine components during period April 1/56—March 31/57.

Railway & Power Engineering Corp. Ltd., Montreal, $38,150 for aircraft hardware.

Spartan Air Services Ltd., Ottawa, $16,800 for radar altimetry surveys.

Standard Aero Engine Ltd., Winnipeg, $659,000 for repair and overhaul of aero engines and engine components during period April 1/56—March 31/57.

Abercorn Aero Ltd., Montreal, $14,074 for aircraft cleaner.

Aviation Electric Ltd., Montreal, $18,869 for aircraft spares.

Avro Aircraft Ltd., Toronto, $448,000 for aircraft retrofit modification kits during period April 1/56—March 31/57.

Bristol Aero Engines Ltd., Montreal, $195,000 for reconditioning and preservation of engines during period ending March 31/57.

Canada Ropes Ltd., Vancouver, $14,950, for target towing apparatus.

Canadian Car & Foundry Co. Ltd., Montreal, $220,307, for airframe spares.

The de Havilland Aircraft of Canada Ltd., Toronto, $30,000 for repair and overhaul of airframes and airframe components during period April 1/56—March 31/57.

The de Havilland Aircraft of Canada Ltd., Toronto, $10,000 for repair and overhaul of aero engines and engine components during period April 1/56—March 31/57.

Eastern Provincial Airways Ltd., Gander, Nfld., $103,111 for charter of aircraft.

B. F. Goodrich Canada, Ltd., Kitchener, Ont., $18,351 for aircraft spares.

J. W. Lawrence Radiators Ltd., Montreal, $220,000, for repair and overhaul of aircraft cooling equipment during period April 1/56—March 31/57.

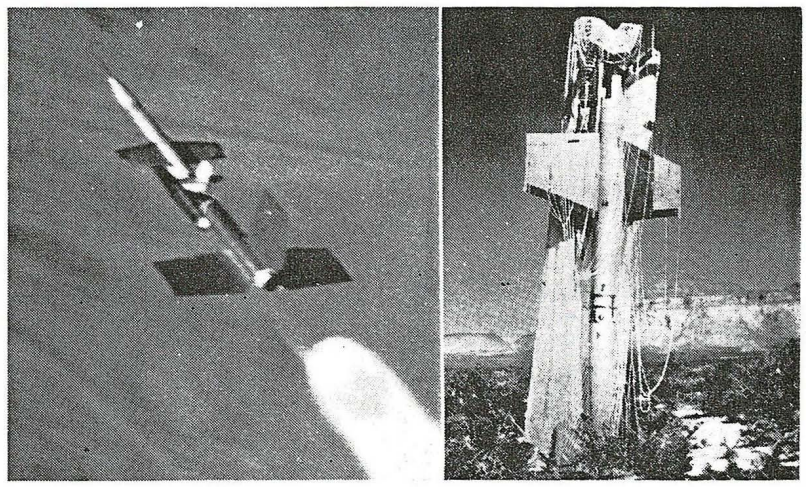
Lucas-Rotax Ltd., Town of Mount Royal, Que., $20,000 for repair and overhaul of installed aero engine fuel control units during period April 1/56—March 31/57.

Prairie Equipment & Radiator Ltd., Winnipeg, $30,000, for repair and overhaul of aircraft cooling equipment during period April 1/56 to March 31/57.

Purolator Products (Canada) Ltd., Toronto, $12,709 for aircraft spares.

Railway & Power Engineering Corp. Ltd., Montreal, $21,642 for aircraft spares.

Vertol Aircraft Co. (Canada) Ltd., Arnprior, Ont., $40,000 for helicopter airframe spares during period July 1/56—March 31/57.



LOCKHEED RAMJET X-7: This X-7 ramjet missile, which is recoverable by parachute, has flown ten trips with no sign of wearing out. A rugged workhorse for the USAF's missile development program, the X-7 wrings out powerful new ramjet engines and other components for supersonic defense weapons. Shown in flight on the left, it is seen draped in its own parachute after landing nose down.

tually as a passenger.

If the carrier deck is not in the proper position for a safe landing, the system automatically gives the pilot a "wave-off" and the airplane is flown around the landing pattern for another attempt. The U.S. Navy requires that the automatic system land the aircraft within a distance not to exceed plus or minus 30 feet longitudinally, and a maximum of plus or minus 25 feet laterally from a pre-established landing spot on the deck.

New Barnes Office

The Wallace Barnes Co. Ltd., Hamilton, Ont., Canadian subsidiary of Associated Spring Corporation, Bristol, Conn., has opened a new sales office in Montreal to give better service to the growing number of industrial plants in the Maritimes and the province of Quebec. The Canadian subsidiary supplies precision mechanical springs to a wide variety of Canadian industries.

Turbojet Relights

Pyrophoric fuels which spontaneously ignite on contact with air have successfully completed sea level and simulated altitude tests for emergency relighting turbojet engines, according to Curtiss-Wright. Using a test stand type pyrophoric supply system and fuel supplied by C-W's Wright Aeronautical Division, the pyrophoric ignition tests were conducted with a Curtiss-Wright jet engine.

Composed of a mixture of aluminium trimethyl (ATM) and aluminum triethyl (ATE), the new pyrophoric fuel has been under evaluation and development by Wright Aeronautical for several years. A measurement of the physical properties of the pyrophoric fuel disclosed that the available energy in the ATM-ATE mixture is approximately 19,000 BTU per pound. Exposed to air, the fuel appears to burn like some aviation kerosene, emitting an orange flame and a small volume of smoke.

Relatively impervious to temperature changes, it will function well in the normal temperature ranges of ramjet and turbojet operations. Freezing point of the mixture is 40° F. Reliable spontaneous ignition has been demonstrated at temperatures from 40° F to 400° F. Increased moisture or humidity is an advantage.

The effectiveness of pyrophoric fuel for aircraft engine ignition at very high altitudes, as well as at sea level, holds a distinct advantage over electrical systems for very high altitudes at which jet powered aircraft are required to operate. In addition, it is providing the ignition requirements for anticipated altitude ranges upward to 120,000 feet.

Any Old Orendas?

With Orenda 14's powering Canadair Sabre 6's, and Orenda 11's pushing Avro CF-100's, what has happened to the older production models of Orenda engines, the 2's, 8's, 9's and 10's?? Orenda's Sales & Service department recently came up with the

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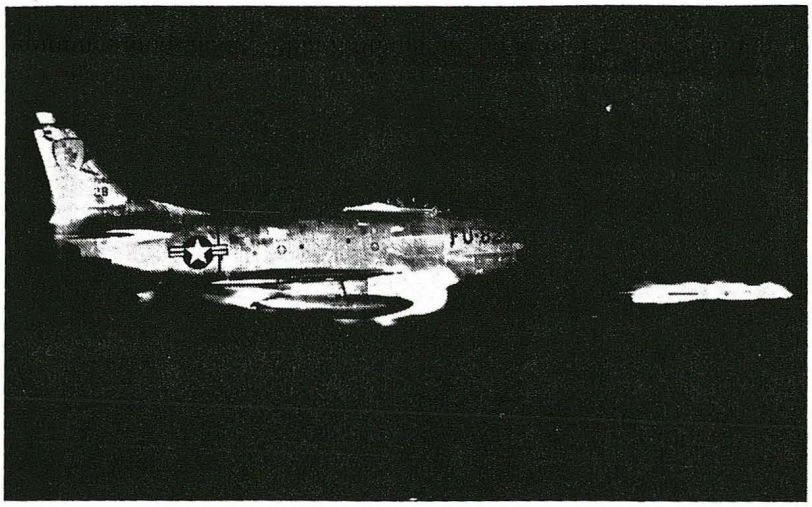


FLASH FIRE: Picture shows a USAF F-86D Sabre firing a Mighty Mouse rocket during a simulated night interception. The photo, taken by a General Electric photographer, is described as the first night flash picture ever taken of one in-flight jet airplane from another, as well as being the first night air-to-air shot showing in-flight jet firing rockets. Reason for the excitement: GE was celebrating 25th anniversary of introduction to the U.S. of photoflash lamps.

pleted more than 40 landings. By their third day aboard they were landing out of formations over the flight deck.

Those who completed the course were Lieutenants C. W. Wilson, H. L. Washington and R.W. Hutchins, Surgeon Lieutenant J. G. Evans and Sub-Lieutenant J. K. Murray.

Postings & Careers

Air Force Headquarters announces the transfer of seven senior officers serving in Europe and Canada.

Group Captain M. E. Pollard, 34, of Montreal and Toronto, formerly senior air staff officer at 1 Air Division Headquarters, Metz, France, becomes commanding officer of RCAF Station Chatham, N.B.

Group Captain E. M. Mitchell, 42, of Halifax, formerly senior air staff officer at 14 Training Group Headquarters, Winnipeg, takes command of RCAF Station Goose Bay, Labrador.

Group Captain A. G. McKenna, 41, of Ottawa, formerly commanding officer of RCAF Station Chatham, N.B., becomes senior air staff officer at 14 Training Group.

Group Captain Sydney G. Cowan, 44, of Victoria, who recently completed the National Defence College course at Kingston, has been appointed commanding officer of 30 Air Material Base at Langar, England.

Group Captain Gerald E. McCormick, 42, of Vankleek Hill, Ont., formerly commanding officer at Langar, becomes senior equipment officer at Air Materiel Command Headquarters, Rockcliffe.

Group Captain B. D. Richer, 44, of Ottawa, formerly commanding officer of RCAF Station Gimli, Man., has been named Group Commander of 1 Auxiliary Group at Montreal.

Group Captain F. C. Carling-Kelly, 43, of Toronto, formerly commander of 1 Auxiliary Group, becomes Director of Ground Training at AFHQ.

RCN Participates

The largest concentration of RCN aircraft ever to participate in peacetime manoeuvres flew about 70 sorties a day to add a touch of realism to the Army's Exercise Rising Star at Camp Gagetown, N.B.

Some 50 aircraft, including Sea Fury fighters, T-33 Silver Star jet trainers, Expeditor communications aircraft and Sikorsky helicopters, were drawn from six naval air squadrons. They flew from the naval air station at Dartmouth, N.S., the naval air facility at Summerside, P.E.I., and from other convenient bases.

The Sea Furies provided tactical reconnaissance and support bombing; the T-33's gave air cover, and the Expeditors were used for liaison, reconnaissance, general communications and transport.

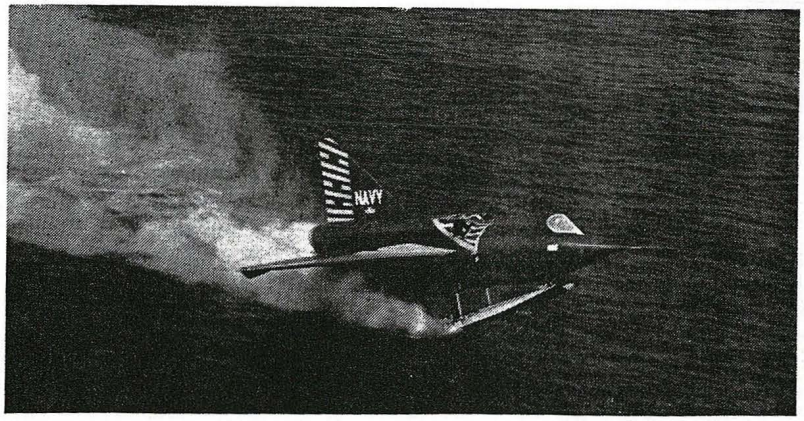
SHAPE Posting

Air Vice Marshal H. L. Campbell last month assumed his new post as Vice Air Deputy at Supreme Headquarters Allied Powers Europe. He was succeeded as commander of the RCAF's 1 Air Division, with headquarters at Metz, France, by Air Vice Marshal H. B. Godwin.

Canberra Visit

Eight Canberra jet bombers of the RAF's 139 Jamaica Squadron, supported by five Hastings transports of RAF Transport Command, completed a 21,000-mile goodwill tour this month which included parts of Canada, the U.S. and the West Indies. For two days they carried out flying displays at the CNE in Toronto.

They made stops at Goose Bay, St. Hubert and Trenton, co-operating with the RCAF in air defence exercises, and showed the flag in Jamaica, British



ONE EQUALS TWO: Re-fitted with a single ski as part of the Convair/USN hydrodynamic research program, an XF2Y-1 Sea Dart makes a high-speed taxi run on San Diego Bay. Tests have been under way with single ski for several months; other Sea Darts have twin hydro-skis. The delta-wing Sea Dart is powered by two Westinghouse J-46 turbojets and has flown supersonically. Recent reports from the U.S. say that the U.S. Navy has decided to drop the Sea Dart program.

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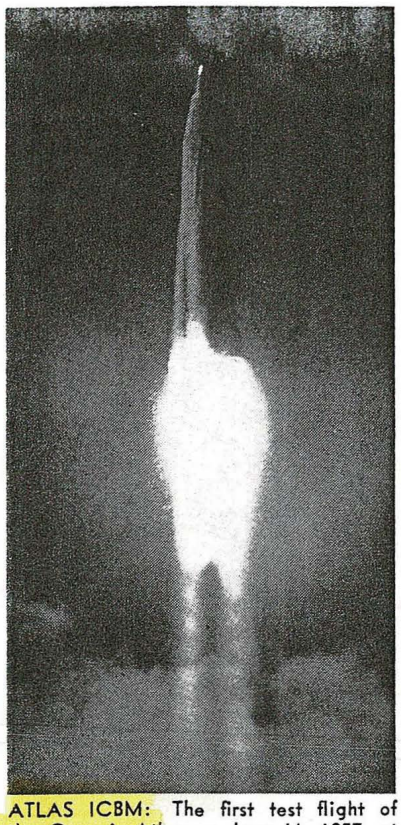

ATLAS ICBM: The first test flight of the Convair Atlas on June 11, 1957, at the Air Force Missile Test Center, Cape Canaveral, Florida. The apparent halo around the exhaust flame is caused by reflection in camera lens of the intense light from the huge missile.

A counterpart of the C-11, the C-10 system which provides the accuracy required for the most difficult continental flights, has been adopted as standard for the DC-8. Both systems can be coupled with the Sperry SP-30 flight control system, also standard on the DC-8, to provide precision control from 100 mph to sonic speeds.

Change of Address

Simmonds Aerocessories of Canada Ltd., formerly of Montreal, has announced that as of January 1, 1958, its new address will be: 637 Parkdale Ave. N., Hamilton, Ontario.

Contracts Awarded

Contractors awarded business in excess of $10,000 by the Department of Defence Production during the period November 1-December 1, 1957, include the following. The list does not include orders placed by the Department outside Canada, or with other agencies, and amendments to orders placed earlier — nor do orders classified as secret appear here:

(Names appearing in bold face type are current *Aircraft* advertisers.)

Airtron Canada Ltd., Toronto $26,218, for spares for aircraft armament equipment.

Aviation Electric Ltd., Montreal, $38,339, for aero engine spares.

Aviquipo of Canada Ltd., Montreal, $10,126, for aircraft instruments.

Brian Engineering Ltd., Montreal, $12,258, for electrical equipment.

Canadair Ltd., Montreal, $200,000 for aircraft modification kits during year ending March 31/58.

Canadair Ltd., Montreal, $14,339, for aircraft spares.

Canadian Applied Research Ltd., Toronto, $38,400, for photographic equipment.

Canadian Aviation Electronics Ltd., Montreal, $767,134, for flight simulator.

Crystal Glass & Plastics Ltd., Toronto, $10,530, for visors for flying helmets.

De Havilland Aircraft of Canada Ltd., Toronto, $38,852, for technical publications.

Dunlop Canada Ltd., Toronto, $10,132, for aircraft tires and tubes.

Parmatic Engineering Ltd., Owen Sound, Ont., $140,271, for spares for aircraft servicing equipment.

Renfrew Aircraft & Engineering Co. Ltd., Renfrew, Ont., $180,000 for aero engine spares during year ending March 31/58.

Sperry Gyroscope Company of Canada Ltd., Montreal, $12,509, for aircraft instruments.

Abercorn Aero Ltd., Montreal, $31,940, for aircraft safety equipment.

Aviation Electric Ltd., Montreal, $13,212, for aircraft starter assembly spares.

Avro Aircraft Ltd., Toronto, $517,560, for aircraft armament equipment.

Bristol Aircraft (Western) Ltd., Winnipeg Man., $160,527, for ammunition components.

Canadair Ltd., Montreal, $190,309, for spares for airborne electronic equipment.

Canadair Ltd., Montreal, $321,000, for airframe spares.

Canadian Aviation Electronics Ltd., Montreal, $1,001,598, for field maintenance services for aircraft fire control systems.

Dowty Equipment of Canada Ltd., Ajax, Ont. $676,126, for aircraft spares.

Sperry Gyroscope Co. of Canada Ltd., Montreal, $72,379, for electronic tubes.

Sperry Gyroscope Co. of Canada Ltd., Montreal, $123,000, for fire control equipment.

Standard Telephones & Cables Manufacturing Co. (Canada) Ltd., Montreal, $11,705 for technical publications.

Stewart-Warner Corp. of Canada Ltd., Belleville, Ont., $18,098, for radar equipment.

Vertol Aircraft Co. (Canada) Ltd., Arnprior, Ont., $107,311, for technical publications.

Northwest Industries Ltd., Edmonton, Alta., $29,789, for supply and installation of sprinkler system in hangar — Edmonton, Alta.

Bach-Simpson Ltd., London, Ont., $41,522, for spares for aircraft instruments.

Canadair Limited. Montreal, $10,000, for illustrated instructional publications.

Canadair Ltd., Montreal, $15,699, for aircraft accessories.

Canadian General Electric Co. Ltd., Toronto, $78,423, for electronic equipment.

Canadian Marconi Co., Toronto, $444,075, for electronic tubes.

Canadian Marconi Co., Montreal, $52,144, for radio transmitting equipment.

Cossor (Canada) Ltd., Halifax, N.S., $55,264, for electronic equipment.

Curtiss-Wright of Canada Ltd., Montreal, $46,361, for technical publications.

Curtiss-Wright of Canada Ltd., Montreal, $14,021, for aircraft accessories.

De Havilland Aircraft of Canada Ltd., Toronto, $79,413, for aero engine spares.

Pacific Petroleums Ltd., Calgary, Alta., $23,325, for aviation turbine fuel during period ending March 31/58.

Stanley Manufacturing Co. Ltd., Toronto, $69,030, for aircraft navigational equipment.

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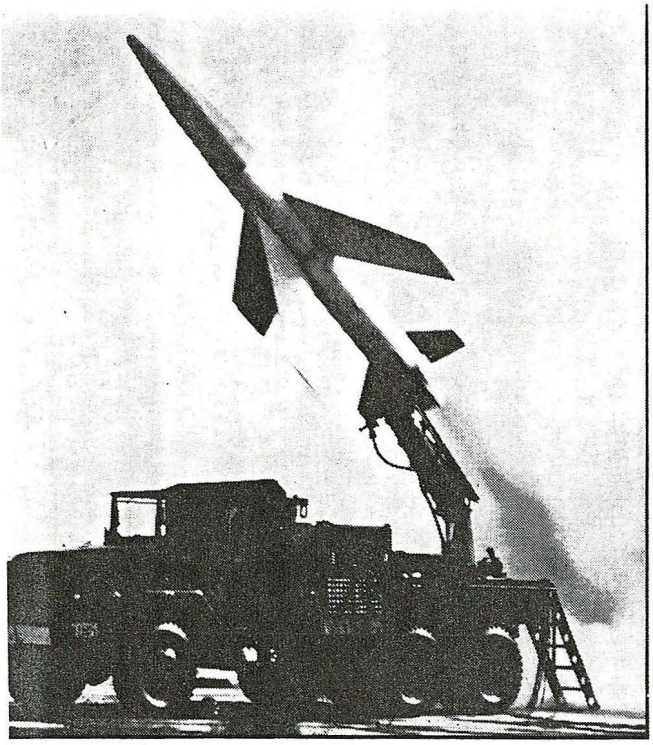


The Canadian Army is soon to get a battery of Lacrosse surface-to-surface guided missiles. A Lacrosse (made by Martin) is shown at instant of firing.

Missiles and Aircraft to Give Army Increased Firepower and Mobility

THE CANADIAN Army has settled on its new battlefield organization and soon will start getting new weapons and equipment — especially missiles — required to make this organization effective.

Maj.-Gen. Jean Victor Allard, Vice Chief of the General Staff, said recently at an Army briefing on its new tactics that "We know what we need and how we will use it."

Outline for Battle: Col. Norman Wilson-Smith, director of combat development, outlined the new equipment and weapon needs of the Army in the era of the atomic battlefield.

These include atomic weapons, missiles, improved anti-tank weapons, small arms and tanks, transport planes and helicopters, drones for camera surveillance, armored amphibious carriers, mobile artillery and new signal equipment.

Because of the atomic weapon, a brigade group of some 7000 men will cover an area held by a corps of 42,000 to 50,000 men during World War II. It would do this by increased mobility and firepower and better reconnaissance, command and control, and supply.

The increased mobility would be provided in part by movement of troops and supplies by transport plane from rear bases to forward echelons. Helicopters would carry them from these forward echelons to the front line.

The increased firepower would be supplied by missiles capable of carrying nuclear warheads. This is the only way an Army field force could cover large areas of ground with small numbers of troops.

First Step: A couple of days after the Army briefing, Prime Minister Diefenbaker announced that the Army will get the American surface-to-surface Lacrosse guided missile. A battery comprising four missile launchers and associated fire control equipment and 12 missiles will be established. Half will be deployed with the 4th Canadian Infantry Brigade in West Germany, the other half at the artillery school at Camp Shilo, Man.

Mr. Diefenbaker declined to say whether the Lacrosse would be fitted with atomic warheads but it is assumed such warheads would be available in Europe for emergency though remaining in the custody of American troops.

The Prime Minister did not say when the Army would obtain the Lacrosse. However, it has just recently gone into production in the U.S. and probably won't be available to the Canadian Army for about a year.

The Lacrosse is used as an artillery piece. It has greater range than present Canadian Army artillery whose biggest gun is the 155-millimetre howitzer. A Lacrosse missile battery comprises 220 men.

Course Completed: More than 50 Canadian soldiers in September completed training courses on the Lacrosse at Fort Sill, Okla., and Fort Bliss, Tex., and will conduct cold-weather tests of the missile at Fort Churchill, Man., this winter.

The Army plans to use the first battery for training purposes and then acquire a sufficient number of Lacrosse missiles to outfit all four infantry brigades.

Staff officers will have to know how to apply weather data to missile firings. A nuclear firing of the Lacrosse would result in radioactive fallout. Thus officers planning an atomic blast will have to have full weather information, mainly about wind, to avoid radiation falling on their own troops. Because many targets are preselected in a defensive position, these officers will have to keep in constant touch with the weather situation over a wide area. Consequently, the study of the application of meteorological data to artillery operation has become one of the most important new courses at the Canadian Army Staff College at Kingston, Ont.

The Army recently announced doubling of the length of the Staff College course to 20 months because of the adoption of new roles and weapons in the Army.

Anti-Aircraft: The Army plans to obtain the U.S. Hawk surface-to-air missile or a weapon similar to it. The Hawk would be employed to shoot down enemy reconnaissance aircraft or manned bombers attacking an army field force.

The Hawk is a versatile air defence missile system designed to reinforce the low altitude capability of anti-aircraft units. The weapon system can carry several types of lethal warhead. Highly mobile, the Hawk can be trans-

ported on the highway, by helicopter or by aircraft. It is about 16-feet long, and 14-inches in diameter; it employs a solid-fuel propellant. The Hawk's guidance system is radar.

The Hawk, or similar weapon, might well become the most important missile in the Army's arsenal.

Col. Wilson-Smith said the struggle for information on troop movements and deployment might well be the turning point of a nuclear land battle.

"Nuclear war today would be like two blindfolded heavyweights in the ring. The one to get his blindfold off first would win."

Thus an important battle now was raging behind the scenes for the technical means for better reconnaissance and surveillance. The army is planning the organization of a reconnaissance unit equipped with camera-carrying, ground-controlled drones.

"We must be the first to get the blindfold off," said Col. Wilson-Smith.

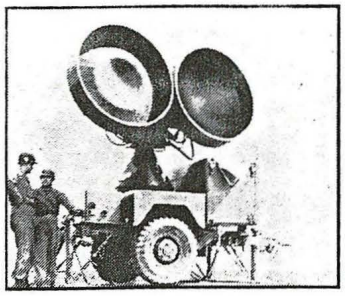
General Agreement: Gen. Allard said Canada, the U.S. and Britain and other NATO allies, notably West Germany, have reached general agreement on army doctrine, tactics and weapons for nuclear war. There were slight but not significant differences among the countries concerned.

"We can live on the atomic battlefield," Gen. Allard said. "The atomic bomb is no longer the absolute weapon."

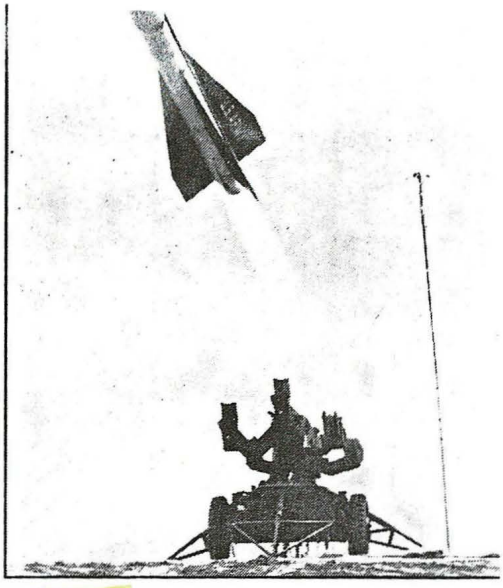
The Canadian Army has started turning out pamphlets on the new doctrine and tactics but it still needs new equipment and weapons, the General said.

No Caribou Decision: The Government hasn't made any decision on acquisition of the de Havilland Caribou for the Army. This will probably await full evaluation trials but it appears that the plane will be ordered. The Army has a helicopter unit at Rivers, Man., to evaluate egg-beaters. Britain's military jet helicopter, the Fairey Ultra Light, arrived in Canada early this month for demonstration flights for the Canadian armed forces. It will be converted as an air ambulance for the Army tests. It will also be put through its paces in artillery observation and fast transport.

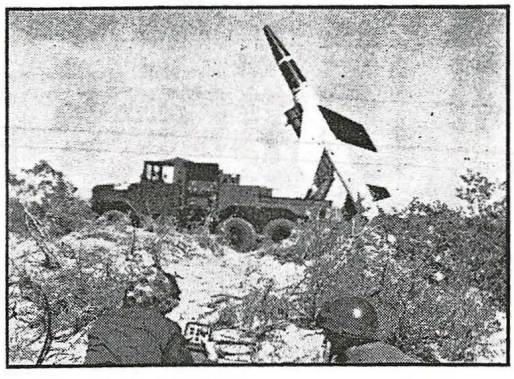
Another piece of equipment the Army wants to test is the French SS-11 anti-tank missile, reputed to be lightweight, highly mobile and cheap.



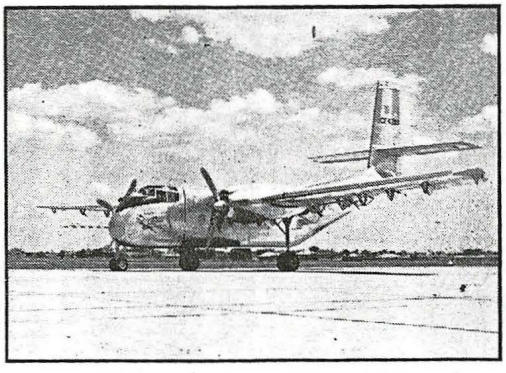
Radar used in Hawk anti-aircraft missile system, which Canadian Army also wants, can track attacking aircraft even at tree-top levels.



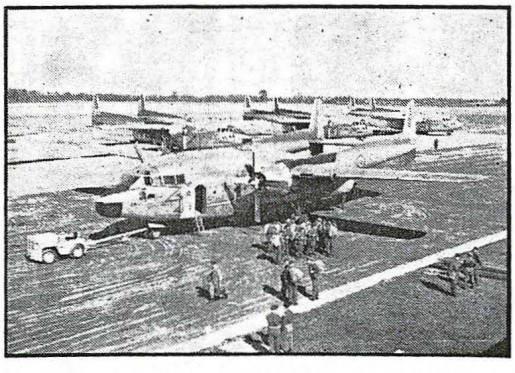
A Hawk roars away from launcher, which can hold total of three missiles at once. Hawk is made by Raytheon.



A Lacrosse, about to be fired by soldiers in foreground. Guidance command is provided by forward guidance station.



Canadian Army has keen interest in new de Havilland Caribou, as a troop and equipment carrier. Caribou is now in production.



Globe Trotter One, recent mobility evercise, involved units of Army and RCAF. Here soldiers board RCAF C-119's at London, Ontario.

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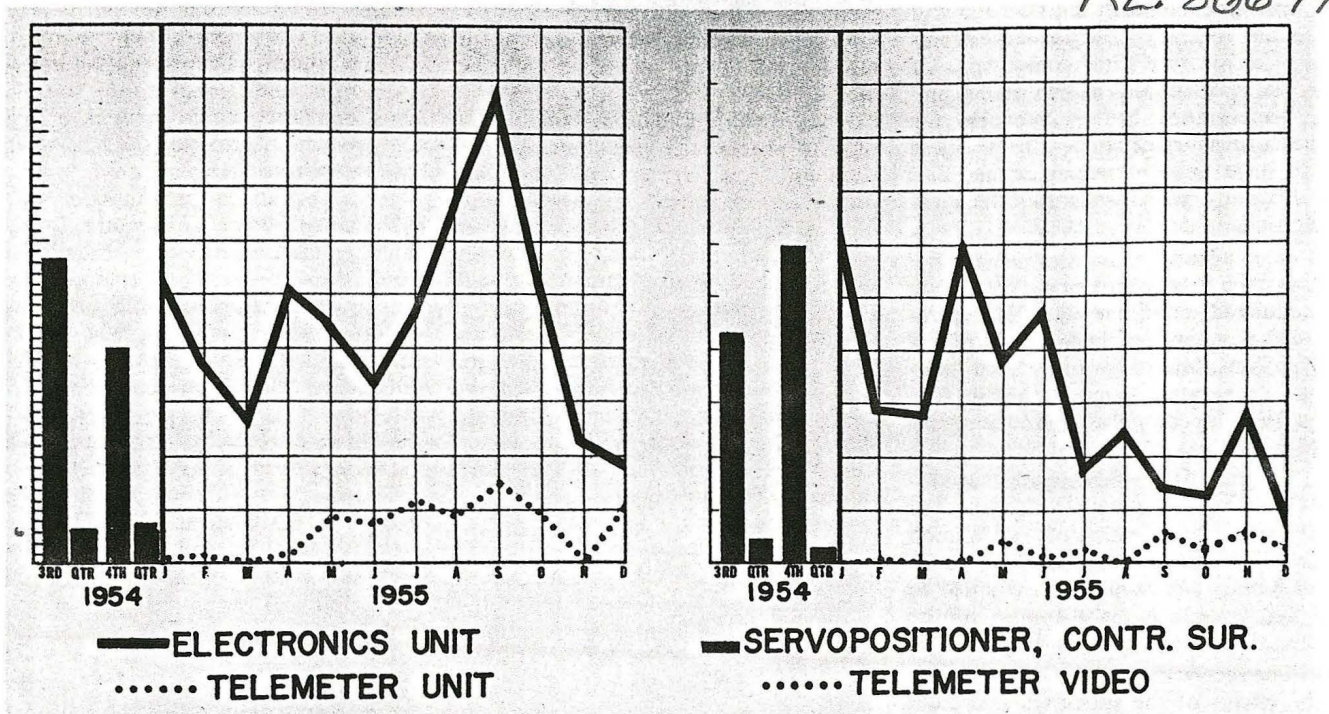


SPOTTING DEFECTS. Periodic control test results are plotted to indicate failure potential of various components.

Quality Control No. 5

Unreliability - Missilemen's Bogey!

By W/C G. B. Waterman, RCAF

"The sombre spectre that is dimming the prospect of easy defense by super missiles and other complex systems is called unreliability."

With these words, Leslie W. Ball, a technical director of the United Geophysical Corporation, Pasadena, keynoted a lecture he was giving to an engineering-management course at the University of California.

He went on to illustrate his thesis by a story of World War II, wherein the German Navy lost a wonderful opportunity to sink a large, ill-protected convoy of American arms on its way to Dunkirk-weakened Britain. For this task, Nazi submarines were equipped with a new type of torpedo, armed with a complex exploding mechanism. Only partially proven, the new torpedoes were not up to the job, and passed harmlessly under the Allied ships.

A man named Murphy once produced a series of dire predictions which go as follows: If it can fail, it will. If it can be hooked up backwards, it will be. All failures occur at the worst possible point in time and space.

The torpedoes of Mr. Ball's horrible example proved that Murphy's maxims are valid. These weapons had not been adequately designed or sufficiently tested, and were therefore not to be trusted for such a mission. As Mr. Ball pointed out, their weakness lay in the fact that "a component is unreliable until every mode of failure is known, understood, measured and controlled."

It is not the purpose of this article to define reliability, nor to attempt to justify the need for it. This is basically an article on quality control and its application to the airplane or missile manufacturer's reliability program. Reliability itself can be considered as being divided into two broad classes, one being concerned with the quality of design, the other with the quality of manufacture. In other words, reliability can be thought of as being the sum of quality components and for this reason, the words can be loosely regarded as synonymous.

I proposed this analogy recently to H. L. McKeown, a man who, as director of quality control for Canadair Limited, Montreal, is singularly qualified to discuss the control of quality in the missile age. He agreed that it was all a matter of definition. Quality control in the more commonly accepted sense, is considered to be the function that takes place after release of engineering, while reliability must be considered under the much broader concept of "over-all" quality.

"This in effect starts with the writing of the specification for the weapon (Mr. McKeown said) and continues through all functions having an effect on the end product". A similar opinion was expressed by G/C Robert McMillan, RCAF Chief of Quality Control, a few weeks ago in a speech to the Windsor Branch of the American Society for Quality Control.

He said: "I believe that the job of quality control is to determine the correct qualities, specify them, and see that they get into the product. I also believe that the job of the reliability experts is exactly the same."

These arguments are not an attempt to show that the problem of reliability is one which can safely be left to the Quality Department, and forgotten by the rest of the company. Nothing could be farther from the truth. Rather, I want to state emphatically that without quality there can be no reliability, and that in every company's reliability group, a prominent part must be played by the quality compon-

ent, a part certainly as great as that allotted to engineering, manufacturing or customer service.

The Canadair special weapons reliability organization is a good example of what I mean. A three-man reliability committee monitors and co-ordinates the work allotted to the major company divisions of engineering, manufacturing and quality control, and reports through a co-ordinator to a special policy committee comprising senior executives in all three branches. Terms of reference of this reliability group show clearly that quality's place in Canadair's new programs has been firmly established.

What is quality's job? How can good quality practices aid the efficient operation of the reliability group? I have said before that quality must be an all-pervasive thing which infiltrates engineering, purchasing and service operations as well as those of manufacturing. This theory accepted, there are a hundred ways in which good quality control practices can increase the reliability of a product. Just a few of them will be listed and discussed in some detail here.

These include: rapid information feed-back; manufacturing control; specifications and standards; procurement methods; testing; inspection; and training.

● *Information Feed-Back.* One thing stressed over and over again in conversations which I have had with USA missile contractors is the need for rapid reporting of quality defects to the reliability analysis group. These reports must be detailed to aid defect analysis, yet objective enough to tie in with some sort of automatic filing and sorting program.

At present, the RCAF relies on an unsatisfactory condition report system, which has proved slow and cumbersome in the past. It is likely that this will soon give way to modern procedures that will utilize Air Material Command's Electronic Data Processing equipment. Similarly, RCAF contractors will require an efficient, objective feed-back system to transmit and collate defect knowledge obtained from research and development, engineering, manufacturing, quality, vendors, field representatives, and other sources.

● *Manufacturing Control.* Reliability and producibility are characteristics of any system that must go hand in hand. The ways in which quality must enter the science of manufacturing are limitless, for unreliability appears continually because of inadequate manufacture.

The human propensity for error is shown more often here than in any other field. For example, one missile man told me that almost 40 percent of his test failures were due to faulty soldering alone.

Interchangeability whether it be functional, mechanical or electronic, is an important factor in missile or aircraft reliability. Tolerances are tighter, so that machines must be more accurate and more specialized. Failure to meet specifications because of 'process drift' is intolerable, and quality manufacture must be controlled by process control charts and adequate periodic inspection by the quality department.

In one missile plant, every production machine has over it four brightly colored signs: In control, Caution, Inspection, Out of control. The applicable sign is set by a roving quality man. Once he has called a machine Out of Control, the sign cannot be touched until he has satisfied himself that the operator is once again meeting tolerances.

● *Specifications and Standards.* One of the most difficult tasks that a military department or a company faces is the writing of specifications and standards that adequately describe the product to be purchased, lay down those qualification and acceptance tests to ensure it is satisfactory, and that are not just a slight variation on some perfectly satisfactory document already published.

It is one of the prime jobs of the quality department to reduce the number of specifications to a minimum, while assuring those that are left will do the job they were written for.

● *Procurement Methods.* Ball pointed out that it is cheaper to buy an unreliable product than a reliable one, and that to obtain reliability, procurement methods must depart from the 'lowest bidder' method of doing business. The next article in this series will consider this aspect in some detail.

● *Testing.* A previous article mentioned the importance laboratory testing plays in quality assurance; in a reliability program, such testing is vital. Testing can, of course, be divided into several different categories, such as: qualification tests; acceptance tests; final inspection and checkout; flight test; and periodic control tests.

The latter provide evidence of the failure potential of the various components, and are essential to any reliability program. To obtain this type of information periodic tests such as SHAKE (Slightly Harmful Application of a Key Environment) or test-to-destruction must be carried out.

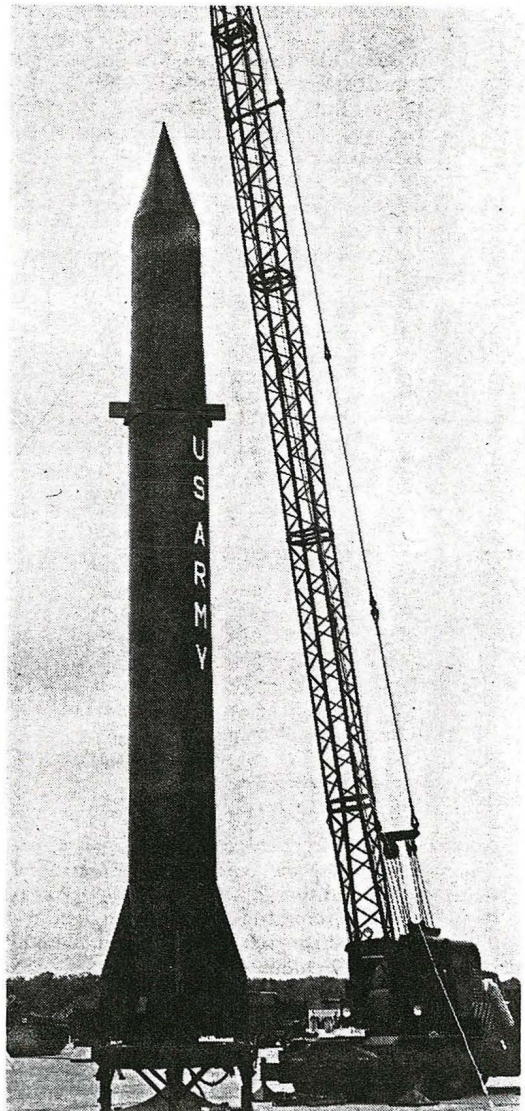
See the accompanying charts. This type of testing is of particular value in the missile industry, where flight test of each item is impossible.

All tests except developments are part of the quality assurance function. It is therefore logical to assume that they should be the responsibility of the quality department, whose sole job it is to see that purchased or manufactured items meet specification requirements.

● *Inspection.* This item has been dealt with in detail in previous articles. It should be pointed out, however, that for 1958 reliability requirements, the tremendous value of statistical quality control concepts must be realized and exploited to the utmost. MIL Standard 105 is no longer completely satisfactory. Newer, more restrictive sampling plans are often required.

● *Training.* "Reliability is an inverse function of ignorance." Reliability and quality thinking do not always come naturally. One of the prime responsibilities of the quality department in the reliability program is to ensure that everyone connected with it is aware of the needs of quality, of the best methods used to measure quality, and of the tools to be used to attain quality.

TALL ORDER. Many hours of arduous inspection and testing precedes the setting up of this U. S. Army Redstone.



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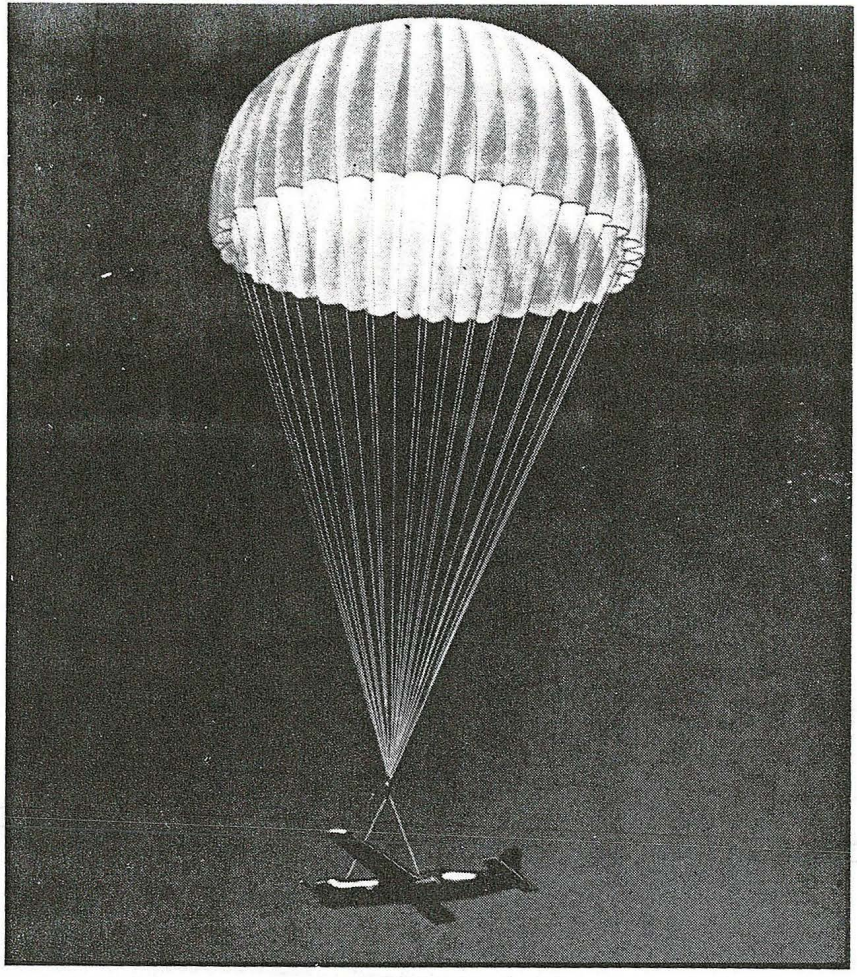
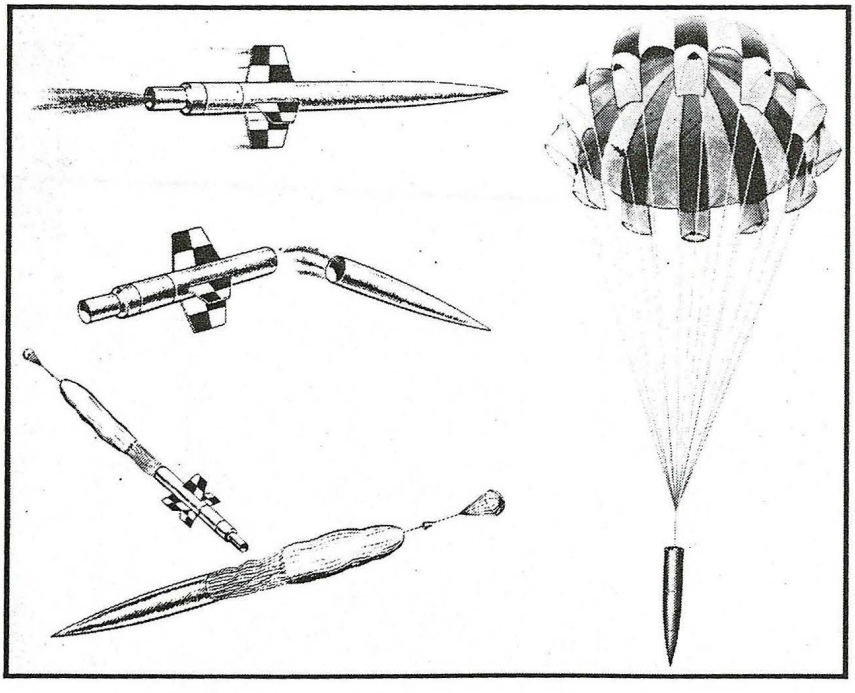


Making a Rapid Recovery

FASTER, higher flying has created the need for new kinds of parachutes. During the years that have passed since the end of World War II, there has arisen the need to explore heights into which men so far dare not venture, and to study the performance of objects flying in the troposphere and the stratosphere. Parachutes have proved vital to the success of these studies.

The result, according to Pioneer Parachute Co. of Manchester, Conn.— whose Canadian subsidiary, Pioneer Parachute Co. of Canada Ltd. is located at Smiths Falls, Ont. — is that the ten years following the war have brought about a remarkable expansion in the field of usefulness of parachutes.

Applications: Among the important new functions of parachutes are: recovery, which may take several different forms; stabilization, or guidance, of streamlined objects; braking, in which chute provides aerodynamic drag to reduce landing roll, etc. Sometimes the job can be done with one specially designed parachute; others require a system of two or more parachutes. Variables in the design problem are speed, function, shape, size and weight of load, atmospheric conditions, elevation, and landing requirements as regards precision and safety. Thanks to the work done in recent years, it is now possible to design a parachute for a particular application on a sound engineering basis, Pioneer says.



At top of page, radio-controlled target is recovered by means of Pioneer parachute. Above, illustration shows how rocket missile, upon completion of flight, separates into instrument and power sections which are then decelerated, stabilized, and lowered to ground by specially-designed Pioneer guide surface parachutes. Special pilot chute pulls out deployment bag containing main canopy, which is designed for stable descent of missile sections.

Recovery is now an extremely important function of parachutes. There are many applications. The rocket-type missle soaring at supersonic speed hundreds of miles above the earth, automatically records research data. Its mission completed, the missile separates in flight. The instrument and power sections are decelerated, stabilized and lowered safely to the ground by parachutes specifically tailored to meet the conditions of high speed and heavy load.

In many instances, several deceleration phases are involved which necessitate the use of additional parachutes or special deployment methods to accomplish a successful recovery.

RL. 866-2004

Calgary Sun
MAY 14/04

Shield slammed

WASHINGTON — The U.S. ballistic missile shield due to start operating by Sept. 30 appears incapable of shooting down any incoming warheads, an independent scientists' group said. An analysis found "no basis for believing the system will have any capability to defend against a real attack," the Union of Concerned Scientists said in a report. The Pentagon rejected the report, whose authors included Philip Coyle, a former top government weapons tester.

RL. 866-1954

NEW LITERATURE

It's a Woman's World

The Stars at Noon—Jacqueline Cochran (Little, Brown & Co. (Canada) Ltd., Toronto 13, 274 pages, $5.00).

This is the story of a most amazing personality, a colorful figure whose fame is of the sort that has little to do with sex, background or any other of the commoner influences which are supposed to have a bearing on success or failure. Miss Cochran is simply one of those rare people who by some mysterious alchemy of nature, are destined from birth to become famous as doers and leaders.

Though Miss Cochran's autobiography will add little to aviation literature, either in the sense that it is superior writing (indeed, it is poorly written) or that it advances the aeronautical art in any way, nonetheless it gives new insight into a personality who is often much-maligned as a publicity seeker. It will also gain new respect for some of Miss Cochran's accomplishments, though in many instances she shows a tendency to take personal credit for achievements and developments where her role appears to have been comparatively insignificant.

Jacqueline Cochran's life is a rags-to-riches story in the most extreme sense. Her first recollections are of her early childhood on the "Sawdust Roads" of the U.S. South . . . a Sawdust Road is sort of a family version of a Skid Road. She was raised by foster parents—to this day she doesn't know who her true parents are—had practically no formal education, fought her way to the top as a business woman, and to fame as a pilot, and along the way managed to contract a happy marriage with a man who is now one of the richest and most powerful financiers in the U.S.—Floyd Odlum.

We enjoyed this book and our sternest criticism would be that Miss Cochran is an incurable name-dropper who seems determined to impress the reader with the altitude records the little girl from Sawdust Road has set in international society. Several of the latter chapters are little better than a tabulation of the high and the mighty with whom she took tea or had audience during her immediate postwar travels.

Aid to Recognition

The Aircraft of the World—William Green and Gerald Pollinger (Thomas Nelson & Sons (Canada) Ltd., Toronto, illus., $5.00).

A little arithmetic reveals that this book contains over one thousand photos, and over 650 silhouettes of aircraft to be seen flying in all parts of the world. The commonest types and the rara avis are included—some being very rare indeed. For its price, *The Aircraft of the World* probably contains more illustrations than any other aeronautical book—and is excellent value for the money.

Photos are good, with a few very poor exceptions, and the printing . . . on art paper . . . is very good.

One does, however, quarrel with the author's claims for profundity; this is essentially a recognition book and is not in the least related to design, nor does it give design information. It is a first-rate quick reference to the general appearance of almost any aircraft in the world since it has an excellent alphabetical index—far better than the cumbersome classification by shape, e.g., "Large multi-propeller (Multi tail-fins)".

There will undoubtedly be many editions of this book and one would recommend the authors to revise their text and data, which are the least satisfactory features. Some of the comments are rather naïve and there is a tendency toward the *non sequiter*. Considerable space is wasted in the tabloid captions (particularly the three line descriptions of the secondary types) by unnecessary repetitions of the name of the aircraft and its maker—already given in the title. Performance figures are often optimistic: the statement that the Hunter F.1 is supersonic in level flight and the implication that the Swift is also, are scarcely borne out by the speed record of these airplanes.—*J.H.S.*

A Missile Roundup

Development of the Guided Missile—Kenneth W. Gatland (Iliffe & Sons Limited, Dorset House, Stamford Street, London S.E.1, 292 pages, illus., $2.25 approx.).

This is the second much enlarged edition of a work which we reviewed a year ago, and in its most recent version is of even greater value and interest. The new edition is, in fact, more than twice the size of its predecessor, so obviously it has been extensively revised and added to.

New features include chapters dealing with the problems of propulsion, research into rocket techniques and requirements, and post-war work on guided bombs. Of considerable interest is the detailed survey of Russian potentialities for long-range rocket development. An appendix reveals some details of the telemetering equipment used in British missiles, and another appendix showing photos, to scale, of over 40 notable rockets from various countries. The table of characteristics has also been enlarged, and now provides data on 140 powered rockets from eight countries (the first edition reviewed only 90 rockets).

Story of Power

Aircraft Engines of the World, 1954—Paul H. Wilkinson (published by the author, 225 Varick St., New York 14, N.Y., 320 pages, illus., $12 U.S.).

This is the twelfth edition of what is now well-established, so far as we are concerned, as a standard reference work. In this newest version we find no reason to temper the high opinion with which we have regarded every one of the earlier editions.

All sections of the book have been completely revised to make certain that they are up to-date, and in addition, there is a new section devoted to accessories and equipment.

In all, 70 turbojets and turboprops are described (most of them are pictured, also), including a number of Russian engines. Of this total, 15 are new engines which have been developed since the 11th edition. Piston engines continue to require extensive coverage and this year there are eight new units in this category, bringing the number described to over 50, including 21 helicopter engines. One of the new powerplants featured is the Canadian Pratt & Whitney PC-1, Canadian version of the R-1340.

Canadian-built engines featured in the gas turbine section are the Avro Canada Orenda and the Rolls-Royce

Power for the Future

Guided Missiles—by A. R. Weyl, A.F.R.Ae.S. "War rockets are of truly ancient origin. It seems that the Chinese were the first to attach plain-powder rockets to feathered arrows (about A.D. 1220), and in about 1500, Wan Hoo, a Chinese civil servant, tried a manned rocket projectile, and disappeared befittingly in a cloud." While it is incidental to the subject of Rocketeer Weyl's fascinating book, it is quite probable that no civil servant has since moved at a speed anywhere near to that at which the brave Wan Hoo travelled.

After reading this book, one can't help getting the feeling that the days of the turbo-jet are numbered before they are even really started. It is indeed surprising to learn of the immense amount of experimenting and practical work that has been done on rocket propulsion, for the purposes of both peace and war. It is also uncomfortably surprising to learn that though practically no information is available on present Russian efforts in this science, it is quite likely that the Soviets are well up in the forefront. And this not just because of the work of captured German rocket scientists either. It would seem that the Russians have long been interested in rockets.

Says the author: ". . . they (the Russians) were the first to use air-to-ground rocket projectiles operationally, and when the Germans penetrated to the Crimea during the late War, their experts were surprised to discover a huge store filled with rocket bombs of about ten hitherto unknown types which had never been used operationally. The experts were immensely impressed by the state of development exhibited by these missiles."

It is only natural that readers should be most interested in that best known of all rockets, the V-2, and in Guided Missiles they will find the complete story.

Apparently Russia, the United States and Great Britain are now responsible for most of the world's rocket experiments. Also apparently, the bulk of this experimenting is being carried on by the U.S. In matter of fact, the willingness of the Americans to let the public in on what is being done probably exaggerates the amount of work they are doing in comparison with the other two countries. This, of course, does not reflect upon the Americans, but rather upon the foolish reticence of the British. The Russians on the other hand, are all of the "strong silent type", so nobody expects them to say very much.

The author gets in a few hefty slaps at bureaucracy. Referring to a time in 1934 when an effort was being made to interest the British Air Ministry in rockets, he states: ". . . the Ministry stated pompously but stupidly that scientific investigation had given no indication that jet propulsion could be a serious competitor to the internal combustion engine and airscrew of the aeroplane."

The blurb on the cover reports that the book covers the evolution and principles of guided and directed missiles for military and peaceful purposes. It does it well, too, and at the same time in about the most interesting book of its type that we have ever read. Its 139 pages are packed with facts and priced at only seven and a half devalued shillings. Published by Temple Press Limited, Bowling Green Lane, London, E.C.1 (publishers of The Aeroplane, in which much of the material contained in this book appeared).

THE AIRBORNE SERVICES

Air Tragedy

An investigation has been launched into the mid-air explosion of an RCAF B-25 Mitchell near Ottawa's Uplands airfield early this month which killed the eight persons aboard including Air Vice Marshal R. C. Ripley, AOC of Air Materiel Command.

The Mitchell, recently converted to a luxury VIP aircraft for use by high-ranking officers, was on a flight from Churchill, Manitoba to Rockliffe, Ottawa. After refuelling at North Bay, the flight continued on to the capital city where, due to ground fog which habitually plagues the low-lying Rockliffe base, it was diverted to Uplands. The explosion occurred during an instrument approach, the wreckage falling some 12 miles from the runway.

Any connection between the Mitchell accident in Winnipeg and the one which followed less than a week later at Ottawa has been discounted by the Air Force. Although the B-25 is of war-vintage, the two aircraft involved were less than 6 years old. They were purchased from the United States at that time as surplus goods, but are attested to as being "almost new."

Missles For Army

According to newspaper reports, recent developments at home and abroad have enhanced possibilities that the Canadian Army will acquire guided missiles before long. The missiles, without atomic warheads, likely will go first to the Canadian Infantry Brigade Group in West Germany. The warheads would probably be supplied to the Army in event of emergency; i.e., Russian ground attack on western Europe.

All western armies now are planning to substitute more fire-power for a good part of their manpower. The British are reported to be preparing to cut their 80,000-man army in Germany to 50,000 men while maintaining four divisions. Until recently, defence planners did not intend that an army formation as small as a brigade would be equipped with weapons capable of firing nuclear packages. But these plans are changing as the fire-power of formations is increased.

In line with current Canadian Army plans for more mobility and flexibility, the 6,000-man brigade in Europe has almost reached the status of a division, which normally numbers some 18,000 men.

Pioneer Retires

Group Captain Lewis Leigh, OBE, ED, a Canadian flying pioneer, retired from the RCAF last month. At the time of his retirement, he was Group Commander, No. 2 Auxiliary Group, Toronto.

Born in England, he came to Canada at the age of 3, was educated in Lethbridge where he began his flying career. After several years of barnstorming across the prairies, he formed his own flying school in Medicine Hat. During the thirties, he flew Canada's northlands as a bush pilot.

In 1936, when TCA was formed, he was one of the embryo airline's three senior instructors. Later he was senior captain, flying the first passenger flights from Winnipeg to Vancouver, and later from Winnipeg to Montreal. Joining the RCAF in 1940, his experience and ability quickly carried him to the top in transport operations. He was senior air staff officer of the RCAF's No. 9 Transport Group, which is now Air Transport Command, and later the commanding officer of RCAF Station Goose Bay.

In 1946, G/C Leigh received the McKee Trophy for outstanding services to aviation in Canada. His decorations include the Officer of the Most Excellent Order of the British Empire, and the United State's Legion of Merit.

RCAF Takes Navy

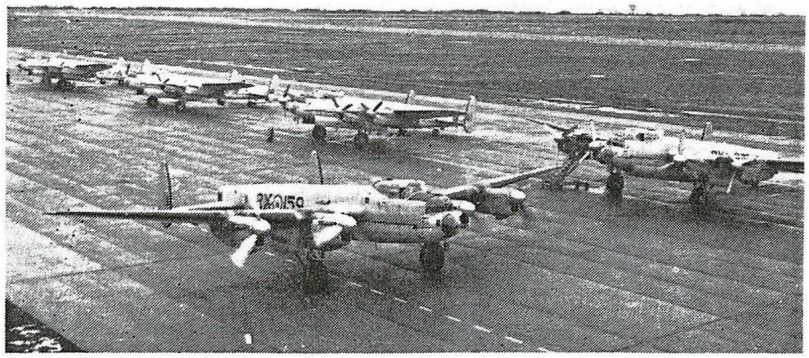
On the RCAF Overseas Ferry Unit's first trip of 1957, their 27th Random Operation since inception in October, 1953, were four Royal Canadian Navy aircraft. These four, a pair of Banshee fighters and two CS2F Trackers, are bound for flight trials aboard the HMCS Bonaventure, temporarily based at Belfast. To complete the menagerie being taken across with the Sabre 6 flights, was a CF-100 left in Bluie West One during the last Nimblebat Operation. The big night fighter had been forced down at the Greenland alternate while enroute Goose Bay to Iceland.

Random 27, led by the Unit's commanding officer, Squadron Leader Don Cuthbertson, DFC, was made up of 22 Sabre 6's bound for No. 1 Fighter Wing, Marville, France. During its three-year life, the OFU has succeeded in delivering over 700 Sabre and T-33 aircraft to Europe without the loss of a single pilot. In command of the Navy aircraft accompanying the Random operation, was Commander H. J. Hunter. They have been flown to the Royal Naval Air Station near Portsmouth, England for initial trials.

New Ejection Seats

At the present time the RCAF is fitting all its T-33 and F-86 aircraft with automatic "Z" type harnesses, incorporating the GQ Mark VII automatic ejection device. Tests on this device for the F-86 and T-33 are about three-quarters complete.

These modifications to the ejection seats will be fitted at the rate of 100 per week on Canadian-based Sabres and



NORTH PACIFIC EXERCISE: The RCAF's 407 Maritime (Squadron 407 Lancs above) based at Comox on Vancouver Island recently participated in routine exercises with the U.S. Coastguard and Naval forces in the Gulf of Alaska. The joint exercise, the first combined operation of its type to be held in the fog-shrouded Gulf of Alaska area lasted from March 5 to 9. One objective of the operation was to train the aircrews in the severe weather usually found in the Gulf of Alaska area.

RL. 866-1957

Editorial

ON THE RIGHT

The author of the guest editorial appearing in the right hand column of this page this month, Group Captain Charles B. Limbrick, CD, AFCAI, writes with some authority on his subject. In the several years prior to his recent retirement from the RCAF he served variously as Director of Guided Missiles and Special Weapons, and Director of Radio Warfare. He was responsible for the organization and installation of major Canadian radar facilities during and after World War II, and he initiated the Air Force Guided missile program.

IROQUOIS ACHIEVEMENT

In recent years Canadian firms have been making quite a name for themselves in the international aviation field. Sales of aircraft and engines — large numbers of both types of equipment being of native design, as well as manufacture — in the highly competitive foreign markets, have grown far beyond token numbers. Now, the crowning achievement: the sale by a Canadian firm to a U.S. firm of a license to build a product that is Canadian from conception. The Canadian firm — Orenda Engines Ltd.; The U.S. customer — Curtiss-Wright Corporation. The product — Orenda's heap big engine, the Iroquois. That the product concerned should be from such a technically complex field as turbojet design; that the customer should be, in a sense, a competitor (and one which has far greater design, development and financial resources at its command than the seller) makes this achievement on the part of Orenda Engines even more admirable. This is the ultimate proof that Canadian design capabilities in technical fields are the equal of any in the world.

SATELLITES AND MISSILES . . . .

by G/C C. B. Limbrick, CD, AFCAI

Since the Russians have launched their world satellite questions have been asked concerning the military significance of this remarkable achievement. Strangely enough, there seems to be more excitement aroused over the satellite project than at the announcement by the Russians that they had successfully fired an ICBM. On the other hand, statements have been made — by experts — that the satellite had little or no military value.

Perhaps it would be useful to examine some of the characteristics of the ICBM and also the possible relationship between it and world satellites.

Countermeasure: First let me point out that the amazingly successful use of *radiating* electronic devices during most of the last war has been drastically limited by the development of powerful electronic countermeasures. The cold fact is that any radiating electronic device can be detected and to a greater or lesser degree countermeasured or made useless to perform its function.

The success of military operations is almost completely dependent on radiating electronic equipment. Radar, communications, navigation, guidance of certain missiles, control of aircraft . . . all employ radiating equipment and are therefore subject to interference.

The ICBM could be launched and controlled throughout its flight from take-off to target with non-radiating devices. It might be found more convenient and more accurate to have a very short duration of radiating signals at the commencement of flight. Such transmissions would be difficult to countermeasure.

Now let us look at the defence. To the best of my knowledge the only way to detect and track an ICBM would be by devices that radiate. Obviously such installations can be located, and should suitable equipment be developed, countermeasured. Here then we have the uncomfortable situation of a quiet enemy and a noisy defence; i.e., the attacker is not vulnerable to electronic interference and the defence is.

How does the satellite affect this situation? In many ways, I believe. The operation of a man-launched satellite will give the Russians the first authentic information of the launch, flight and control problems in outer space. New data on items such as temperature, pressure, functioning of electronic devices, mathematical compution, stabilization, power requirements and last but not least — confidence — will be of tremendous value in the development and operation of ICBM's. However, there is another possibility, the use of satellites as vehicles to carry equipment to countermeasure our ICBM detection and anti-missile control systems. There are many problems to solve before this is possible; perhaps the Russians have some of them beaten. The facts are that a satellite has been launched and that it does radiate energy, therefore is conceivable that satellites could be used to confuse the noisy defence whilst the silent ICBM is making an attack.

Non-Fiction: It is also possible to conceive of a gradual building up of a large number of satellites, all making precise orbits on different courses and at varying altitudes. These fleets of satellites could be under radio control and used either to drop weapons or to carry out large-scale countermeasures.

My suggestion is that if we are to survive in our way of life that we must make every possible effort in the application of science and invention to defence, and that we must close the gap between military requirements and delivery of the equipment.

NEWS ROUNDUP

Airport Zoning

An amendment to the Aeronautics Act to provide for zoning around Canada's airports was introduced to Commons by Transport Minister Lionel Chevrier on May 7. The new zoning regulations will control the height and/or existence of all structures or natural obstacles which lie on the approaches to airports.

Provision is also made for the payment of compensation to parties whose property is devalued as a result of the proposed regulations.

In answer to questions Mr. Chevrier said that each airport would be considered on its own merit. He described the proposed restrictions as being divided into three classes: Restrictions which would apply horizontally from the centre of an airport to about 13,000 feet outside the centre; restrictions which would apply to the approaches on a sloping plane; and restrictions which would also apply to the sides of the approaches.

Although the Minister did not seem to think that there would be many instances where buildings now in existence might have to be taken down, he did explain that when such a problem arose, the removal of the obstructions would be dealt with under the normal procedures of expropriation for which compensation is provided under the Expropriation Act.

Gunk Licensee

Curran Corporation has announced the appointment of Radiator Specialty Company of Canada Limited as exclusive manufacturers and distributors in Canada of Gunk Solvents, widely used in cleaning and degreasing processes in aircraft engine and aircraft overhaul plants. Radiator Specialty Company is located at 340 Gerrard Street East, Toronto.

Jack & Heintz Agent

Jack & Heintz, Inc., of Cleveland, Ohio, has named Aircraft Appliances & Equipment, Limited, Toronto, distributor of the complete line of Jack & Heintz rotomotive equipment in Canada. The Toronto firm, which is also exclusive Canadian distributor and repair contractor for Hartman relays, will continue to act as repair contractor for J & H electrical aircraft accessories.

As a result of the new distributorship, Aircraft Appliances & Equipment has increased its sales staff, added personnel, and nearly doubled repair and storeroom facilities by adding a new wing to its building at 71 Kipling Avenue South, Toronto 18. In addition, E. C. Thompson has been named plant superintendent and chief inspector.

Met Meet

The 117th National meeting of the American Meteorological Society will be held in Buffalo, July 1-3. On July 2, the Buffalo Section of the Institute of the Aeronautical Sciences will act as joint sponsors with the AMS. Full details of the meeting may be obtained from the Buffalo Section at P.O. Box 235, Buffalo 21, N.Y.

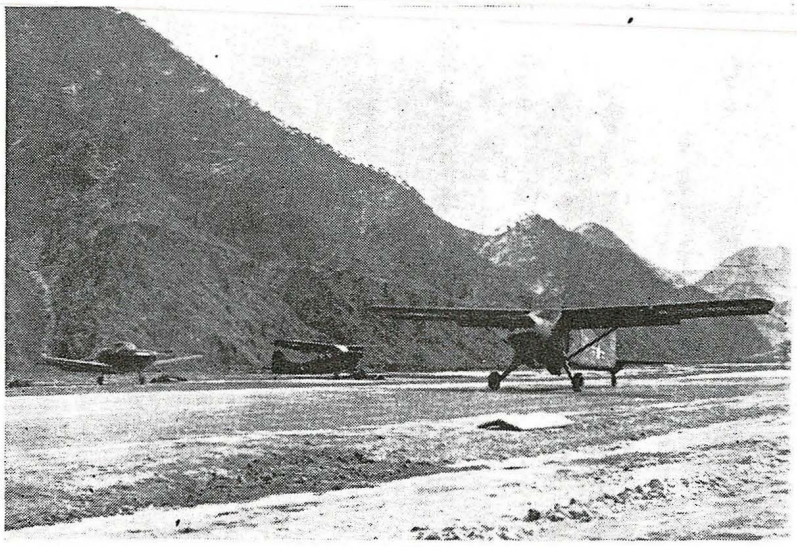
missile is intended for use by the RCAF.

Other recent information from the Valcartier research laboratory is that Professor Carleton Craig, who has been superintendent of the Armament Research & Development Centre for the past two years, has returned to his post at McGill University, which had loaned his services to the Defence Research Board. Prof. Craig is credited with initiating the guided missile project. He has been succeeded at Valcartier by Dr. Hugh Massey Barrett, chief superintendent of the Defence Research Board's Suffield Experimental Station, Ralston, Alberta.

U.K.-N.Z. Air Race

Entry forms are now available for the England to Christchurch, N.Z., Air Race to be held next year. The Race comprises a Speed Section and a Transport Handicap Section, to be flown concurrently over the same course. Flight refueling will be allowed in the Speed Section only. The winner of each section will receive 10,000 pounds in prize money and in addition the Harewood Gold Cup will go to the winner in the Speed Section.

The Race is being sponsored jointly by the Royal Aero Club and the Canterbury International Air Race Council of Christchurch, and is due to start on or about October 10, 1953. Airplanes of all types and nationalities are eligible for entry.



ACTIVE SERVICE: Beavers are now playing an active role in the Korean War. Known as the L-20 to the U.S. Army, the Beaver is being used mainly for ambulance work. Shown here on a Korean landing strip, the Beaver's unique take-off and landing characteristics make it particularly adaptable to Korea's mountainous terrain.

National Air Show

The date of the Toronto Flying Club-organized National Air Show has been set at September 20. In charge of the organization work is Chairman Frank Young and Vice-Chairmen William Mulock and Russ Bannock.

Guided Missile

An air-to-air guided missile is one of the projects under development at the Armament Research & Development Centre, Valcartier, P.Q., Dr. O. M. Solandt, chairman of the Defence Research Board revealed recently. The

NEW LITERATURE

Missile Warfare

War and Peace in the Space Age— by Lt. Gen. James M. Gavin (The Musson Book Co. Ltd., Toronto, 289 pages, $6.00).

Written by one of the U.S. Army's brightest young generals, *War and Peace in the Space Age* comes as a warning to the western world to modernize its military thinking or go under. Covering the years between the first atomic bomb and 1955, "The Decade of Dilemma", he moves on to the following "Decade of Decision", 1955 to 1965. Gen Gavin feels strongly that the western powers are falling behind in the race for technological and scientific supremacy with Russia. In particular he criticizes the American government for having permitted the situation to deteriorate as it has, and charges that little is being done at the present time to correct matters.

As regards the present, and looking ahead to the immediate future, Gavin offers the following opinions:

- Too much emphasis is presently placed on missiles themselves and not enough on support systems and ground handling equipment for those missiles.
- An Army man, Gavin feels that the USAF's SAC should not be allowed to continue working on the manned-bomber concept. Bombers are ready to be replaced by IRBM's and ICBM's.
- Mobility of missiles is of paramount importance. Both government and scientists tend to think only of permanent launching sites which are vulnerable to enemy missile attacks. (As proven in the last war when every static German V2 launching site was obliterated by Allied bombers, while not one mobile V2 was destroyed).
- Nuclear weapons will be refined to a point where they will become of tactical value, capable of being fired by a single rifle-carrying soldier. Atomic warheads will be used much as explosives were in the last half-century.
- Air mobility for ground forces is a must. Nuclear warfare will demand smaller, more highly-trained units of "sky cavalry".

General Gavin resigned from the U.S. Army as a protest against the system which brings a military man before the Congress to sell the program of his particular service. Despite the foreboding picture of the straits we are in at the present time, and the gloomy years of "The Missile Lag", (1959-1962) Gen. Gavin sounds a cautiously optimistic note:

"I am of the personal conviction that the space age offers for the first time a real prospect of lasting peace . . . if this planet is to remain habitable by man, a space program must be developed under the United Nations."

To sum up: A clear word of warning. Is it in time?

Book of Many Words

A Dictionary of Contemporary American Usage — by Bergen and Cornelia Evans (Random House of Canada Ltd., Toronto 3. 567 pages, $7.50).

The authors have set out to list words, phrases and sayings which are commonly and uncommonly used in the U.S. today. They explain the generally correct usage of the term and the incorrect employment of it. They try to show the word used in its different contexts, its different meanings and implications.

While it is not in the true sense a grammar text, the book does contain a full discussion of English grammar. It is a dictionary intended as a reference book on current English in the United States.

Sample excerpts: "Airship — when used at all; designates what is now more generally called a dirigible, a lighter-than-air craft which, in contradistinction to a free-floating balloon, may be navigated."

Old Soldier Refuses to Fade

Mission Completed — by Sir Basil Embry (The Ryerson Press, Toronto. 336 pages, illus., $5.00).

Sir Basil Embry, GCB, KBE, DSO (3 bars), DFC, AFC. This is the autobiography of one of England's military professionals who served in the RAF for 35 years and rose to the exalted rank of Air Chief Marshal. His childhood ambition to fly was realized in 1921 when he had his first trip in a Mono Avro RAF trainer.

Embry served as head of the RAF Fighter Command in the years immediately following the war; in 1953 was made Commander-in-Chief of AAFCE. Says the author himself of this, his last post: "In all my 35 years' service I have never felt as frustrated as I did during the latter half of my period of command of the air forces of Central Europe."

The reason for Embry's disquietude is of utmost importance to the Western world. Said Embry: "The Western European Theatre was organized to deal with an out-of-date war . . . Its military thinking was geared to a 1945 concept and its strategy to a land campaign of the same vintage." The author feels that the refusal of the NATO military hierarchy to progress from the memory of field-by-field, house-by-house warfare to the realities of today's atomic air strike concepts will lead to disaster. The way is being shown by Russia and the USAF's SAC, but NATO isn't following suit.

Air Chief Marshal Embry feels we are neither efficient nor ready for "instant action."

To sum up: Well written and provocative.

Air Power Today

SAC: Strategic Air Command — by Richard G. Hubler (Longmans, Green & Co., Toronto 16, 280 pages, $5.25)

"SAC lives in the midst of nations that give lip service to peace and yet can find no agreement to maintain that peace except by the threat of war. In an age which calls itself the most civilized in the history of man, the ultimate appeal must still be raw force."

Mr. Hubler not only tells the interesting-in-itself story of the USAF's Strategic Air Command, he forthrightly states its reason for existence, its capabilities and its intent. In 18 well-written chapters he outlines the history of SAC, its set-backs at the hands of other military interests, its leaders, equipment and training of personnel.

If the anticipated advances in missilery come about, it seems likely that SAC as it is now known will be abandoned. Armed peace will continue grudgingly maintained at the crushing expense of scores of ICBM's poised on underground launch pads. For the time being, as for the past 12 years, SAC must stand as the organization which expects to be expendable should America be attacked. "Everything in that Command", says Hubler, "is instantly and totally dispensable."

MISSILES

Minute Man Approved

The USAF received approval late last month for a new project to produce an advanced type of ballistic missile whose range can be varied from 500 to 5,500 miles. The project, known as Minute Man, calls for underground installations harboring solid fuel missiles situated miles apart to make them less vulnerable to enemy attacks.

The Minute Man project is reported to have caused some resentment from the U.S. Navy faction which claims that the USAF has used misleading material to show that Minute Man would be from 10 to 100 times cheaper than the Navy's submarine-based Polaris missile program.

Amateur Rocketeers

The U.S. Civil Aeronautics Board has indicated concern that amateur attempts to fire rockets will become a hazard to aircraft. "There is no question", the CAB said, "that amateur rocketry should be encouraged in the interest of greater scientific orientation, particularly of students. It is equally obvious, however, that instruction and experimentation in this field must not become a threat to the safety of other users of the nation's airspace."

The Board has endorsed a proposal made by the CAA that civilians planning to launch rockets should first discuss their plans with CAA safety inspectors located at points throughout the country. Both groups of officials are working closely to maintain surveillance of amateur rocketry in order to reach a conclusion as to whether special legislation will be required.

Missile Squadrons Form

The USAF has formed its first two squadrons to be equipped with intermediate range ballistic missiles. It is indicated that the two missile squadrons, after a period of training, will be sent to the U.K.

The squadrons, which will come under SAC, will make the first addition of ballistic missiles to U.S. long-range striking power. One of the squadrons will be equipped with the Thor missile developed by the Air Force, and the other with the Jupiter, developed by the U.S. Army.

Both missiles have a range of 1,500 miles and can carry thermo-nuclear warheads. Under a 1956 Defence Department decision, the USAF is to have operational control of intermediate range ballistic missiles, and of intercontinental ballistic missiles with a 5,500 mile range.

U.S. Army Missile

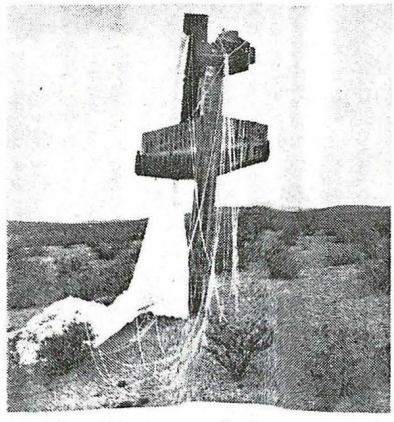
The U.S. Army's newest surface-to-surface guided missile, Lacrosse, gets its extreme accuracy because it is controlled by a forward guided station which acts in a capacity similar to a field artillery observation post. Control by a forward guidance station enables Lacrosse to accurately hit a target without precise target data at the launch site which other surface-to-surface guided missiles require.

Since the U.S. Army is the major using arm, development of the weapons system has been under Army control; prime contractor is the Martin Company. A Lacrosse guided missile unit is now in training at the U.S. Army Ordnance Guided Missile School.

Although originally designed for close troop support, Lacrosse's role has been expanded to include general support, and the missile is capable of delivering numerous types of warheads.

Lacrosse has an overall length of 19.2 feet, a fuselage diameter of 20.5 in., a wing span of 9 ft. and a fin span of 4.7 ft. The missile body has three major assemblies: the nose section, the centre section and the tail section. Four swept wings and four movable tail fins control pitch, yaw and roll. They snap into slots in the body. Propulsion is by a solid propellant rocket.

Martin is also producing the missile launcher which is mounted on a standard 2½ ton army truck, along with ground equipment which rounds out the complete weapon system.



WELL DONE: Burned to a black waffle pattern by searing air friction heat, this Lockheed X-7 ramjet missile recently set new speed and altitude records for air breathing vehicles.

Polaris Ahead

The USN's Polaris ballistic missile is running more than a year ahead of a top-priority development schedule, thanks to a streamlined Manhattan-Project-type organization and the efforts of a well-knit industrial and scientific team. Rear Admiral William F. Raborn, director of the Special Projects Office recently said that the Navy's thermonuclear missile will be operational in the fleet by 1960.

"All phases of Polaris development are making such good progress that our greatest fear is over-confidence," the Admiral said.

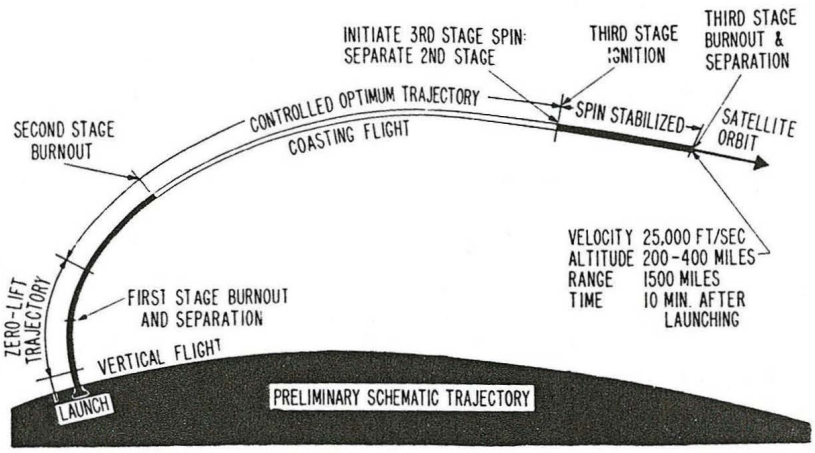
Admiral Raborn conceded that the Polaris will be smaller and lighter than other long-range missiles, but he gave no specific figures. He did indicate that the range, in the 1500-mile class, would be capable of stretching as improvements in solid fuel motors are instituted.

Boron Fuels

Aerojet-General Corp., and Stauffer Chemical have announced a joint partnership agreement under which they will develop and produce boron compounds, expected to be widely used as a fuel for rockets, missiles and aircraft. The partnership will be known as the Stauffer-Aerojet Co. The business of the new company will be conducted principally at Azusa, Calif., corporate headquarters for Aerojet General, which has the largest chemical staff in the west devoted to rocket fuel research.

Main activity of the new firm will be research and development of suitable methods of manufacturing high energy fuels.

Stauffer Chemical Co. was founded in San Francisco in 1885. Since 1895, it has been mining boron ores and producing boric acid and more recently, other boron chemicals. Last year, Stauffer completed the country's first large scale plant to manufacture boron trichloride, an important chemical intermediate for the production of boron fuels.



Science Non-Fiction

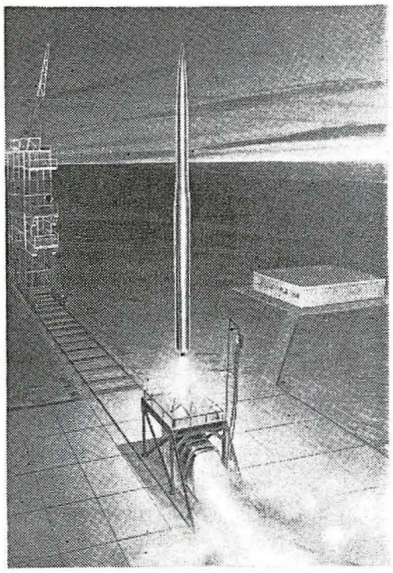
"Project Vanguard", the program which the U.S. hopes will put the world's first man-made earth satellite in orbit about the earth, seems to be moving ahead with commendable speed. Vanguard is part of the contribution of the U.S. to the world-wide scientific program planned for the International Geophysical Year (1957-58)

Recently, the USN (which is responsible for the program) and the Glenn L. Martin Co. (which is the prime contractor), released the accompanying drawing illustrating the three-stage rocket vehicle (right) which will transport the satellite to outer space, and the trajectory of the vehicle (top) from its launching point at Cocoa, Florida, to its orbit some 300 miles above the earth.

According to Martin, the satellite launching vehicle will incorporate the first liquid fuel rocket designed to be controlled without the use of fins. Changes in attitude of the vehicle will be accomplished by thrust diversion.

The vehicle will comprise three stages, made up as follows: the first stage, approximately 4 ft. in length, and utilizing liquid propellant, will resemble the Martin Viking research rocket; the second stage, mounted above the first stage, has a cone-shaped nose section. It also uses liquid fuel. The third stage, with the satellite attached to its nose, will be carried completely enclosed within the second-stage rocket. A solid-propellant rocket was chosen for the third stage because of its simplicity. Liquid-fueled rockets were chosen for the first and second stages because it is easier to guide this type.

The first stage, which launches the entire assembly, will burn out its fuel at an altitude of between 30 and 40 miles. Then it will separate and drop off. The second stage will start firing, and at a certain time during the second stage burning will jettison its nose streamlining, leaving the third stage and the satellite exposed.



The second-stage rocket will tilt in the direction of the satellite's predetermined flight path. After its burnout, the second stage will continue to coast upward until it attains the satellite's intended orbital altitude. There a spinning movement will be imparted to the third-stage rocket to insure directional stability. By that time, the third stage will be set on its course; the second stage will drop off, and the third stage will start firing.

The third stage, which has no guidance system, will be required to boost the satellite's speed to some 18,000 mph. At burnout, the satellite may be nudged ahead by means of a releasing device, thus making its speed slightly greater than that of a rocket. The latter will not immediately fall away to earth, but will trail the satellite until atmospheric drag causes both gradually to slow down and spiral to a lower level. Friction induced by the increasing density of the atmosphere will cause both satellite and rocket to burn and disintegrate.

edge. The latter is for engine hot-air de-icing and there are two outlet slots at the tip.

The fuselage is less well finished, suggesting that the visiting airplane was a prototype. The rivetting is decidedly rough in places. The skin panels look as if the longitudinal stiffeners were attached to them before offering up to the frames, and the fuselage was undoubtedly built in sections—eight or nine. There is considerable reinforcement of the skin along the line of the windows and above the wing spar.

There is a front cabin with four windows, and behind this are two small dining saloons (starboard) and the galley/pantry (port); both the saloons and the galley/pantry have raised windows. The main cabin has seven windows and is followed by a vestibule, and finally, just ahead of the tail, a toilet and cloak section. This section also features raised windows, these being provided for the sake of modesty. The cabin floor is continuous and level from nose to tail.

Ample Room: Seating is 50 in the VIP version and 70 in the "tourist", but by Western standards, up to 100 could be seated. Furnishing, in blue and walnut, is the same "Victorian" style as the Tu-70—in fact, fuselage layout (windows, etc.) is almost identical.

The fuselage is fully 11 feet across, with the floor near the diameter. The windows scale at 15 in. and suggest a present seat pitch of between 41 and 43 inches.

There are underfloor holds with very close-fitting doors on the centre line. The fuselage bottom is high (about seven feet), so side hatches would have been very inconvenient.

The cockpit windows have windscreen wipers and the rearmost triangular window opens for direct vision. There is more roof glazing than usual in a transport. Crew space aft of the cockpit is considerable, while there is a navigator's station in the nose—complete with a bomb-aimer's window and H2S type radar.

There are front and rear doors on the port side, with a sealed door to starboard near the cockpit—Russian airliners normally have doors in the starboard side.

The tail unit appears identical with that of the Badger, even including the curiously abrupt dorsal fin. Both fin

(Continued on page 85)

Swallow SD-4 Drone

The newest surveillance drone to be announced by the U.S. Army is the SD-4 Swallow. The Swallow is being developed and produced by Republic Aviation under a $25 million contract. The versatile drone will use a variety of advanced sensory techniques for military surveillance purposes, including radar, infra-red detection and photography.

The Swallow will start its mission by being launched from a special zero-length launcher with the aid of rockets. Once airborne, the rockets will be separated from the drone and its jet engine will take over. Missions can be accomplished by either a pre-programmed automatic guidance system, or by ground and air controlled systems.

The new drone has a delta wing spread of 11 feet, and has the air intake in the form of a scoop under the fuselage. Recovery is made by parachute.

USAF White Lance

A new version of the US Navy's Bull Pup, air-to-ground missile, has been adapted for the USAF and is known as White Lance. Manufactured by Martin, the White Lance has TV-type guidance, liquid-propelled engine, and a nuclear warhead.

Television guidance will increase the missile's effective range to horizon limits. A scanner-transmitter will be mounted in the nose of the White Lance, while a receiver in the cockpit will allow the pilot to monitor its flight path. The packaged liquid-propellant engine will be provided by Reaction Motors. Chief advantage claimed for the "packaged-liquid" concept is that it can be shelf-stored for years. Several NATO countries have already expressed interest in White Lance; will possibly want to produce them under licence.

New Missile Carrier

The U.S. Army now has a "Thermobile", which resembles a highway refrigerated trailer, for preconditioning solid propellant missiles before they are fired in calibration tests at Redstone missile base. Four of the mobile chambers have been built by Lockheed and delivered to the Alabama missile site.

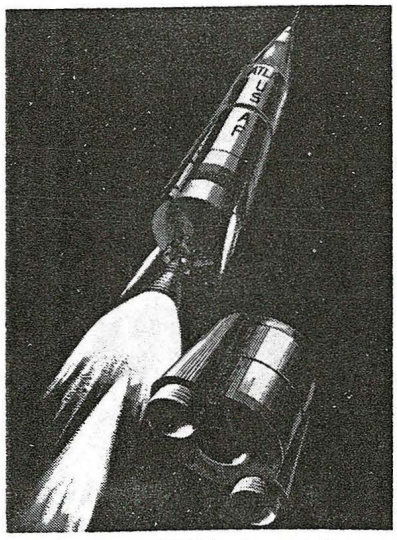
Propulsion effectiveness of a solid propellant missile is dependent upon temperature and moisture content. The Army has been using a stationary conditioning unit to simulate varying weather conditions. The mobile unit eliminates travel distance, and temperature change, between the stationary conditioner and the firing site.

The Thermobile can also be moved from one test site to another, either by highway, or by removing the wheels and slipping the steel chamber into a C-130 Hercules for air transport.

Foreign-Built Hawks?

Some speculation has arisen as to whether the Hawk missile might be put into licenced production in several European countries. Five different companies are said to be interested: three Dutch, one Italian and one French. In France, Sud Aviation is reportedly seeking to build the missile in association with Fiat of Italy. The Dutch companies thought to be involved in preliminary negotiations with Raytheon are: Fokker, Philips, and Hollandse Signalapparaten.

Although nothing definite has been decided, it is considered likely that if licencing agreements were made, Raytheon would provide technical assistance to the companies involved while they would themselves handle the problems of production. It has also been reported that a couple of Dutch manufacturers are similarly interested in the Sidewinder.



ATLAS SEPARATION: An artist's conception shows booster separation during a long-range flight of the Atlas. Twin-booster and sustainer engine are ignited together at launch; booster is jettisoned at relatively low altitude to reduce weight. Atlas develops 360,000 pounds thrust.

Halogen Leak Detectors

Missile failures due to leakage of rocket engine propellant at critical stages are fast becoming a thing of the past. General Electric has devised a super-sensitive instrument known as the Halogen leak detector.

The leak detector consists of a new standard control unit and one of several probes. To test for leaks, the operator introduces a tracer gas containing a halogen compound into the rocket engine system. Then he passes the probe over the external surface of the engine. Any escaping gas sets off an audible alarm and causes an electrical signal on the control unit. Leak detectors of this type are being used in many installed pressure or vacuum systems. Among these are piping systems, pressurized tanks, vacuum furnaces, air-conditioning and refrigeration.

Goose Cooked

The Fairchild Goose missile research program has been cancelled by the USAF. Reason given for the cut-off of the SAC missile was that rapid changes in operational concepts had altered the requirement.

The USAF directive stated that the Fairchild J-83 power-plant, which has been powering the Goose during recent successful test firings, is being re-evaluated. No decision regarding its status is possible until such study is completed. The Goose air-breathing missile research project was begun in 1955 and all its test firings have been held under tight security wraps at Cape Canaveral.

Regulus Automatic Landings

Bell Aircraft Corp.'s automatic all-weather landing system has landed the Regulus II surface-to-surface guided missile on two occasions as part of an evaluation program. The landings were made at Edwards AFB on October 8 and 15. Purpose of the test program was to determine whether the Bell automatic system could be used to recover the Regulus missile after test flights at the California base.

Another type of automatic Bell control system has been credited with saving more than $100 million during the Regulus I program by landing missiles more than 600 times.

RL 866-0000

THE INDUSTRY

S.A. Buys Sabre 6's

Canadair recently announced the sale to the South African Government of sufficient Sabre 6 aircraft, plus spares to equip two squadrons of the South African Air Force. The exact number of aircraft was not disclosed, though probably about 40 machines are involved. Canadair President J. Geoffrey Notman placed the value of the order at over $10,000,000.

SAAF veterans of Korea, who had flown USAF F-86's there, recently flew late model RCAF Sabres in Europe, and this experience apparently helped influence the South African Government in favor of the 6's. Canadair VP Sales Peter Redpath commented that the superior performance of the 6 clinched the sale. Though deliveries could start immediately, South Africa has asked for them to be delayed until nine months hence, with completion of the order in the following three months.

Training of key SAAF personnel, both air and ground crews, will be done at Canadair. The fighters will likely be ferried from Montreal via the U.K., Europe, and North Africa.

Avro Expansion

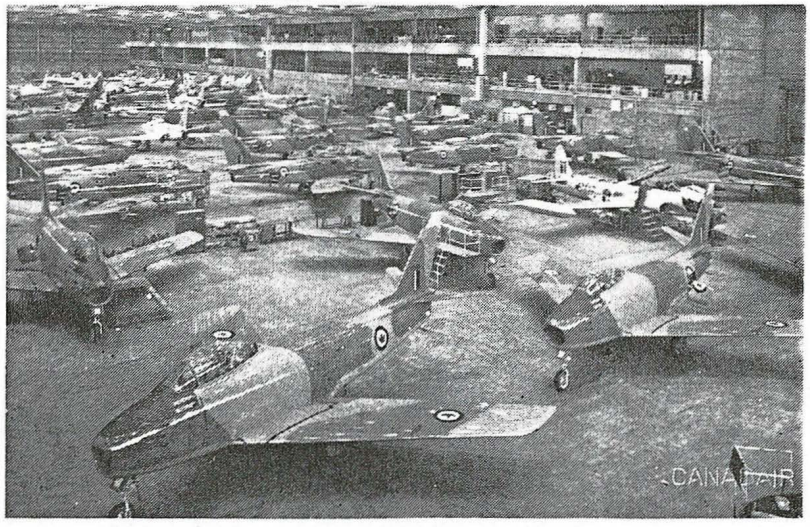
A. V. Roe Canada Ltd. has offered, for $30 a share, to purchase all the outstanding stock of Canadian Car & Foundry Co. Ltd. The transaction would amount to roughly $22,200,000.

Cancar, with plants at Montreal and Fort William, manufactures aircraft, aircraft components, railway cars, streetcars, buses, mining equipment and steel castings. It is currently completing a USAF contract for Beechcraft T-34 Mentor trainers and tooling up to build components for the Grumman CS2F Sentinel anti-submarine aircraft. Some months ago it filled Canadian and U.S. orders for more than 500 T-6 Harvard trainers.

Among the company's wartime assignments were the construction of Hurricane fighters and Helldiver bombers and the fabrication of parts for other combat aircraft. It also built prototypes of two of its own designs, the Gregor biplane fighter and the McGill biplane trainer, and the prototype of a twin-engine transport, the Burnelli Loadmaster. Before the war it built a small number of Grumman Goblin naval fighters.

If Avro's offer is accepted — and the shareholders have until October 8 to make up their minds — CanCar would join the industrial complex that already includes Avro Aircraft, Orenda Engines and Canadian Steel Improvement. Avro's expansion is patterned generally after that of the Hawker Siddeley Group in Britain, of which it is a member.

Avro president Crawford Gordon, Jr., said the proposed integration was a natural one and that there were many mutual advantages which could accrue. It "represents another step toward the previously announced goal of A. V. Roe Canada . . . toward a broadening of its industrial base and a diversification of its operations and interests . . . and reflects, I believe, the deep-rooted interest of the Hawker Siddeley Group in our Canadian operations and in the future of Canada itself."



COLORFUL SABRES: Crowded with Sabre 6's and T-33's is Canadair's big flight test hangar. Sabres wear the new camouflage scheme in which all aircraft of this type are now being finished. Scheme utilizes two shades of green on upper surfaces, and light blue underwing and belly. RCAF Sabres in Europe have flatter finish than evident above and also have Canadian ensign in place of the tri-color bar on the vertical fin. No squadron insignia are being permitted.

Otters to the U.S.

Four Otters were to be delivered this month from the Toronto plant of de Havilland Aircraft to the U.S. Navy for an expedition to the Antarctic. This is the USN's first Otter order; substantial numbers are being delivered to the U.S. Army.

They are to be carried aboard icebreakers and will operate into the heart of the polar continent, performing reconnaissance and flying men, equipment, stores and dog teams to base camps.

Drone Prototype

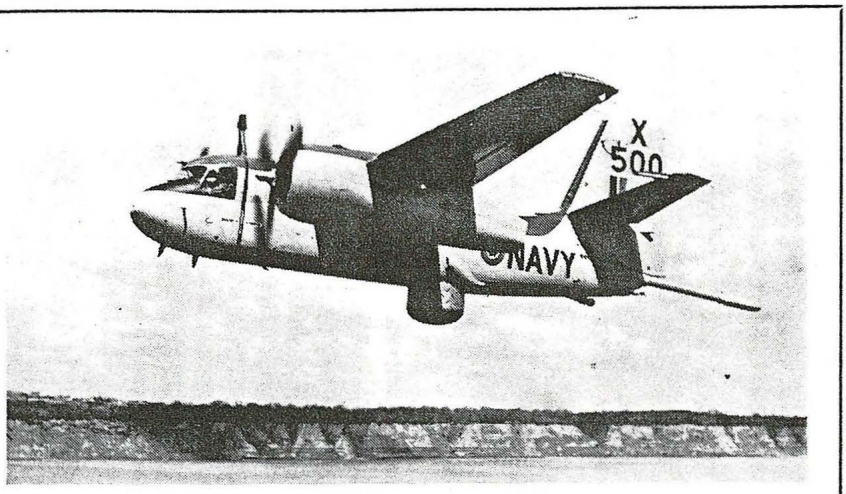
Canadian Aviation Electronics of Montreal, after extensive research into the subject, is engaged in the design of a radio-controlled drone target aircraft. The project is described as a private and speculative one; military interest has not yet been expressed in contract form.

Before CAE gave the go-ahead for the design of a prototype, its design and development group carried out work in these fields: operational requirements, aerodynamic design, structural design analysis, autopilot analysis, radio-command link analysis and electronics design of specialized equipment.

"It is of decided interest to Canadian industry and all Canadians," says a company announcement, "to visualize the divergent skills which were concentrated on this one project and the studies in many separated, yet related fields, which could be carried out through the availability of an electronic design and development group which ranks as the most complete assemblage of electronic brainpower in Canada.

" . . . The company was also able to rely on its experience in circuit design, in servo mechanisms, transmitter receiving design, the packaging of electronic circuits for airborne use and in radar design and analysis."

RCAF interest in flying targets was



FULL DRESS: Shown in RCN colors for the first time is the Grumman S2F-1, a modified version of which (known as the CS2F-1) is now in production at the Downsview plant of The de Havilland Aircraft of Canada Ltd. This particular aircraft, a Grumman-built model, was supplied to the RCN by the USN for study by the Canadian contractor and for trial modifications. A total of 100 of these anti-submarine airplanes are on order for the RCN, with the first scheduled to fly by the end of this year. Planned delivery rate is some 25 units per year.

evidenced a few years ago by a series of tests at Deseronto, in the Trenton area, using a number of small, U.S.-supplied drones. Two Mitchell bombers at Trenton were radio-equipped to control them.

AEL Expansion

The immediate beginning of construction of an addition to the main plant in Montreal of Aviation Electric Ltd., has been announced by A. Bandi, president. Plans call for the construction of a second floor of 19,000 sq. ft. at the front of the present building. This will provide increased facilities for engineering and research, and space for expansion in other departments, according to Mr. Bandi.

It is expected that the construction program will be completed by the end of September.

Canadian Agent

Data Processing Associates Ltd. of Ottawa has been appointed exclusive Canadian sales, service and engineering representative for Mid-Century Instrumatic Corp. of New York, manufacturer of electronic precision analogue computers and computing equipment.

New Accommodation

The manufacturing engineering facilities of Canadair Ltd., Montreal, are now housed in a new, single-storey, $1,500,000 building, providing 139,600 sq. ft. of floor space, at the south end of Plant 1. It includes a foundry and plaster shops; jig shop; template and photo reproduction areas, and pattern shop.

Vice President—Manufacturing R. A. Neale, addressing himself to the 92 members of the management and supervisory staff, said during the official opening ceremony:

"It is obvious to me, as I hope it is to each one of you, that those of us who sponsored this project can look forward to an immediate gain in output at less cost in less time, solely by virtue of this vastly improved facility.

"At the same time, because of improvement in the physical plant, your job has been made easier and your burden lightened. You don't have far to travel, communication has been shortened, lifting capacities, convenient space for production and storage, template reproduction, die cleaning and fitting, and many other functions, have been expanded and improved upon.

"The degree of our success in achieving good tooling cost performance on the CL-28 (Canadair's maritime reconnaissance adaptation of the Bristol Britannia) will certainly reveal Canadair's competitive position in regard to future business."

President & general manager J. G. Notman said the original discussions about a building for the manufacture of tools and fixtures took place in 1951 but at that time funds were not available for such an extensive project.

"Early in 1954, with the advent of the CL-28 program," he said, "consideration was again directed toward providing a facility to permit centralization of tooling activities and this large building is evidence of the company's confidence in the future."

Administrator of all activities in the new building is R. J. Higman, Canadair's manager of manufacturing engineering.

Field Diversifies

Field Aviation Co. Ltd. of Oshawa, after acquiring several new lines of aircraft supplies this month from MacDonald Bros., Winnipeg, now lays claim to being Canada's foremost aviation supply house.

The principal additions are paints, dopes and varnishes, skis, aircraft tapes, cables and hoses, oxygen equipment, batteries, propellers, aircraft instruments, parts and accessories, sheet metal, hardware and plastic products.

Oshawa will continue to be headquarters for the expanded business and sales outlets will be maintained at Winnipeg, Calgary and Ottawa. A warehouse is being established at Vancouver.

Field is the exclusive Canadian distributor for the aircraft of Blackburn & General, Hunting Percival and Beech, and the gas turbine engines of Blackburn-Turbomeca.

Fuel Flow Checks

Standard Aero Engine Ltd. of Winnipeg has become the first Bendix distributor to establish overhaul facilities for jet engine fuel controls. It has received an RCAF contract to overhaul and test the Bendix fuel flow control units used on Orendas.

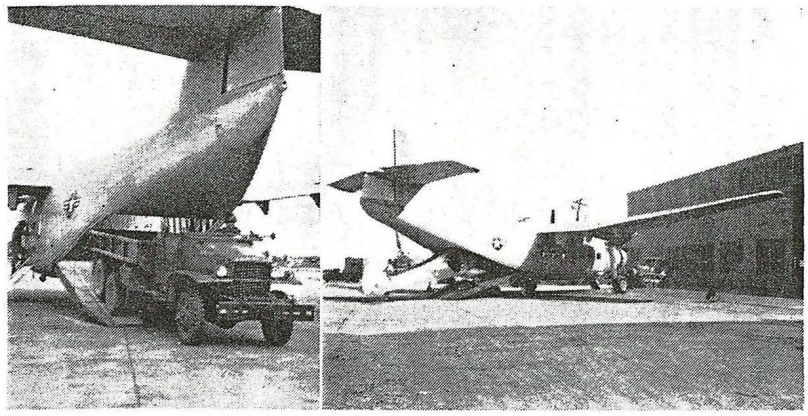
The company has recently completed a one-storey concrete addition to its present building. Some 9,000 sq. ft. has been allocated to accessory overhaul and 2,000 sq. ft. to the stores department.

CAE Simulators

Some time this summer, Canadian Aviation Electronics of Montreal expects to deliver to the RCAF its first home-designed CF-100/4 flight simulators. They were designed and developed under a Defense Production Department contract.

DDP Purchases

Since the formation of the Department of Defence Production in April of 1951, it has purchased 3,700 airplanes, according to T. E. Stephenson, director of the DDP's Aircraft Branch. Mr. Stephenson, who was speaking to a group of aviation writers in Toronto, said that of this total, approximately 700 had been imported, while an



DRIVE-IN: The big ramp door on the Northrop Raider makes it possible to drive directly aboard any vehicle which can pass through the 6½ by 9 foot opening. The right hand picture shows also how small aircraft may be easily loaded aboard the Raider. A total of 23 Raiders have been ordered from Northrop by the USAF. Canadair Limited was licensed last year to manufacture the Raider for world markets.

mph. Turn around time (approach, touch-down, taxi in, refuelling, starting, taxi out, and take-off) was confined to 8½ minutes. Average speed for the whole journey (London, Copenhagen, and return) was 478.592 mph.

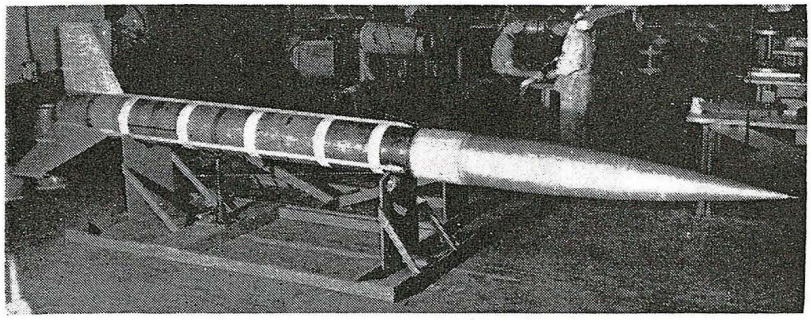
•The Bristol Brabazon is equipped with a device that **lets the pilot know when the main wheels leave the ground.** Apparently the size of the aircraft is such that as soon as the nosewheel lifts, as far as the pilot is concerned the aircraft is airborne.

•The Fairey Aviation Company plans to reveal **a new prototype aircraft** at an early date. This will be in addition to the Fairey 17 anti-submarine aircraft which is now undergoing tests.

•In order to simplify the work of the pilot and to avoid confusion, the RAF has decided that all its new aircraft from now on will incorporate **Cockpit knobs of standardized shapes.** In future the major control knobs in the cockpit must be of distinctive specified shapes. Thus all flap control knobs will be uniform-sized spheres with small cylindrical projections each side, the supercharger control will be a three-quarter-inch cube, and the mixture control will be a disc with small pyramids on the rim.

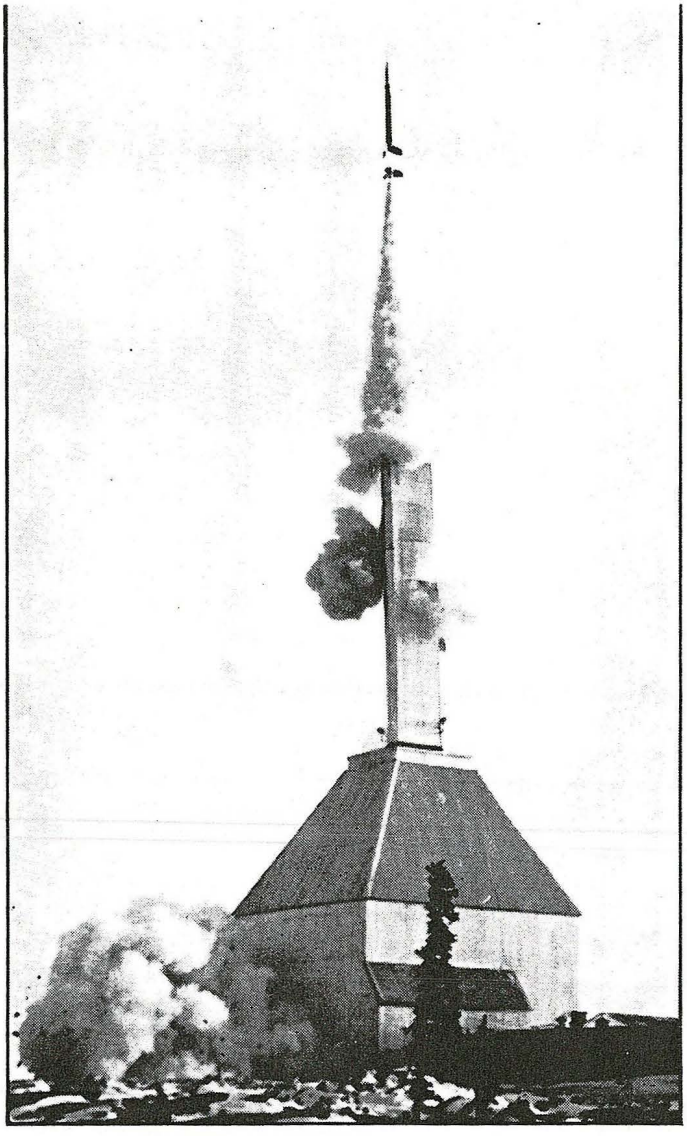
•A new guide to the selection, installation, and servicing of **oil and gasoline hose** has been published by the New York Belting & Packing Co., 1 Market St., Passaic, N.J. Data are furnished on the principal types of hose used for aircraft refuelling, etc.

•A new dry lubricant and anti-seizing compound **"Molykote"** is now being distributed in Canada by Frank O. Farey, 5866 Decarie Boulevard, Montreal 29. Molykote is said to be especially good wherever bearing pressures are beyond the capacity of conventional lubricants and where the danger of scoring, galling or seizing exists.



POINTING TO THE FUTURE: Shown here is an Aerobee high altitude sounding rocket in an advanced stage of construction. This type of rocket is somewhat smaller than a V-2, being only 20 feet long. It attains speeds of 3,000 mph and heights of 75 miles. It was from an Aerobee that photos showing earth's curvature were taken.

RL. 866-1957



An IGY Aerobee-Hi rocket is launched at Fort Churchill.

Sounding the Skies

THE 1957-1958 International Geophysical Year was inaugurated July 4 at Fort Churchill, Manitoba, with the firing of an Aerobee-Hi rocket some 160 miles into the ionosphere.

These rockets are 30 feet in length, and when fully loaded, including instruments, weigh more than 1800 pounds. When the booster getting the rocket off is fired, hot gases and smoke suddenly create a turbulent 18,000 pounds of thrust.

All-weather Igloo: For this reason, and because of the extreme weather conditions encountered at Churchill, the rockets are fired from a specially constructed all-weather launching facility. This "igloo" was designed by architect-engineers of the Aerojet-General Corporation of California, which produces the Aerobee-Hi rocket. It was constructed by the U.S. Army Corps of Engineers, which has jurisdiction over the Churchill rocket facility.

In a typical launching, the booster is ignited first. As soon as it has lifted the rocket up a foot or so from a concrete and steel "pad," the sustainer engine, with a thrust of 4100 pounds, starts. This means that the house from which a rocket is launched in the Arctic has to remain intact under a total thrust of approximately 22,100 pounds. This is roughly equivalent to having a multi-engine jet aircraft take-off from within a hangar.

The launching building at Fort Churchill has a steel frame and is metal covered. Inside are metal stairways and galleries permitting rocketeers to reach all parts for inspection, adjustment and fueling. The building is 40 feet square and 56 feet high, approximately five stories. Above it projects the tower that guides the rocket on its way.

Slow Start: The Aerobee is moving relatively slowly as it pushes through the roof into the open air, so that high winds could cause shifts in direction that might seriously impair tests and instruments. Winds of great velocity are common in that region and engineers had to develop a novel device to minimize their influence. This is a turn-table type pad, which permits the tower to be revolved at will and sloped as required at angles up to 10 degrees in any direction. By this means, rockets may be launched at a slant to counteract winds from any quarter. Untried elsewhere, this unique feature has worked well at Fort Churchill. *(Turn page)*

To accomodate a tower that not only rotates but leans, a considerable opening had to be made in the top ridge of the launching building; this posed another problem. Unless there were some means of closing the opening, it would be nearly impossible to heat the interior. The solution was a tent of nylon fabric fitted loosely to the tower to permit swivel.

Since the forces of the blast at the moment the rocket is ignited are like those of a small volcano, some means had to be provided to let them escape. This was done by designing mechanisms that raise the metal panels forming the lower walls of the launching structure as soon as all preparations for launching have been made and personnel have taken cover. The rockets are then fired by remote control.

One of Many: The launching igloo is only one of the many buildings at the site. Others house fuel storage tanks, working space for scientists, and machine shops. There is even another small launching building for shorter-range Cajun rockets, a Canadian variety. The Aerobees are prepared for each flight in an adjacent building and trucked through a heated and insulated tunnel to the launching pad.

Tracking stations equipped with radar to follow the flights are spread over the countryside, and are part of the facility which is used by U.S. Army, Navy and Air Force scientists. The rockets themselves are never recovered. After four or five minutes of high-speed flight they fall into Hudson Bay, into the sparse vegetation, or into one of the numberless lakes of the region. By then, however, instruments aboard have radioed vital data that scientists will be analyzing for years to come.

The U.S. Armed Services and scientists of several universities have scheduled a broad program of upper atmosphere research at Fort Churchill during IGY.

Fort Churchill is a lonely spot, but the clear, cold air permits excellent visual observation of celestial phenomena. Besides the Aerobee launching building the only other prominent structures in the locality are the grain elevators used during the brief Hudson Bay open season.

Infrared Eyes for the Night

The effectiveness of infrared reconnaissance as a military weapon is strikingly revealed in a series of photos recently declassified by the USAF. The infrared photo of Republic Aviation Corp.'s plant at Farmingdale, N.Y., accompanying this article (top) was recorded by an early passive infrared system designed and manufactured by Servo Corp. of America, New Hyde Park, N.Y.

It indicates the impressive ability of infrared techniques to translate into photo pattern the warmth radiated day or night from a ground target. The bright areas, or "hot spots", are regions of greatest heat radiation, and the darker or "cooler" regions are less active and radiate less heat.

Bottom is a conventional aerial photograph taken from an identical position. Strategic points in this photo blend with all other areas. In contrast in the infrared photo, the runways with engine exhaust, moving planes, auxiliary trucks, areas of greatest heat acivity, show up clearly as bright spots.

The plant itself, another active area, stands out as brilliant clusters of heat radiations. Another bright cluster is created by the factory building where furnaces, boilers and machine tools emit tremendous heat.

Servo Corp's infrared detection system is said to be so sensitive that it can "feel" out the warmth of an object even if it's blinded by camouflage on the ground.

This great sensitivity of the infrared technique was revealed in the photograph of "Project Applejack". Here an airplane flying at night at an altitude of 3,000 feet, spotted military maneuvers in a heavily wooded area. In spite of total darkness, the photograph taken with the infrared system showed clearly a road, a tank, its track, forest, and a meandering river.

Every inanimate and animate object emits infrared radiation as a function of its temperature. The hotter an object, the greater the amount of infrared radiation generated. In all of these pictures, the bright areas indicate the areas of greatest activity, while the darker spots reveal a lesser degree of heat. From a military standpoint, this means that heavy industrial areas and specific targets such as factories, railyards, airports, etc., can be readily spotted by infrared reconnaissance.

Another important characteristic of Servo's infrared reconnaissance systems are their ability to remain co-ordinate: they cannot be jammed by electronic counter-measures.

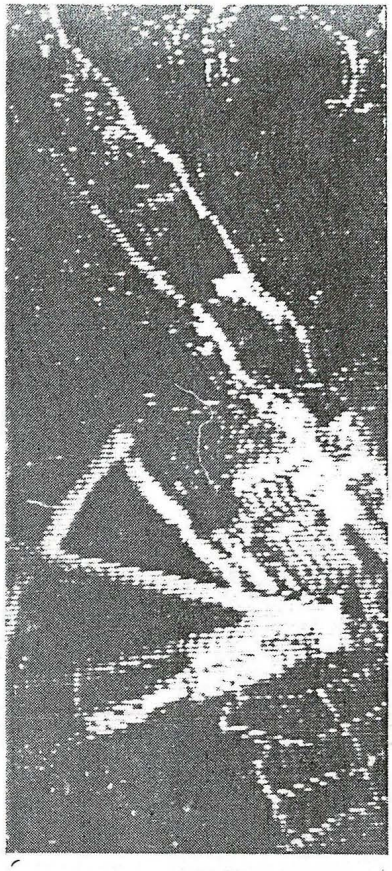


PHOTO BY INFRARED

THE SCENE BY DAY

RL. 866-1957

NEWS ROUNDUP

Airport Report

According to figures just released by the DoT, the year 1956 was the busiest ever for Canadian airports in terms of landings and take-offs. During the year under review, there were 2,225,384 landings and take-offs at airports with control towers. This is an increase of 17% over 1955 when the figure was 1,900,810.

During 1956, Vancouver led all other airports in numbers of take-offs and landings with 225,063. Montreal's Dorval airport had 219,742, followed by Edmonton with 196,196 and Ottawa with 190,144. During the last quarter of 1956, Montreal's control tower recorded 60,220 landings and take-offs, making it the busiest for that quarter.

Forward Scatter Link

ICAO announced late last month that Canada has agreed to build a $650,000 VHF "forward scatter" station near Gander Airport in Newfoundland. It will be part of a new-type chain of radio stations which will improve communications for air traffic control and other aviation purposes across the North Atlantic.

The North Atlantic network calls for a multiple connection, (one direct voice channel and four teletypewriter channels), between Ganger, Narsarssuak, Greenland; Reykjavik in Iceland; and Prestwick/Shannon.

The new forward scatter technique, known technically as "forward propagation by ionospheric scatter", uses high-powered transmitters working in the VHF band. Signals from specially designed antennae are scattered by a highly-ionized layer of air about 55 miles above the earth, and come back to ground receiving stations a considerable distance away.

New Montreal Terminal

Construction of the new Montreal Air Terminal building is progressing steadily with two contracts already completed; these are foundations and structural steel. A third contract has been let for the hanging of the curtain wall which is scheduled to commence shortly. A general contract will be called for completion of the building which is estimated to cost between $10 million and $12 million.

The new terminal will be constructed with two "fingers" attached to the main building. One finger will provide gates for domestic aircraft and the other providing gates for trans-border and trans-Atlantic aircraft. These fingers will consist of two-level corridors, the upper corridor for the enplaning passengers and the lower corridor for the deplaning passengers.

It is estimated that the building will near completion late in 1958, but it will take some time after to install all the necessary electronic, radio and other equipment required for its operation. It is hoped that the new terminal will be put into use early in 1959.

Low-Cost Computer

Low-cost digital computers are now available. This means computers priced around $50,000 as contrasted to large computers and custom-built, specialized data-processing systems priced from $100,000 to $3,000,000.

The Bendix G-15, a general purpose computer, can perform computations as much as 30 times faster than by traditional calculations methods. Airframe manufacturers, suffering from a shortage of engineers, designers and draftsmen, can make a mathematical model and reach a logical design under a wide variety of conditions in a comparatively short time. These smaller digital computers are already being applied to many complex fields including oil surveys, gear-shaping, navigation and optical design.

Emergency Air Corps

The Emergency Air Corps, an organization of civilian volunteers, has been formed in Canada to provide flying support similar to the U.S. Civil Air Patrol. The constitution and by-laws are now being drawn up by the provisional committee and the aims and objects include the following:

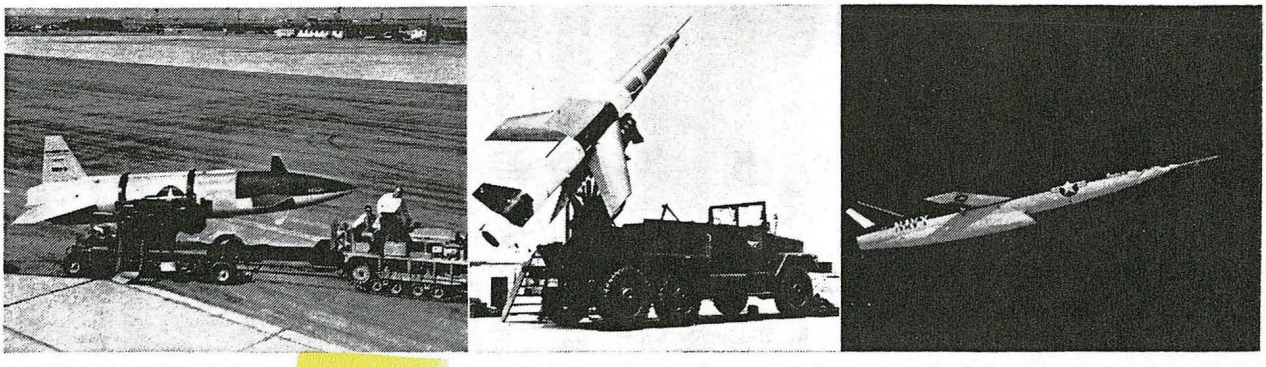
(1) To provide a national organization to supply pilots, personnel, aircraft and equipment for search and rescue, civil defence, and other local and national emergencies.

(2) To classify pilots, personnel, aircraft, and equipment available in various localities.

(3) To encourage and assist with the formation of local units across Canada.

(4) To organize a program of specialized training necessary for such work.

The Corps has been formed through the efforts of the Canadian Owners and Pilots Association. The constitution and by-laws will include the minimum standards of experience for



MISSILE PARADE: Left, the GAM-63 Rascal, a long-range rocket powered air-to-surface guided missile developed and produced for the USAF by Bell Aircraft Corp. It is designed for use in conjunction with manned bombers. Middle: the Martin Lacrosse, an all-weather surface-to-surface guided missile for use by U.S. Army units. In above photo it is shown on a launcher mounted on a standard Army truck. Lacrosse is propelled in flight by a solid rocket fuel motor, and was designed by the Cornell Aeronautical Laboratory. Right: the Chance-Vought Regulus II jet-powered surface-to-surface missile. The Regulus II was designed for launching from submarine carriers and other surface vessels and will be used against shore targets.

NEWS ROUNDUP

Aero Symposium

The Second Canadian Symposium on Aerodynamics was held at the University of Toronto's Institute of Aerophysics, February 25 and 26, and during this time a considerable number of technical papers were presented on a wide variety of subjects. These are as follows:

The Aerodynamics Involved in High Speed Wing Design—J. Chamberlain, chief technician, A. V. Roe Canada Limited.

The Development of a Turbojet Installation in a Single-Engine Fighter Aircraft—R. D. Richmond, chief development engineer, G. Rosenthal and F. M. Figueroa, Aerodynamics Section, Canadair Limited.

The Contribution of Aerodynamic Theory to the Understanding of Aircraft Behaviour at Transonic Speeds—B. G. Newman, Flight Aerodynamics Group, National Aeronautical Establishment.

Some Aerodynamic Characteristics of Delta Wings at Low Speeds—P. J. Pocock and W. E. Laundry, Aerodynamics Section, National Aeronautical Establishment.

Load Distribution on Supersonic Wings of Arbitrary Shape—B. Etkin, associate professor of Aeronautical Engineering, University of Toronto, and F. Woodward, Aerodynamics Section, A. V. Roe Canada Limited.

On Some Problems of Unsteady Wing Theory—A. Robinson, associate professor of Mathematics, University of Toronto.

Drive and Operation of Large Intermittent Wind Tunnels—J. Lukasiewicz, head of the High Speed Aerodynamic Laboratory, National Aeronautical Establishment.

Optimum Design of Finned Projectiles—R. N. Cox, Aerodynamics Section, Canadian Armament Research & Development Establishment.

Mechanics of Rarefied Gases—G. N. Patterson, director, Institute of Aerophysics, University of Toronto.

A General Approach to Turbomachinery—D. L. Mordell, chairman, Department of Mechanical Engineering, and director of the Gas Dynamics Laboratory, McGill University.

Turbulent Boundary Layers—Francis H. Clauser, chairman, Department of Aeronautics, Johns Hopkins University, Baltimore.

On the Reflection of a Shock Wave from an Open End of a Duct—George Rudinger, principal physicist, Cornell Aeronautical Laboratory, Buffalo.

An Experimental Study of Shock Wave Refraction—A. Ford, Aerodynamics Section, A. V. Roe Canada Limited; I. I. Glass, research associate, Institute of Aerophysics; W. A. Martin, research assistant Institute of Aerophysics.

Lift and Moment of Low Aspect Ratio Wings in Incompressible Unsteady Flow—J. Leyds, Aerodynamics Section, A. V. Roe Canada Limited.

Non-Linear Waves in Solids—G. L. Cann, Ballistics Div., Canadian Armament Research & Development Establishment.

A Technique of Manufacture of Supersonic Nozzles—J. G. Laberge and L. T. Conlin, High Speed Aerodynamics Laboratory, National Aeronautical Establishment.

Increase of Engine Icing Due to Inertia Separation of Cloud Droplets in High Speed Flight—D. A. S. Millar, Engine Laboratory, National Aeronautical Establishment.

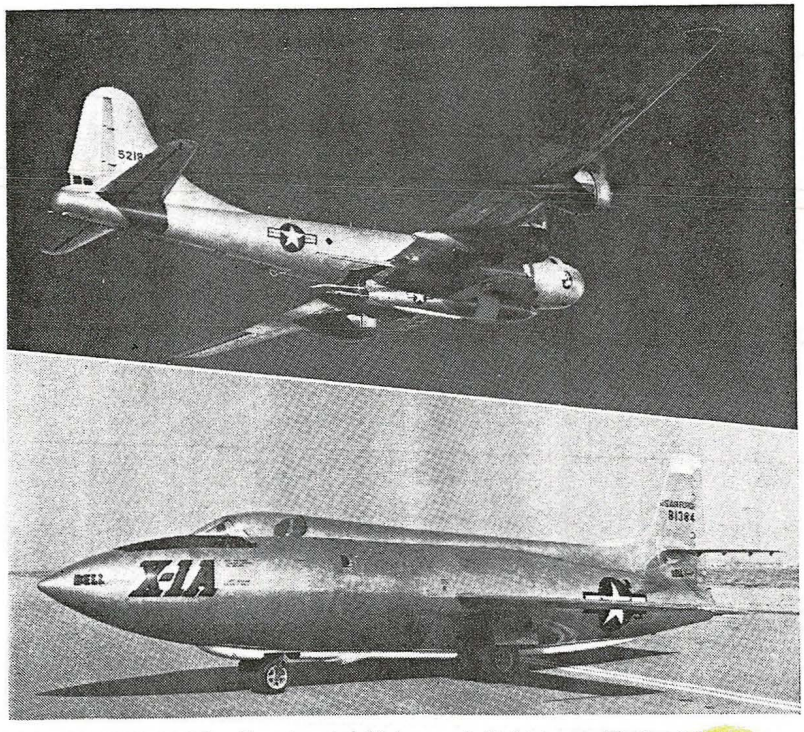
Super Sabre Record

The F.A.I. has confirmed the speed mark of 755.149 m.p.h., set by North American's F-100 Super Sabre, October 29, 1953, as the official world's absolute speed record. The mark was set over a 15 kilometre course by Lieutenant Colonel F. K. Everest. Best run was 767.337 m.p.h.

SAC Meet

For a soaring flight of 256 miles, Albert Pow, London, Ont., was awarded Canadian gliding's top award at the Soaring Association of Canada's annual general meeting held Saturday, March 13, at the Chateau Laurier, Ottawa.

Some 50 representatives of gliding clubs in Montreal, Winnipeg, Calgary, Toronto and Ottawa gathered for the annual election of officers and presentation of awards. John D. Agnew, Montreal, was elected president; Dick Noonan, Winnipeg, vice-president; Frank Brame, Toronto, Brother Hormisdas, flying Christian brother from Buckingham, Que., and Al Pow, directors.



SETTING THE PACE: Experimental high speed flight tests with the Bell X-1A are continuing, which a new mark being set several months ago when Major Charles E. Yeager flew the USAF's research airplane at a speed of "more than 1,600 mph". At that time, Major Yeager reported the 16,000 lb. rocket-powered aircraft responded perfectly to all controls and, except for the terrific speed attained, the flight was uneventful. The rocket engine is a product of Reaction Motors.

Diminutiveness of the X-2 is evident in this photo. Aircraft has a unique landing gear incorporating a retractable flat skid under the belly and a nosewheel. First X-2 was destroyed in an explosion two years ago at beginning of test program.

BELL's X-2

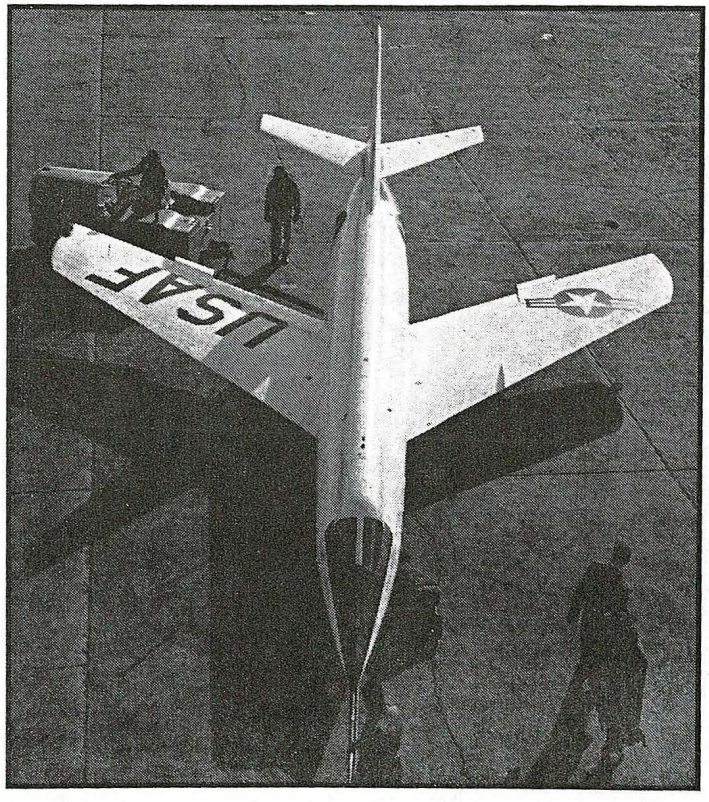
BELL AIRCRAFT'S rocket-powered supersonic, experimental aircraft, the X-2, is soon to make its first powered flights. These flights which will take place at Edwards Air Force Base, California, are the next step in a test program that has so far consisted only of a number of glide tests. The launching will be from a converted B-50. Pilot will be Lt. Col. F. G. Everest.

Produced under USAF contract, the X-2 is the first airplane to be designed and built to probe the so-called "heat barrier". This is the speed regime where skin-friction-inspired heat becomes so intense that conventional structural materials soften and lose their strength and cabin temperatures rise to a point where ordinary air conditioning equipment cannot keep them at a level acceptable to the human body.

To counter these problems, it was necessary to incorporate many innovations in the X-2, among them the use of stainless steel and K-monel in the fuselage and wings. Ordinary glass would melt at the temperatures the X-2 is expected to encounter, so the windscreen is made of highly tempered glass capable of withstanding almost 1,000°F.

From a drag and power standpoint, the X-2 is designed to exceed the record 1,650 mph attained by the X-1A in December, 1953. The powerplant is a Curtiss-Wright XLR25-CW-1 rocket motor rated at 12,000 lbs. thrust.

Crew safety measures include a detachable pilot cabin which is heavily insulated and pressurized. The windshield resists infra-red rays, which are very intense at the expected 100,000 ft. altitudes the X-2 will fly, and could seriously sunburn the pilot.



In this picture the leading edge wing fences and large aerodynamic tabs on the ailerons are evident. Rocket engine is throttleable. Note razor-sharpness of wings.

BACKGROUNDER

What's a Scud?

by Bruce Berkowitz

The Scud missiles causing so much anxiety in the world today are Soviet designs that originated in a weapon developed by the Nazis.

"Scud" is a Western term. The names of Soviet weapons we're familiar with came from the Air Standards Coordinating Committee, a military group founded in 1948 by the United States, Great Britain, Canada, Australia, and New Zealand. The committee gave surface-to-surface missiles names starting with "S"—Shyster, Sandal, Skean, etc. The North Atlantic Treaty Organization later adopted the naming conventions, as did the Soviets, who were so secretive that they would often use the Western terms rather than utter the forbidden Russian names.

During the cold war, NATO used "Scud" to refer to a specific missile, the R-11, a Soviet theater-range weapon intended to strike targets in Western Europe. Scuds were manufactured by the Votkinsk Machine Building Plant from 1959 to 1984. Today, however, "Scud" is like "Kleenex" and "Xerox," brand names that are used to refer, generically, to all similar products. In this case, the product is any single-stage, storable-propellant military rocket with a range of between 186 and 372 miles.

Scuds are often described as Soviet modernizations of the V-2, a surface-to-surface rocket that the Germans built during World War II. In fact, the Scud family was derived from a relative of the V-2, the *Wasserfall*, a radio-directed anti-aircraft missile that rocket pioneer Wernher von Braun and his team first tested in the German town of Peenemünde in 1944. Olaf Przybilski of the Technical University of Dresden discovered this link a few years ago when he interviewed German rocket engineers that the Soviets had conscripted to work for them after the war.

What distinguished the Wasserfall from similar weapons was its oxidizer: nitric acid. Unlike liquid oxygen, the oxidizer used by the V-2, nitric acid can be stored at normal temperatures inside a rocket for long periods—essential for an anti-aircraft missile, which needs to be ready to fire on a moment's notice. In the late 1940s, the Soviet air defense force cloned the Wasserfall and called its version the R-101. The Soviet army soon realized storable propellants offered the same benefit, shorter prep time for launch, for surface-to-surface missiles. Soon engineers drew on the R-101 to design the R-11 ballistic missile—the Scud. The die was cast.

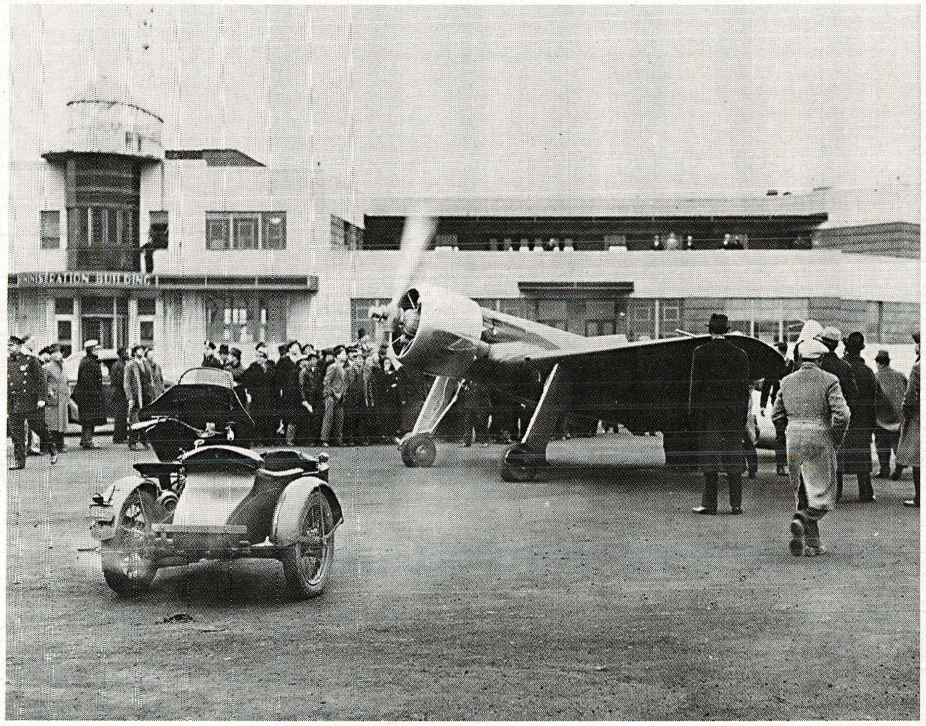
A few years later, the Soviets designed a successor to the R-11, the R-17. With a more powerful motor and more potent propellants, it had more than twice the range (186 miles versus 80). Western military services did not know the R-17 was really a new design so they called it the Scud-B. During the 1960s and 1970s, the Soviets exported Scud-Bs, which were often an inexpensive substitute for an air force, to their Warsaw Pact allies and to clients in the developing world. South Yemen was one example. The Scud-B's extended range gave South Yemen the ability to hit Sanaa, capital of North Yemen, its perennial rival.

AP/WIDE WORLD PHOTOS

Was there a bear trap waiting for us?"

Wright lifted off in a level attitude at about 115 mph. The airplane exhibited benign flying qualities as it climbed. But when Wright leveled off at 5,000 feet, the propeller remained stuck in the low-pitch setting, limiting him to a paltry 120 mph at the engine's 2,625-rpm redline. As the engine temperatures rose, Wright quickly reviewed his options for an emergency landing. Fortunately, the temperatures stabilized, and he was able to set the airplane down in Corvallis, as planned.

Notwithstanding the champagne celebration that followed, it was clear that something was amiss. Wright knew from his research that the propeller had misbehaved during Hughes' first flight too. After poring over before-and-after photos of the original airplane, Wright and his team realized that Hughes had retrofitted a bigger counterweight to the propeller. Since the counterweight enables the prop to shift into high pitch, the team surmised that Hughes must have run into the same problem that Wright did 67 years later. A larger counterweight was mounted on the replica, allowing the airplane to take full advantage of 700 horsepower.



NASM DISC #1B07335

In 1937, after breaking his transcontinental record with an average speed of 332 mph, Hughes taxied triumphantly at Newark Airport in New Jersey.

Wright made 19 more takeoffs and landings during his flight test program. Aside from an abrupt stall characteristic and poor visibility on approach, the airplane was so stable that Wright says it could be flown with no trouble by a low-time pilot. By the time Wright made the 65-minute hop from Cottage Grove to Stead Field in Reno—cruising at 295 mph, 50 percent power, and 10,000 feet—the replica had accumulated more flight time than the Racer logged in its entire career.

The speed record attempt in Reno was just the means to an end: giving the Racer replica an appropriately grand debut. Wright shattered the old mark with an average speed of 304 mph. But back on the ground, after accepting the congratulations of his crew and hundreds of well-wishers, he quietly confides, "We've still got some issues to deal with." A lingering pitch problem limited Wright to 62 percent power, and the leather seal in the prop took such a beating that grease flowed into the airstream and slathered the canopy. "Visibility was so bad I couldn't have done one more run," he says.

In January, the right landing gear collapsed on rollout. The damage is being repaired, and Wright hopes to replicate Hughes' record-setting cross-country flight. He also plans to take his airplane on the airshow circuit. As it is, the Racer is the star attraction where it's parked on the ramp in Reno. In fact, hardly anybody seems to notice the rare P-63 Kingcobra or F7F Tigercat on either side of it.

Later, after most of the spectators have left, a passerby spies the unguarded Racer. "Major wow!" he says. After a furtive look around, he ducks under the protective rope and reverently strokes the fuselage. A security guard materializes and orders him to get out of there, pronto. "Sorry," the interloper says sheepishly. "I couldn't resist."

The two of them stand there for a moment, gazing at the airplane. "It's like a beautiful woman, isn't it?" the guard says.

"Yeah," the interloper agrees. "Like a beautiful woman."

IN BRIEF: SCUDS

▶ During the 1991 Gulf War, a Scud attack on a barracks in Saudi Arabia killed 28 U.S. military personnel and injured 100 more.

▶ In a move to eliminate Iraq's Scud arsenal, the cease fire ending the Gulf War limited Iraq to missiles with ranges of less than 93 miles.

▶ In addition to carrying warheads containing high explosives, Scuds could be modified to deliver biological, chemical, or nuclear payloads.

The R-17 not only became the most proliferated ballistic missile in history, it also inspired more derivative designs than any other. But even today, Wasserfall DNA appears in the Scud and in all of its progeny: They all have the same 35-inch diameter as the original.

The event that spread Scud technology around the world was the 1973 Israel-Egypt Yom Kippur War. As a sign of socialist solidarity, North Korea sent a few pilots to Egypt. After the war, Egyptian officials hoped its new Korean friends would get into the business of manufacturing replacement parts for the Egyptian army. (Egypt was equipped mainly with weapons from the Soviet Union, but relations between the two governments had soured.) So in 1976, Egypt shipped a few Scud-Bs to North Korea. The North Koreans reverse-engineered the missiles, and by the 1980s they were ready to build their own. It was largely this Egyptian-Korean connection that spawned the many Scud variants we see today.

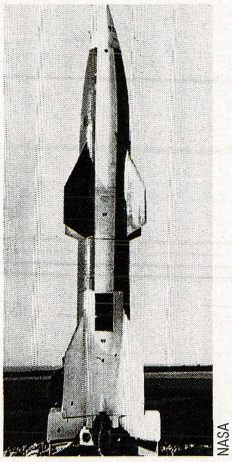
Western analysts called the Korean R-17 copy the Hwasong-5. Officials in Pyongyang quickly realized that sales of R-17 knock-offs might bring in badly needed hard currency. (Indeed, it was a derivative of the Hwasong-5 that the Spanish navy discovered on a North Korean freighter headed for Yemen last December.) North Korea found a ready customer in Iran, which in the 1980s was in the middle of a no-holds-barred war with Iraq. At this point, the R-17's genealogy began to double back on itself. The Iraqis, as it happened, had their own Soviet-supplied Scud-Bs. After the Iranians hit Baghdad with a few dozen Hwasong-5s, the Iraqis wanted to retaliate. The Iranian city of Tehran, though, was much farther from the border than Baghdad. The Iraqis' solution was to extend the range of their Scud-Bs by splicing additional sections into the propellant tanks and using a smaller (and therefore lighter) warhead. Iraq, whose leader apparently couldn't miss a chance for self-promotion, dubbed the missile al-Hussein. It could deliver a one-ton warhead 370 miles, just far enough to reach the Iranian capital. During the winter of 1988, the two countries fired missiles at each other in what became known as the War of the Cities.

All Scud-derived missiles are mainly terror weapons. Because their gyros and electronics date back to the 1950s, the missiles are notoriously inaccurate. The original R-17 had a circular error probable (CEP) of about 3,300 feet, meaning that half the missiles aimed at a target would land more than two-thirds of a mile away. This never mattered to the Soviets; since they planned to arm the missiles with nuclear or chemical warheads, most targets would still be in the lethal zone. Other countries used the imprecise Scud as a crude device for lobbing a ton or two of high explosives somewhere into an opponent's cities. In 1988 Iraq fired about 500 al-Husseins at Tehran, killing 1,000 to 2,000 people.

Yet the greater threat of Scuds has always been not what they are today, but what they can lead to tomorrow. After the War of the Cities, the North Koreans took a cue from the Iraqis and began a project to build a Scud derivative that was 50 percent bigger in each dimension. Western analysts labeled the rocket the No Dong (as with all North Korean rockets, the analysts simply named the missile after the town near where it was first spotted). Because the No Dong can hurl a one-ton warhead 930 miles, it can reach any part of South Korea and Japan.

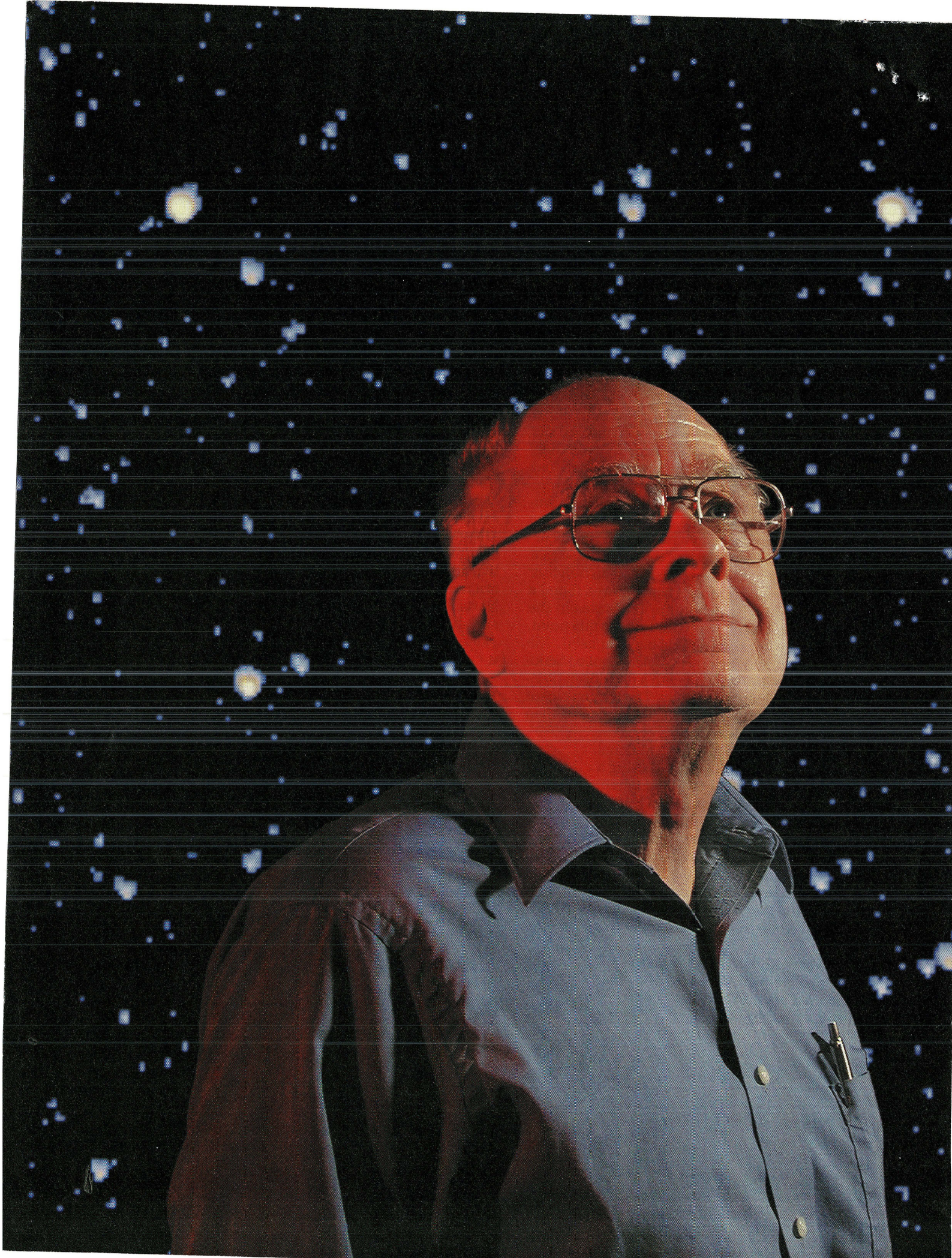
Pyongyang has exported No Dong missiles, components, and technology to Pakistan (where it is called the Ghauri 2) and Iran (the Shahab 3). North Korea reportedly is also developing missiles that combine No Dong and Hwasong components into multi-stage rockets. These missiles, the Taepo Dong series, could reach Alaska, Hawaii, and even parts of the continental United States.

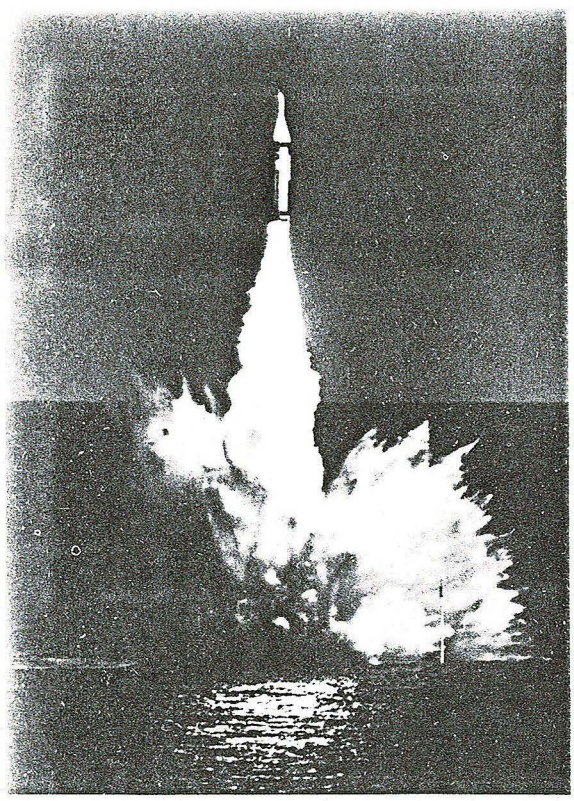
It's easy to make light of missile programs in North Korea, Iran, Iraq, and other developing countries. Compared to our own, they seem primitive. But each country is really just going through the steps Soviet designers followed 50 years ago: using borrowed technology, making gradual improvements, and combining smaller rockets into bigger, longer-range rockets. And so it's only a matter of time—probably less rather than more—before these countries, left to themselves, will be able to build truly threatening weapons.



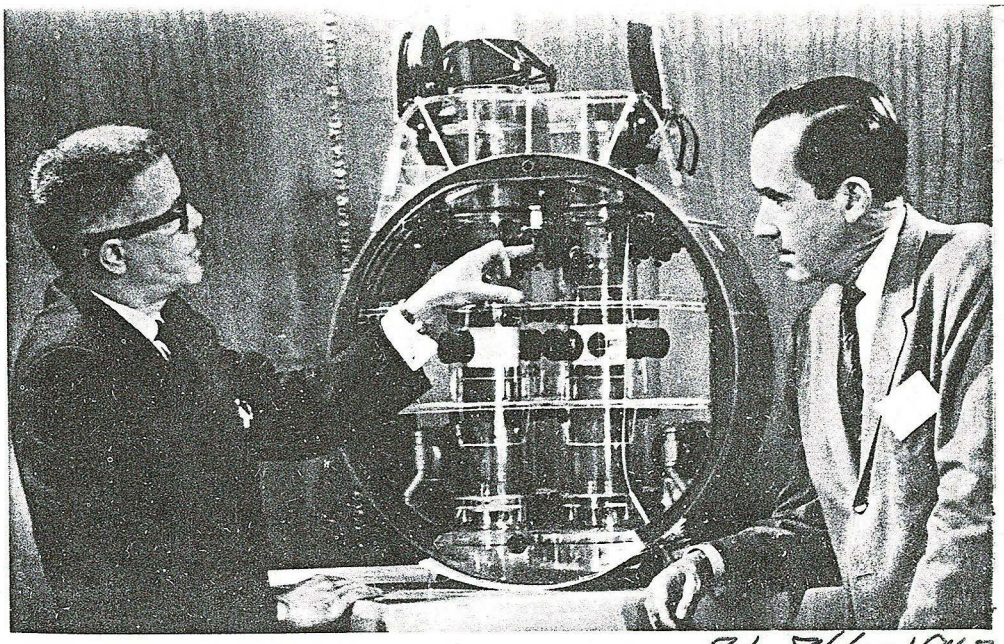
NASA

Opposite: A North Korean Scud-B towers over missiles at the War Memorial Museum in Seoul, South Korea. Right: The Scud's progenitor, the Wasserfall.





US Navy Lockheed Polaris A-1 rockets skyward after launching from submerged submarine.



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Cross-section of nuclear-powered submarine showing Polaris missiles in position.

WINGS IN SPACE - AUG/63

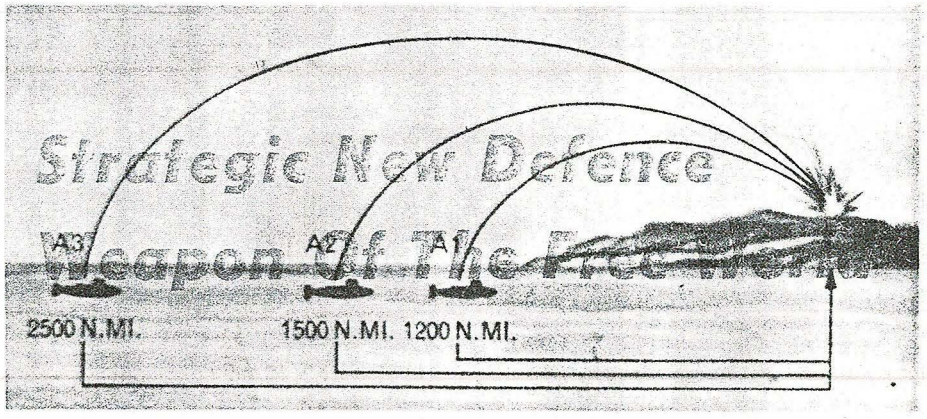
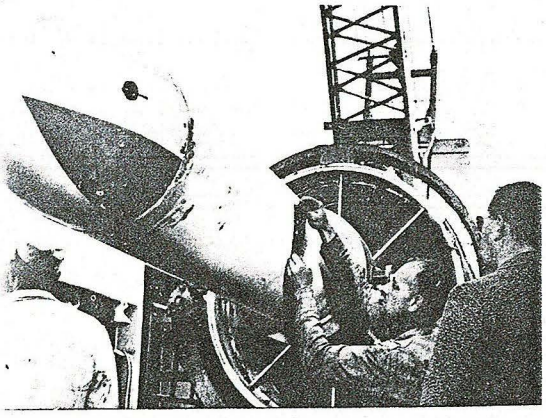
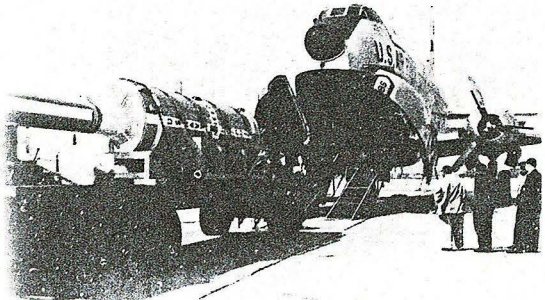


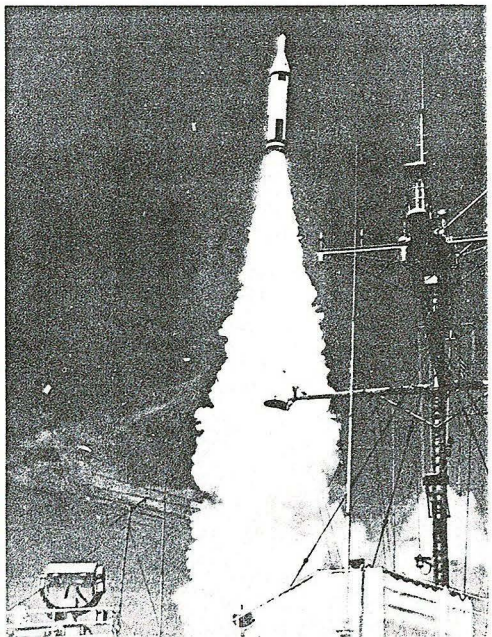
Chart shows range of free world's major deterrent-force missile, the Polaris A-3.

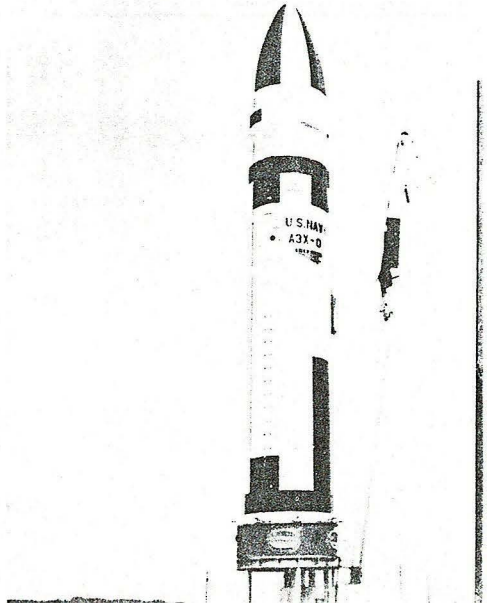
Polaris being placed in launching tube prior to loading aboard submarine.
From Lockheed plant, California, Polaris missiles like this are flown to submarine bases around the USA.





Close-up of US Navy A-3 Lockheed Polaris
Unusual shot of Polaris A-2 streaking skyward from its submarine launching pad.





$3.78; Canada, with a 3" surface, an 8" base, and a 32" sub-base (total, 43"), $3.88; U.S. Army, with a 3" surface, an 8" base, and a 41" sub-base (total, 52"), $4.33; CAA, with a surface of 3", a base of 8", and a sub-base of 42" (total, 53"), $4.38.

In conclusion, Mr. Macatee has this to say: "Pavement thickness-differential between the Canadian design and that of the Army on the weak soil is nine inches, yet the cost-differential is only ten percent less, and unfortunately . . . there is sacrificed the added durableness which the more conservative design provides. It will be observed that four of the curves . . . maintain relatively steep trends as heavier loads are encountered, whereas the Canadian curve, for the weak subgrade, tends to flatten out, becoming less and less constructive.

More Conservative

"Mr. Benkleman noted that the more conservative design received the benefit of extensive work to establish its validity. Significantly, he said: 'The construction program of the Army engineers was wider in scope than that of the other agencies and as a result considerably more work was done during the war period in an effort to establish the validity of their design procedure. In addition to a study of certain phases of the procedure in the laboratory, experimental sections of runway were built and tested at different locations throughout the country.

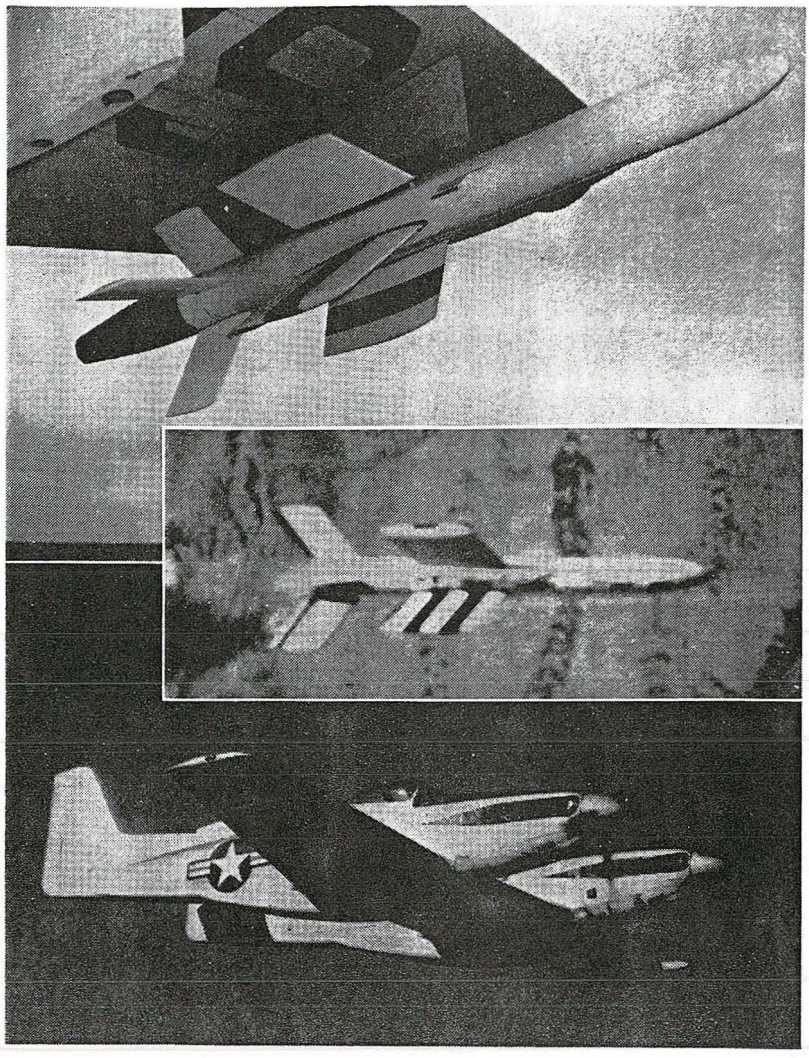
"Keeping in mind the relative sameness of costs reflected by these several methods of design, one is inclined to wonder why thickness-requirements should arouse in any group serious conflicts of opinions."

Briefly

• Sudbury has **given up trying to get air service from TCA** and has now proposed that CPA consider establishing an airport and a feeder route from Sault Ste. Marie to Sudbury.

• Improvement of facilities at **London City Airport** (Ontario) is costing the Department of Transport approximately $185,000. These improvements include the installation of ILS and a 150 kilowatt stand-by power plant.

• **Traffic headquarters of Canadian Pacific Air Lines** is remaining in Montreal under Hugh B. Main. President Grant McConachie recently moved his headquarters to Vancouver International Airport.



THE FIREBIRD

The USAF's first air-to-air missile, the Ryan "Firebird" (above) is designed to be as effective for night or bad weather interception as in clear skies, since visual sighting is not required.

Designated the XAAM-A-1, the Firebird is compact for the complete radar navigational system and large explosive charge it carries. Launched from a mother plane, it is capable of heading off and destroying its objective in a matter of seconds.

Little more than half a foot in diameter, it is about ten feet in length, and seven and a half feet after dropping its booster rocket.

The four vane-like wings are located about midway on the rocket portion of the projectile. Two feet behind the wings are the four tail vanes. Both wings and tail surfaces serve to control the flight of the missile.

Of about three foot span, the wings have an aerodynamically smooth surface not equalled by the usual sheet metal construction. Except for the plastic radio and wings, the basic missile structure is conventional aluminum alloy sheet.

After the missile is launched from the parent plane, a booster rocket takes over. Then, when the Firebird reaches maximum speed, the spent booster is jettisoned by an explosive charge. Thereafter, during the latter phase of interception, power is supplied by flight rockets. The warhead is designed to explode when it is close enough to an enemy aircraft to ensure destruction. Should the missile miss its target, the warhead automatically detonates in the air.

RL. 866-1950

will not be completed until late in the year, it is expected that the number of pilots to be trained this year will be considerably below the target. The RCAF is purchasing 37 Chipmunks from de Havilland and four of these will be held in reserve.

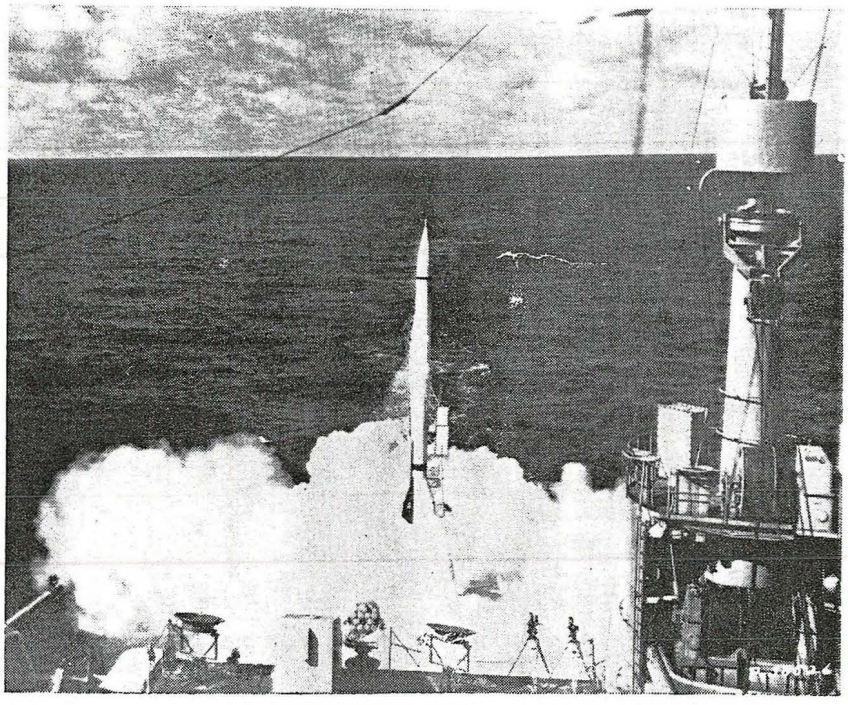
Pilots accepted for the scheme will receive a bonus of $100 on successful completion of 20 hours flying and 20 hours ground school. Those who successfully complete one year's training may repeat the program in following years as long as they continue to meet age and medical requirements. No age limit has yet been set but it is expected to be around 30. To be eligible, a pilot must hold RCAF pilot wings.

According to Defence HQ.: "The scheme complements, but does not duplicate, the RCAF's Auxiliary Squadron program, which is aimed at maintaining a pool of flying personnel at near-operational training standards, and within the age bracket for operational flying. Most of those taking refresher training will be wartime veterans, over-age for 'ops'. In time the scheme will include many short-service commission officers of those who entered the service since the war and retired after the normal six-year term of duty. Mainly because of the age factor, the Air Force expects that though some might fly operationally in the event of war, most of these pilots would serve as instructors or staff pilots if required. The training, accordingly, is not intended to achieve operational standards."

Avenger Delivery

Delivery is now nearing completion of the Grumman Avengers purchased from the U.S. Government by the RCN. The first batch consisted of four aircraft and since then they have been arriving at RCN Air Station, Dartmouth, at the rate of eight or nine a week. The machines are being equipped at unnamed Canadian aircraft plants with additional anti-submarine equipment.

In connection with the operation of these aircraft, the Navy has announced a new aircrew rating, that of Observer's Mate. The Observer's Mate will be the third man in the crew of three that the Avenger requires and will specialize in anti-submarine duties, which will consist principally of the operation of sonobuoys, radio communication sets and radar. The new aircrew members will have three classes, the highest being equivalent to Chief Petty Officer 2nd Class.



NEW HIGH: A Martin Viking high-altitude research rocket is shown taking off from the deck of the USN's guided missile ship, the Norton Sound, to establish a new altitude record for American-built single-stage rockets—106.4 miles. The record is 115 miles and is held by a German V-2. Built by Glenn L. Martin Company, this type of rocket is expected eventually to attain heights of approximately 200 miles.

Briefly

•**Group Captain H. H. C. Rutledge, OBE** has been named Air Attache to Sweden and Finland, replacing **G/C H. G. Richards, OBE,** who returns to Canada to command RCAF Station, Summerside, P.E.I.

•**Captain R. B. Jackson** recently qualified as a parachutist at the Rivers Joint Air Training Centre, making him the third army dental officer to qualify for his jump wings in the Canadian Army Active Force. He brings to five the number of Royal Canadian Army Dental Corps personnel qualified as airborne troops.

Gordon R. McGregor, OBE, DFC, president of TCA, has been appointed honorary Wing Commander of 401 Fighter Squadron, RCAF Reserve, Montreal.

•The first two of **16 Boeing SB-29 Superforts,** especially modified for use by the USAF's Air Rescue Service, have been accepted for operations. The aircraft carry 30-foot all-metal lifeboats which are parachuted to survivors during air rescue operations at sea.

•The maintenance cost of the aircraft carrier HMCS Magnificent is about **$20,000,000 a year,** according to news reports quoting RCN Vice-Admiral H. T. Grant. During 1948 and 1949 the carrier spent 153 days at sea.

•**Refresher flying courses** for air specialist officers of the active and retired lists of the RCNR are now being held at RCN Air Station, Dartmouth.

•According to press reports, **RCAF Station, Aylmer, Ontario,** may be closed within the next year or two. At present Aylmer serves as a manning depot and as a school to bring airmen up to matriculation standards.

•The **Air Armament School at Trenton,** Ontario, is soon to be moved to RCAF Station, Summerside, P.E.I., it is reported.

•There are now **nine groups of USAF Superfortresses stationed in the U.K.** There are at present 30 bombers in each group but this is to be raised to 45. A squadron of 20 tanker planes for flight refuelling is also to be added to each group.

was a leader in getting the Association organized. The group is presently working on a ten-point program which aims at (1) putting an air safety program into effect; (2) bringing about a general lowering of flying costs through safety mediums; (3) reviewing the government subsidy program; (4) holding a comprehensive publicity campaign for private flying; (5) reviewing radio license requirements; (6) reviewing medical requirements of licenses; (7) reducing import duties and sales tax on aircraft; (3) organizing of mass air meets; (9) airmapping of cities, towns, and villages in Canada; (10) sending special bulletins to member-pilots.

Memberships are priced at five dollars a year. Detailed information may be obtained by writing to the Association at P.O. Box 914, Ottawa.

Free Flight

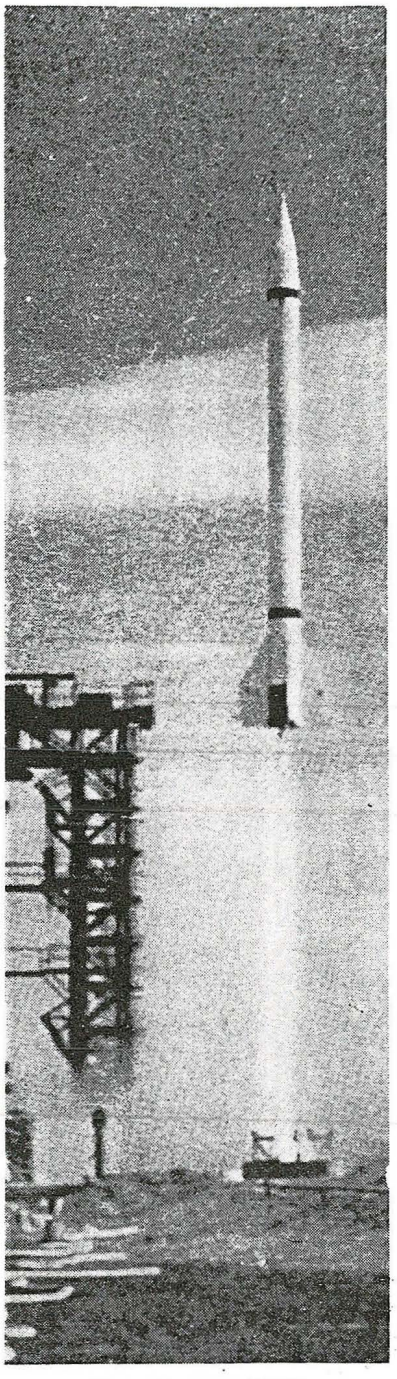
Commencing next September, when the Lethbridge Air Cadet Squadron commences a new active season, every new cadet that is recruited into the Squadron will be given one-half hour of flying instruction free by the Lethbridge Flying Club, it was announced recently by Club President E. R. McFarland. In addition, President McFarland said that the cadet who introduced the new recruit would be given one hour of free instruction.

The Lethbridge Club is instituting this new policy in order to provide a stimulus in Air Cadet recruiting in Lethbridge.

Periscopic Sextant

TCA, along with many other major air lines, is now using the new Kollsman Periscopic Sextant as standard equipment on its trans-Atlantic North Stars.

The use of this sextant permits the elimination of the astrodome which is a familiar part of most modern airliners. The sextant does away with "dome error" according to Kollsman, and results in more accurate sighting. As compared with the hand-held sextant, it is more easily and more rapidly operated and its timing device and averager are superior. In addition, the use of the new sextant removes the need for the astro-compass, since the azimuth ring on the mount provides an indication of the aircraft heading.



SPACE EXPLORER

The first American-designed high-altitude research rocket, the Martin Viking, made its first flight at the White Sands Proving Grounds in New Mexico on May 3 (above, at moment of launching).

The Viking reached a height of 51½ miles and a peak speed of 2,250 mph. Built for the USN, the 45-foot-long rocket was developed to replace the German V-2.

The powerplant was developed and manufactured by Reaction Motors, Inc., of New Jersey. Subsequent flights of the rocket are expected to reach a 200 mile altitude.

Goodyear Race

Prospective entries for the 1949 Goodyear Trophy Race at Cleveland next Labor Day weekend totalled 49 planes on June 12. Forty-five owners, four of whom are readying two aircraft, have signified their intentions of entering this year's 190 cubic inch championships.

The Goodyear Trophy Race competition will again be run over all three days of the National Air Races, September 3-5, with elimination heats on Saturday, semi-finals on Sunday, and the final event on Monday. Sponsored by the Goodyear Tire and Rubber Company, the Goodyear Trophy and the lion's share of the $25,000 cash purse will go to the winner.

Last year's champion, Herman "Fish" Salmon, will enter again, as will Runner-up Steve Wittman. Dave Long, designer of the "Midget Mustang" (*Aircraft and Airport,* April, 1949) will also be an entry.

Measured Agreement

The nations of the world don't agree on many things, but apparently they all feel that flying would be a lot simpler if everybody used a single set of dimensional units. Just last month, 34 of ICAO's 52 member nations agreed in Montreal to take the first step in a plan designed to relieve the confusion in air-ground radio communication caused by the differing systems of measurement now employed in various countries.

The ICAO standardization plan consists of an agreement on five tables of units incorporating elements of both the metric and the foot-pound-second systems. One table uses the English system, the second the English system plus the measurement of air pressure in millibars rather than inches of mercury. The third table replaces statute miles with nautical miles; the fourth employs the metric system entirely, and the fifth- and eventually final-table is a combination of the third and fourth, using the metric system for all purposes except that nautical miles would be used for long distances and for speeds. All five tables use the centigrade scale for temperature measurements.

The dimensional standardization plan provides for the progressive reduction of the number of tables until all ICAO member nations will be us-

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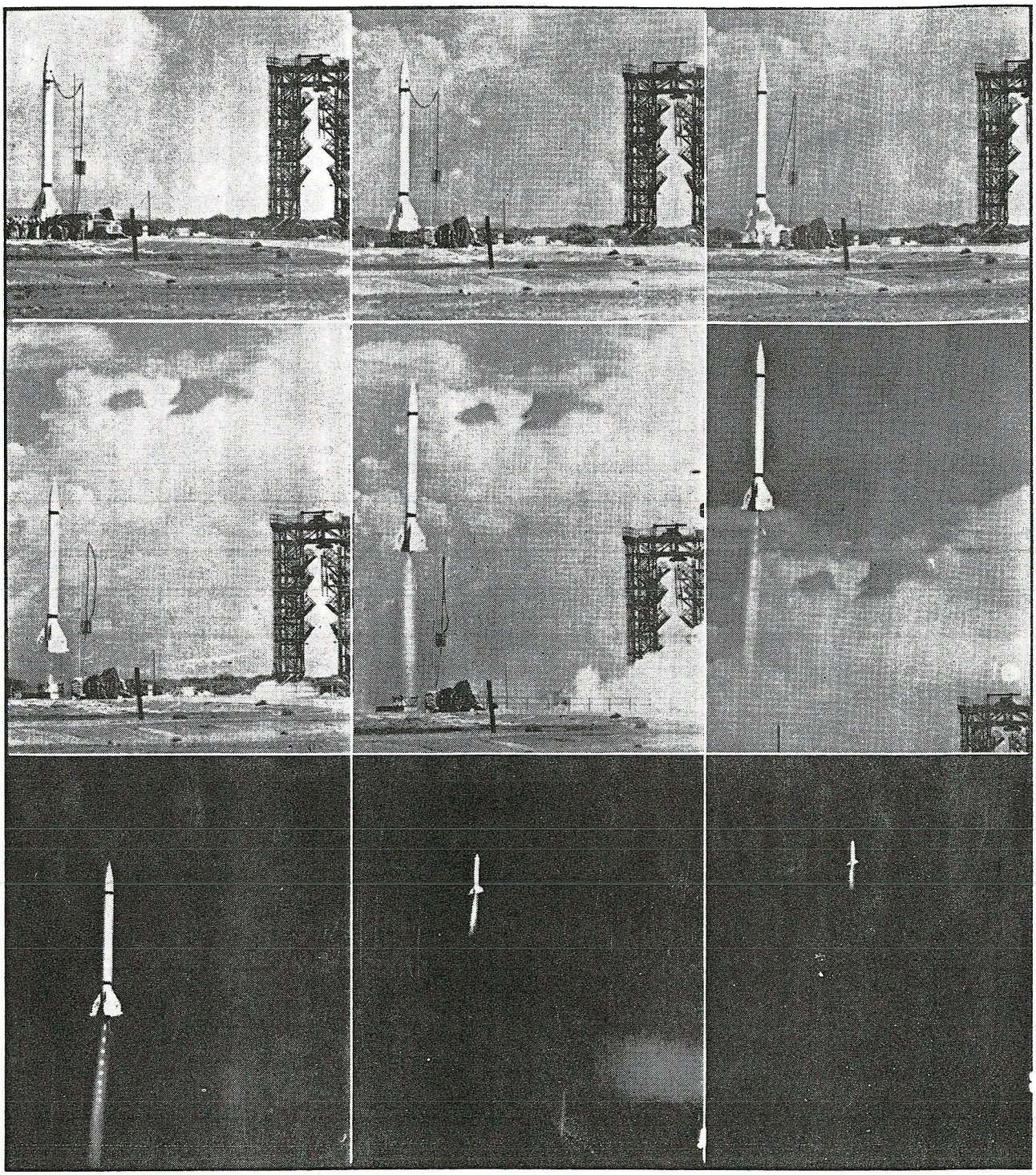
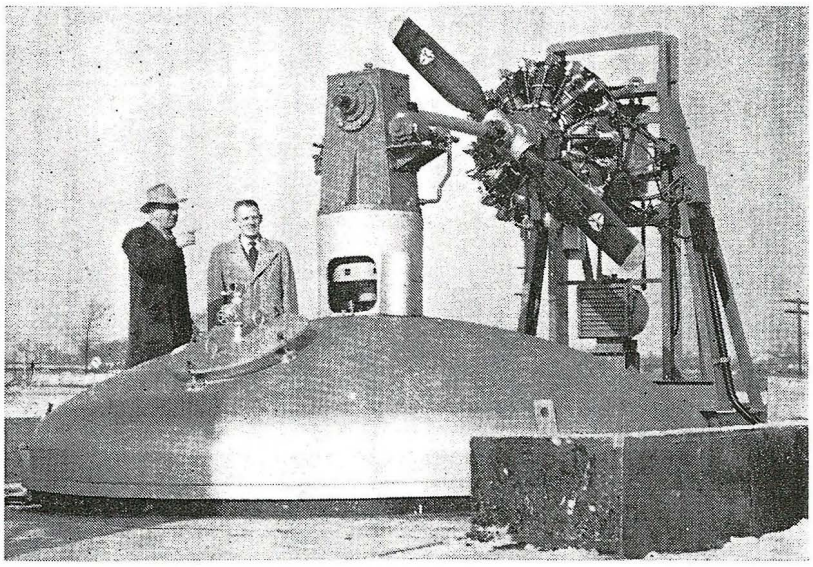


Higher and Higher

Fifteen seconds in the life of a Martin Viking high-altitude research rocket are depicted here by this remarkable series of photographs. The first picture at the top upper left shows technicians clustered around the base of the rocket making final checks. The second photo shows the moment before firing, when everybody has ducked behind sandbags. The third shot shows the moment of firing, just as the connection breaks away. The following pictures show the rocket rapidly rising into the upper reaches. Final photo at left reveals nothing but a trail of smoke twisted by the vagaries of the winds aloft. This rocket reached only 33 miles, but the first Viking got to 51½ miles. This scene took place at White Sands, N.Y., September 6. Structure in first photos is gantry for working on rocket.

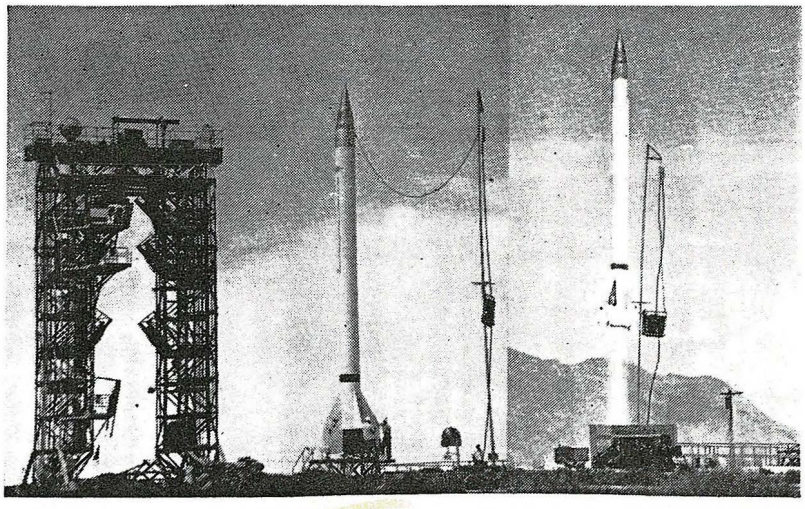


SPIN PIT: The Aeroproducts Division of General Motors Corporation describes its supersonic "Spin Pit" as the first of its kind in the world. The pit is used for testing propellers designed for supersonic flight. Power for turning the test propellers is provided by a P & W Wasp Junior driving a geared up shaft. Prop apparent here is for cooling the engine mainly. Test props are not visible.

major stations in the radar fence across the Canadian Arctic and in the Air Defence Identification Zones along the international boundary.

The GE announcement said that the systems were the most complex yet to be made. Some hint as to how elaborate the systems must be is contained in the statement that an estimated 400 men are required to operate each installation on a 24-hour basis, and that each system could intercept several raids simultaneously.

Earlier the CAA announced that it had completed the setting up of the last four of six Air Defence Identification Zones, which means that there is now a broad belt running clear across North America in which any aircraft flying higher than 4,000 feet is under constant surveillance by radar. The belt is unbroken except for two short stretches. In Canada, somewhat narrower Canadian Air Defence Identification Zones also exist, but there is still a large gap in the Canadian system extending from Northwestern Ontario across the three prairie provinces.



135 MILES UP: The USN's Martin Viking rocket No. 7 recently attained an altitude record of 135 miles and reached a maximum speed of 4,100 mph. in so doing. It is shown at left standing near its servicing gantry, which has been moved away shortly before firing. Picture at right was taken the instant following take-off. The Viking weighs 5½ tons and is 48 feet long. Three more are to be built.

Pilots flying planes entering or leaving the zones, either U.S. or Canadian, must previously file flight plans. This also applies to planes carrying out flight within the zone, but which involve climbing to above 4,000 feet. Failure to comply in the U.S. leaves violators open to fines up to $10,000 and a prison term of up to one year. In Canada there is no such drastic action threatened, as no definite punishment has been laid down by the Government. In both countries, of course, violators run the risk of interception by Canadian or U.S. fighters.

Dampening Down

The feasibility of scattering Calcium chloride or sodium chloride from an aircraft is being studied by the Ontario Department of Lands and Forests as a means of "dampening" down the bush during periods of high fire hazard. Aircraft have also been used by this department in the experimental dropping of water-bombs on small bush fires. The water bombs are made by filling cement sack type containers with water.

Lifesavers

Operators of aircraft carrying out over-water flights must equip their machines with life preservers that meet the United States National Aircraft Standards Committee Specification No. 801, it was ruled recently by the DoT. All life preservers currently in use which do not meet this or an equal specification must be replaced before May 1, 1953.

The ruling was made as the result of recent investigations of seaplane accidents which revealed that many types of lifebelts were inadequate due to poor buoyancy and to the attitude of the wearer when supported by such equipment.

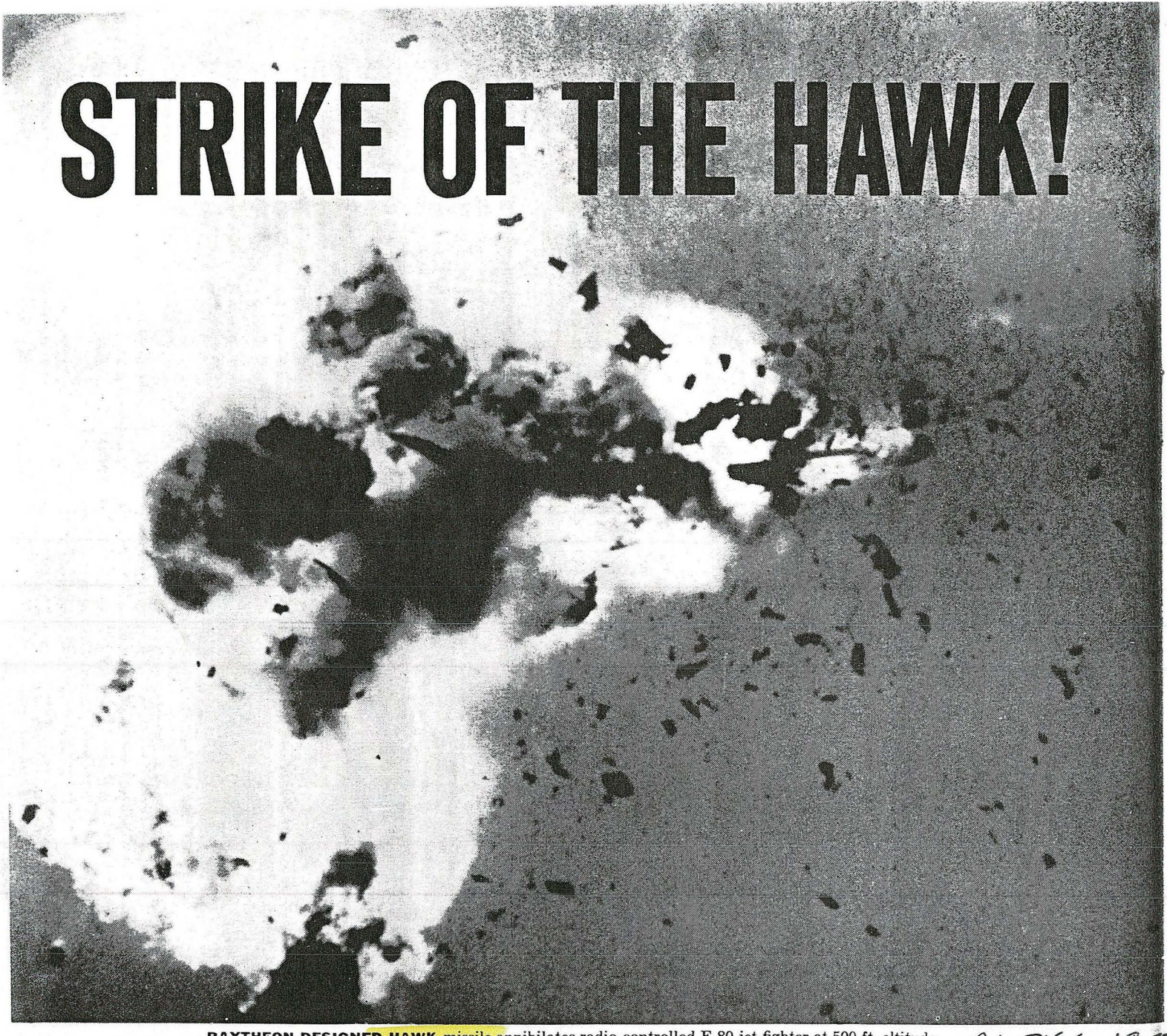
New Type Licenses

A reminder that old type Private, Public Transport, and Commercial licenses will no longer be valid after May 1, 1953, was recently sent out by the DoT in the form of an information circular. All concessions with regard to the exchange of Limited Commercial licenses for a new type license have now been cancelled.

Concessions still in effect relating to other old type licenses are as follows:

1. Holders of a valid Public Transport certificate and a valid Instrument Rating with at least 100 hours flying experience in the twelve months pre-

STRIKE OF THE HAWK!



RAYTHEON-DESIGNED HAWK missile annihilates radio-controlled F-80 jet fighter at 500 ft. altitude.

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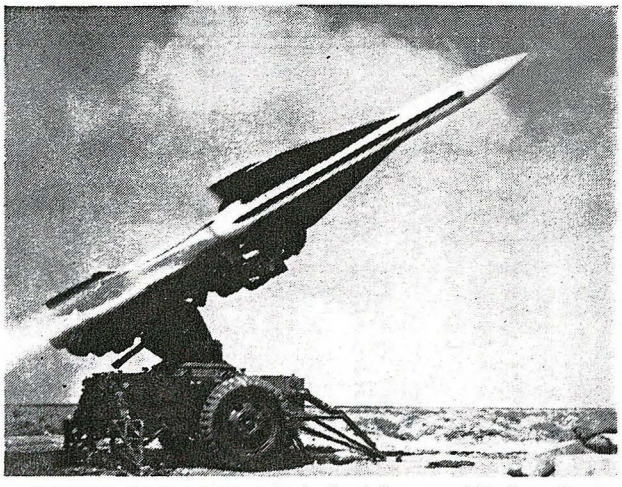


ARMY'S HAWK MISSILE is fired from mobile launcher. Missiles, launcher and support equipment can be air-lifted or quickly transported by Army or Marine ground forces.

NEW ARMY MISSILE DESTROYS LOW-FLYING AIRCRAFT

This *proven* anti-aircraft missile operates even at tree-top heights, in the blind zone of other radar-controlled missiles.

Raytheon is prime contractor for the U.S. Army Hawk weapon system—now in production and slated for use with fast-moving Army and Marine Corps ground forces as well as for the defense of U. S. cities.

RAYTHEON

Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY, Waltham, Mass.

RL. 866-1952

THE AIRBORNE SERVICES

Over to You

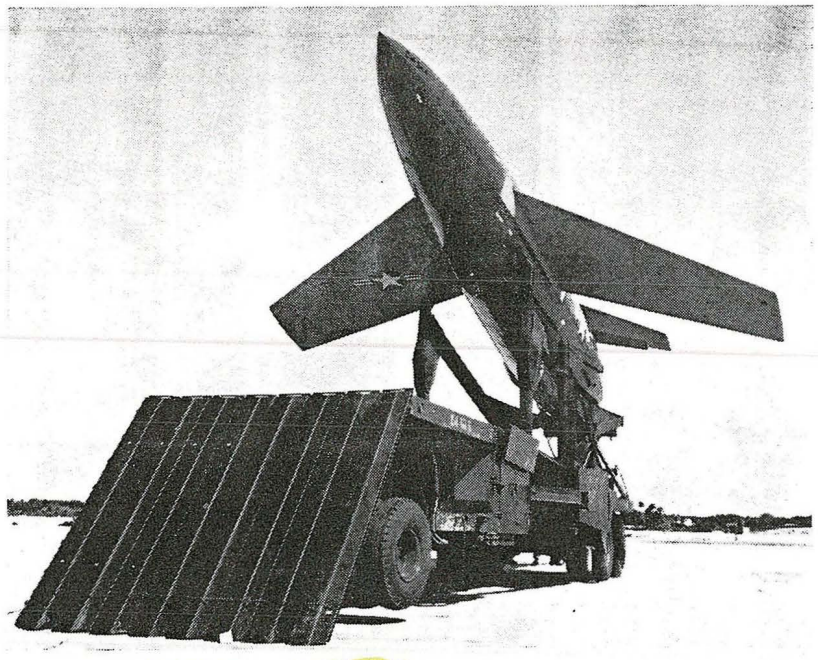
This is the month that No. 441 Silver Fox Squadron will take leave of St. Hubert, P.Q., and head for North Luffenham, England, where it will begin its tour of overseas duty as one third of No. 1 RCAF Fighter Wing. Already at North Luffenham is 410 Cougar Squadron and it has now been officially announced that the third unit, No. 439 Squadron, will leave for the U.K. from its Uplands (Ottawa) base in the spring.

While in the U.K., the three squadrons forming the RCAF Fighter Wing will be under operational control of RAF Fighter Command. At a later date, when adequate airfields and accommodation are available, the Wing will move to the Continent, where it will be grouped with USAF forces.

Led by its commanding officer, Squadron Leader Andrew MacKenzie, DFC, 441 is to sail from Saint John, N.B., February 13, aboard the Empress of France, and is to disembark at Liverpool. Canadair-built F-86E Sabres are already at North Luffenham, having been taken across on HMCS Magnificent on the same crossing that took personnel of 410 and their Sabres during November.

No. 441 Silver Fox Squadron was reformed in the spring of 1951 at St. Hubert, equipping initially with Vampires and later converting to Sabres. As a wartime unit, the Squadron operated from the U.K. early in 1944 until after D-Day, when it moved to the Continent. It flew from airfields on the Continent for several months, returning in late 1944 to Britain to fly escort for heavy bomber daylight attacks on Germany. It was disbanded in England in August, 1945.

No. 439 Squadron, commanded by Squadron Leader Cal Bricker, DFC, was re-formed at Uplands in September of 1951, and also flies Sabres. Originally formed in Britain in January, 1944, the Squadron flew Typhoons and played an important part in the pre D-Day softening up operations against the enemy. After D-Day the Squadron moved to the Continent, and was disbanded in August, 1945, in Britain.



NO HANDS: A Martin B-61 Matador pilotless bomber is shown on its launching platform just prior to take-off. The Matadors are being delivered to the USAF's 1st Pilotless Bomber Squadron (Light), now being activated in Florida. Initial take-off power is provided to the turbo-jet powered B-61 by a rocket, which falls free when expended.

Fortitude

The Air Force Cross has been awarded to Wing Commander James Mitchell, DFC and Bar, for captaining a Dakota on a hazardous mercy flight to Eureka Sound, 800 miles north of the Arctic Circle in September, 1950. The 5,844-mile flight was made to bring out a member of the staff of the weather station at Eureka Sound who was suffering from gangrene and needed immediate medical attention.

The flight for which the award was made began in Edmonton and went via Baker Lake, N.W.T., and Resolute Bay, on Cornwallis Island. At Eureka Sound there was only a rough landing strip on the ice marked out by oil barrels. W/C Mitchell successfully landed the ski-wheel Dakota and two hours later the aircraft made a JATO take-off with the patient aboard, under extremely poor weather conditions. At Churchill an instrument landing was made by W/C Mitchell against a 40° crosswind with gusts of more than 40 mph. When he completed this landing, he had flown 4,757 miles in less than 29 hours flying time and had had only 3½ hours sleep since the beginning of the flight.

New RCAF School

On January 1, Nos. 1 and 2 Advanced Flying schools officially came into being in Western Canada. No. 1 AFS is located at RCAF Station Saskatoon, while No. 2 AFS is based temporarily at RCAF Station Macdonald, Manitoba (which is also called home by the Pilot Gunnery School), and will later move to Portage la Prairie.

In command of No. 1 AFS is Wing Commander Donald C. Skene, DFC, who has been a military aviator since 1937, when he joined the RAF. During the early part of World War II he served as a flying instructor and in 1943 he transferred to the RCAF, with which he completed a tour of operations on Mosquito bombers with the Pathfinder force. The following year he was named to command a bomber OTU in Britain, later serving as a flight commander with an RCAF Mosquito squadron. A graduate of RCAF Staff College, prior to going to Saskatoon he was on staff duties at the headquarters in Edmonton.

The school which W/C Skene commands will fly Mitchells and will provide advanced flying instruction for pilots destined for duty on multi-engine transport, photo survey, or maritime squadrons.

RCAF Station Saskatoon, of which No. 1 AFS is part, is commanded by Group Captain Robert S. Turnbull, DFC, AFM, DFM, who is credited with the fastest rate of climb in the RCAF—he rose from the rank of ser-

FEB/52

RL. 866-1951

NEWS ROUNDUP

New Squadron

Another new fighter squadron has been formed by the RCAF—No. 430 at North Bay, Ont. The squadron will be equipped with F-86E Sabres and will be commanded by Squadron Leader J. F. Edwards. North Bay is also the location of No. 3 All Weather OTU.

Orenda Production

Some production machinery has been set up and is already in operation at the new Avro Canada Orenda gas turbine manufacturing plant, near Malton, on which work was first started less than a year ago. The huge plant is rapidly nearing completion and it is expected that it will be in full production on Orenda engines next year.

Genaire Limited

Now ready to commence operations is Genaire Limited, according to H. B. Picken, president of the newly-formed organization.

Genaire Limited is located on the Municipal Airport at St. Catharines, Ont., where the firm has taken over the management of the airport. D. W. McLarty has been designated as Airport Manager and is also a vice-president of the company. Mr. McLarty has been in civil aviation for the past six years as a pilot for Kenting Aviation and was also formerly managing director of Photographic Surveys (Western) in Vancouver.

The new firm intends to do repair, maintenance, and overhaul work on aircraft and subcontract work on components. The engineering and installation of electronic instruments for customers using such equipment will also be undertaken.

Superintendent for the firm is F. G. Clarke who has been in the aircraft industry for some 15 years on inspection and supervisory work. Chief Inspector Alec. G. Martin has had some 14 years aircraft experience in construction, inspection and bush operations maintenance. Mr. Martin holds an "M" license, with endorsation for A, B, C, and D work, and a commercial pilot's license.

Mr. Picken said that the recent arrival of G. R. "Gerry" Wooll and C. E. Graham, formerly managing director and accountant/office manager respectively at Field Aviation Company, Oshawa, had rounded out the initial group of employees. Mr. Wooll holds the position of managing director of Genaire, and Mr. Graham is secretary-treasurer.

National Air Show

Not since the International Air Show of 1946 had a Canadian air display attracted such a crowd. On September 15 the National Air Show, sponsored by the Toronto Flying Club, drew an estimated 75,000 persons and clogged roads for miles around Malton Airport. Although the International Air Show attracted about 100,000 persons, it lasted eight days, so that in effect the National Air Show set an all time record for attendance.

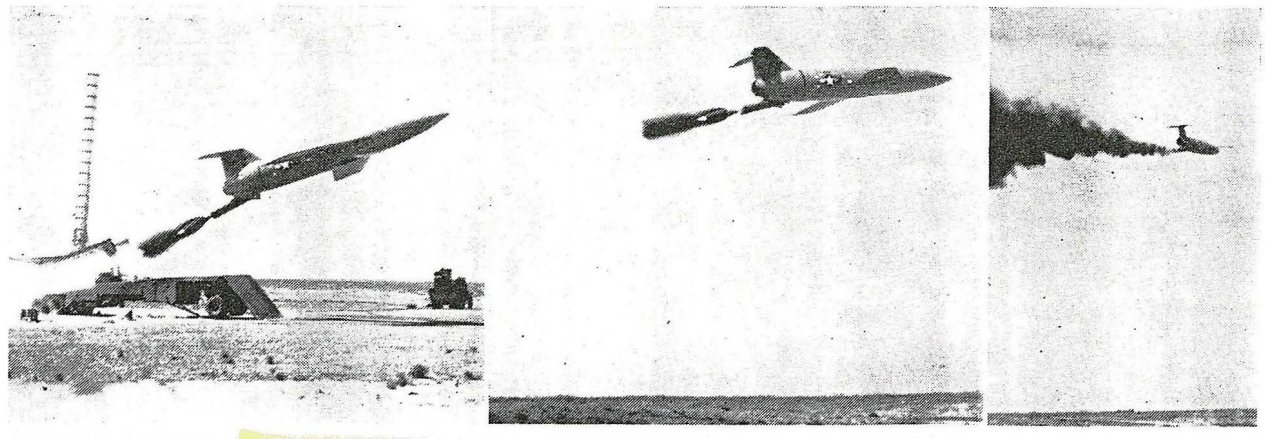
Near perfect weather aided materially in drawing the record crowd, but at the same time the show was one of the best to have been put on in Canada for several years, though its appeal was primarily to the general public. Aircraft exhibited included the CF-100, the Orenda Lancaster, Mustang, RCN Grumman Avenger, Vampires, USAF Boeing B-29, Bell helicopter, Chipmunk, TCA North Star, and American Airlines' Convair, as well as such smaller private type aircraft as the Navion, and the Piper Super Cub. Flying displays were put on by most of these aircraft. The program included a mock attack by sixty paratroopers dropped from three Dakotas.

Airports

The Vancouver City Council was recently badly winded by a blow in the form of an offer from the Department of Transport to buy Vancouver International Airport for $420,000, about one-fifth of the value the Council had earlier placed on the field. City officials had appraised the value of the airport at $2,175,000. Actually, the DoT's offer, made in the form of a letter from Transport Minister Lionel Chevrier, was for the buildings and equipment. Mr. Chevrier suggested that the usual procedure be followed and the city grant title to the lands for the nominal sum of one dollar.

Future developments will probably depend on negotiations between the Council and the DoT. Meanwhile, a $2,000,000 airport expansion project is soon to get started.

And from across the Dominion



PILOTLESS BOMBER: The Martin B-61 Matador is soon to be put into active service by the USAF. Though described in initial reports as one of a number of new "fantastic" weapons, it is actually nothing more than a guided missile powered by a jet engine and fitted with rocket assist for take-off. The rocket, evident in this series of take-off pictures (from launching truck at left), drops away from the Matador once its fuel has been expended. The B-61 has a typical modern configuration and is thought to have a speed of about 700 mph. A USAF squadron is now being activated in Florida to operate the new weapons.

A AND A Construction

That's How It Is

Many people in the aviation industry in Canada have often wondered why the RCAF picked on the F-86A as a standard fighter. Often as not, this wondering was nothing more than curiosity, but because it is apparently the accepted policy of the Department of National Defence to explain none of its actions to the people who are picking up the tab, the questions about the F-86A have never been more than vaguely answered.

It would seem now that the reasons for the Department's actions are not in any way secret, but rather it was that nobody had thought to let the public in on the thing. The assumption that the matter is in no way confidential comes from the fact that Air Marshal W. A. Curtis, Chief of the Air Staff, recently sent out one of his periodical letters which go to all reserve, retired, and former members of the RCAF. This takes in a large number of the common people. The letter in question goes into great detail to explain the whole affair.

The reasons for building the F-86A in Canada are summed up by A/M Curtis in two points: (a) A sound aircraft industry must be maintained in Canada; (b) The RCAF must not be dependent on overseas sources of supply for major equipment. In his letter the Air Marshal enlarged on these points and then continued:

"In 1948 the Government . . . authorized increases in the size of the RCAF, with emphasis on the fighter element. The RCAF required two fighter types, a day-fighter and an all-weather fighter to replace the Vampire III . . . and to equip new squadrons. The Vampire III's are excellent aircraft . . . (but) . . . time to arrange for eventual replacement is before they become operationally obsolescent, and not after. . .

"All available day-fighter types in the U.K. and the U.S. were carefully investigated . . . with two major points in mind. First, the aircraft selected must be one which would not become operationally obsolescent at too early a date after introduction into the Service. Second, it would be unwise to choose an aircraft which was extremely advanced, but yet hardly more than an idea on the drawing boards, and which might fail completely to live up to its hopes. Furthermore, an aircraft at this stage of development would probably not be available in quantity by the time we required it. . .

"A number of . . . British fighters were considered, but their purchase ruled out because of the policy points which I have mentioned. The potential danger of relying upon an overseas supply source for engines was so great we could not risk it. Consideration was given to the possibility of manufacturing British airframes in Canada, and fitting them with engines manufactured in North America. To have made the airframes here, however, would have entailed a good deal of re-engineering, to allow the work to be done to North American standards. This would have resulted in an aircraft standard with neither the U.K. nor the U.S.

"It did not appear likely that a suitable jet engine was available on this continent to serve as a power unit in the event that British airframes were made here, and it was doubtful whether our own Orenda engine, still in its development stage, could be fitted into an acceptable British-made aircraft without extensive engineering changes to the aircraft.

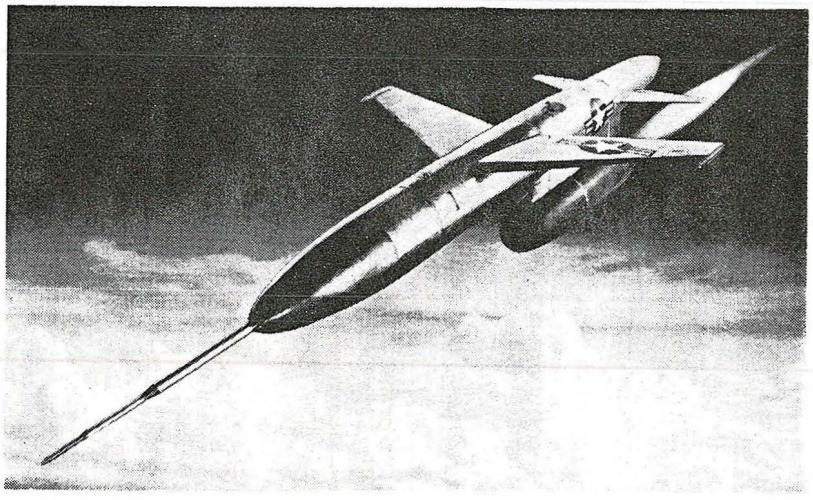
Undesirable

"It would have been possible to have manufactured British jet engines in Canada, as well as British airframes, but this was undesirable. Canada's jet propulsion facilities are busy with development of our own Orenda engine, an engine having, strictly for our own purposes, greater potentialities than any available overseas engine that we might make. To commence manufacture of a second jet engine in Canada at this time would mean a tremendous outlay for a very limited result. It would also mean spreading our jet production facilities very thinly.

"It can be seen, therefore, that acquisition of a British-made day-fighter would not have been in keeping with the desirable factors discussed above. On the other hand, manufacture of the F-86 in Canada would fall into line with them.

Comparable

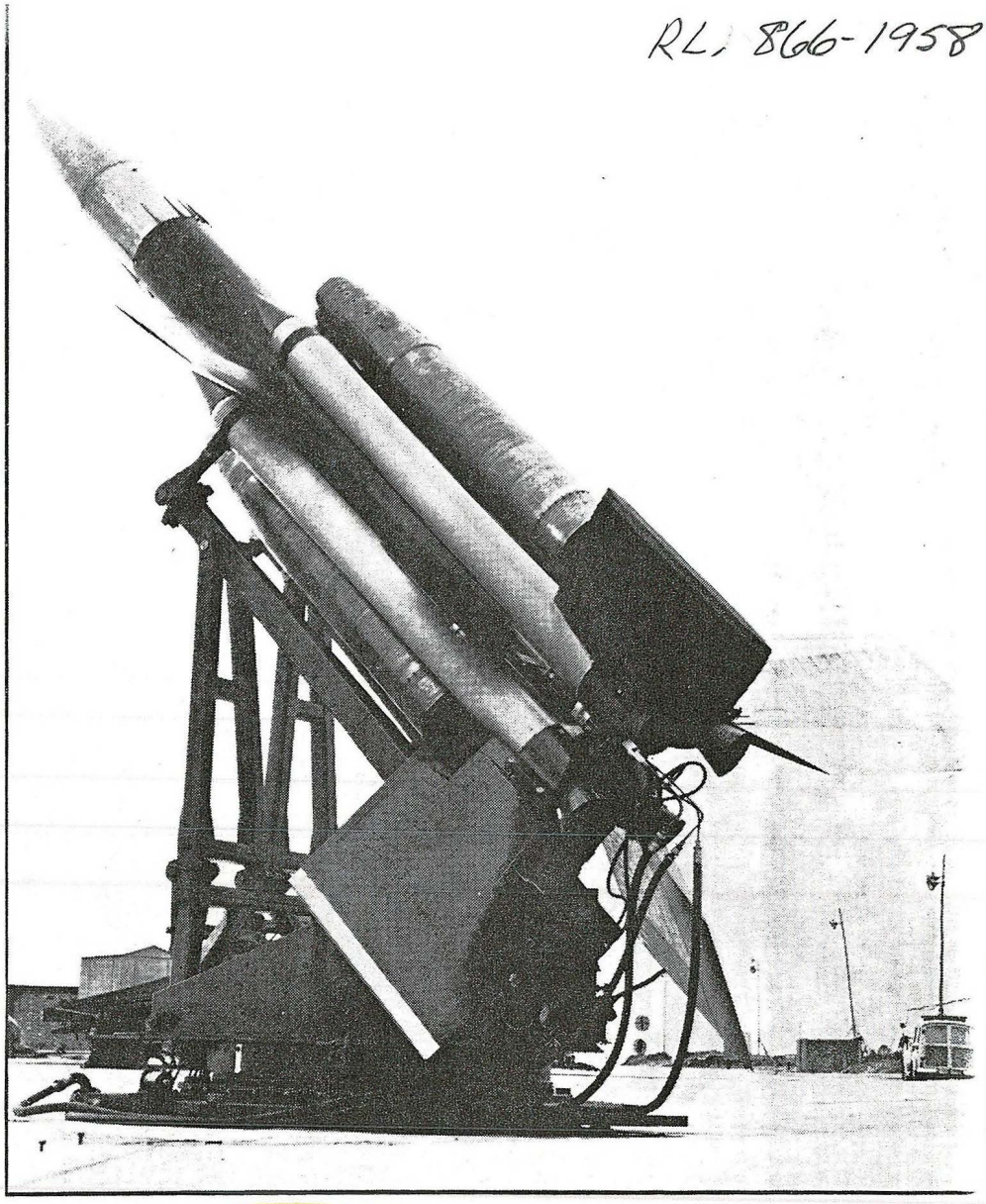
"There has been some speculation concerning the cost of the F-86, which is high. So is the cost of every other comparable fighter now entering production or under development. Advaces in jet fighter design in the last



TARGET: The Martin KDM-1 is a pilotless, radio-controlled, ram-jet target drone which is to be used by the USN for anti-aircraft gunnery practice. The KDM is the successor to the Gorgon IV and will attain speeds approaching those of the fastest fighter planes, according to Martin. A twenty inch Marquardt ram jet engine provides the power for the KDM's, which are launched from a parent plane.

Missiles

THE NAME of Sir W. G. Armstrong Whitworth Aircraft, the prime contractor, was directly linked with that of the British General Electric Company, as designers and manufacturers of the guidance, SAH radar, and the British Sperry Gyroscope Company, as providers of the control and stabilizing equipment of the Royal Navy's Seaslug SAM. A "propulsion test vehicle" for it was shown on a turntable launcher. Aerodynamically this closely resembled last year's round, apart from a slightly boat-tailed stern associated with the new solid-propellant motor. With a support ring for the stern of the missile and a guide rail for a shoe on the lowest boost, the Seaslug rests with its aerofoils at 45°. Each boost has a shoe, which only slides about a foot before leaving the rail, so that it can be loaded any one of four ways. The forward-mounted boosts have been completely changed; four large single rockets, instead of triple clusters, and a new type of swing-out forward release gear. Struts to each rocket from the thrust ring would appear to swing clear under drag forces at booster burn-out to start the cases on a clean throw-clear course —perhaps this is the reason why the booster nose cones are not now canted outboard.



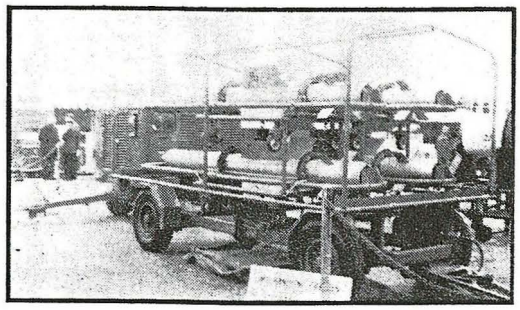
The Bristol/Ferranti Bloodhound missile, selected for operational service by RAF and also by Sweden. Bloodhound is propelled by two Bistol Thor ramjets.

On the Hawker Siddeley Group stand was a partly-sectioned and working model of the triple launcher designed for the fore deck of HMS Girdleness and the four Hampshire class AA missile cruisers. The rounds are run on trolleys along individual galleries in the tween-decks from the magazines, aft or amidships, to "breeches" pointing upward at 45° to meet the rear of the launching gantry. The latter is orientatable, so one presumes the rounds are slid up above deck before firing, connection being made with the several initiating services through the launcher's barbette —and the deck hatch closed before firing.

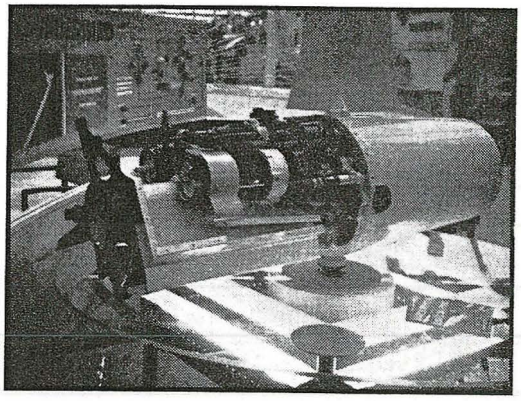
Avro exhibited a large air-launched "aerodynamic test vehicle" and a three foot long wind tunnel model; both bearing a close resemblance to the canard Avro stand-off bomb that was briefly flown past, half buried, in the belly of a Vulcan. It is a circular-section streamlined body, fineness ratio about 12:1, with a large 60° delta foreplane, a small, thin delta wing, well aft, and upper and lower vertical fins—in the Vulcan the lower fin was folded sideways for ground clearance. The delta foreplane is all-moving, there are inboard ailerons on the wing and a small rudder, or perhaps directional trimmer, on the upper fin. A boat tail contains two rocket nozzles on the large model.

The Bristol/Ferranti Bloodhound, the RAF's first SAM, was on and off loaded between its ML transporter trolley and mobile ML launcher/elevator—which requires a simple hard standing and some ground services—by a six man crew from RAF Fighter Command. Alongside were the Bloodhound control van with the BTH target-illuminating radar. In the outdoor equipment display, ML showed the main body assembly stand, virtually a mobile assembly jig for the Bloodhound's rear fuselage, Thor ramjets and aerofoil surfaces.

A film showed the interception of a Meteor drone, apparently at about 10,000 ft. As the four concentric boosters "umbrellad" outward and away, the missile half rolled, then hunted gently in roll for some distance as it sought the target, flying in from the right. The Meteor was banked away steeply by radio control and the Bloodhound turned righthanded on a collision course, emitting a brief vapour trail—which could have been due to increased engine power or lift in the turn. The unarmed missile hit the drone fair and square with a fearsome

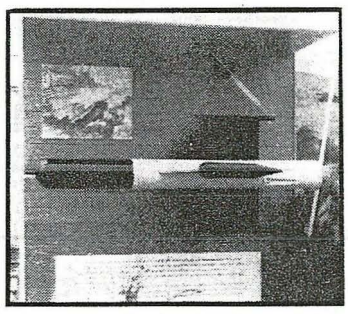


Made by ML Aviation, this trailer carries four de Havilland Firestreaks, each on a handling trolley.

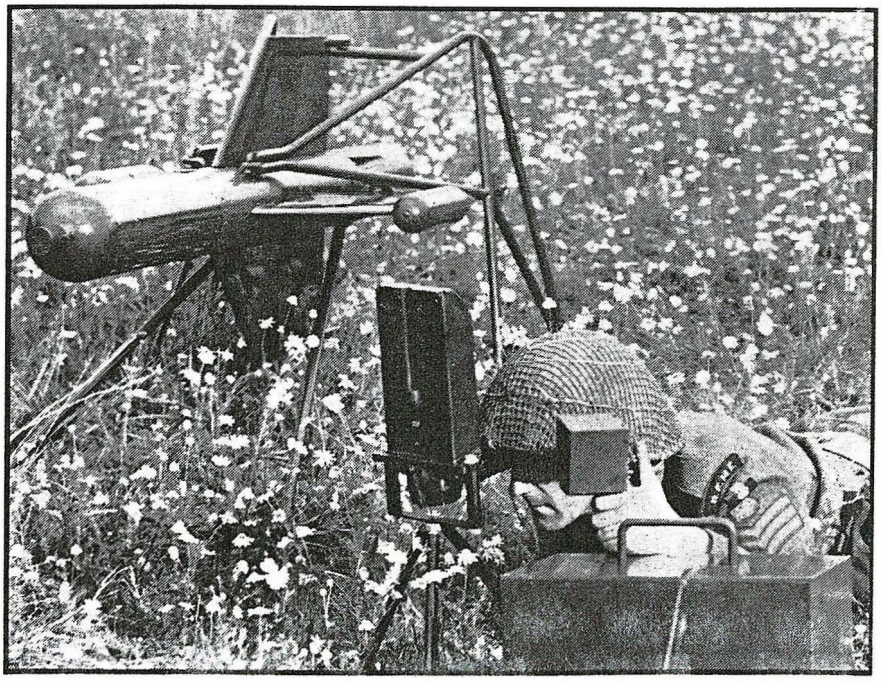


Sectioned tail of EE Thunderbird, showing gas-fed hydraulic accumulators and actuating rams.

Part of Pye's display of its anti-tank missile, which has jet steering and a large destructive, as opposed to penetrative warhead.



Below, again the Pye anti-tank wire-guided weapon, with sighting binoculars, control "pistol" and signal generator.



explosion of fuel — operationally, of course, a proximity fuse ignites the warhead.

De Havilland Propellers, which is a close-knit, self-sufficient missile "complex", this year relied mainly upon dummy Firestreaks on the airplanes and the ML four-weapon trailer.

The company was also allowed to give some new dimensional information, which may prove interesting: length 125.44 in., span 29.4 in., dia. 8.75 in.; alternator 17.5 in. x 5.71 in. dia., condenser 6.25 in. x 6.0 in. dia., controlled 11.0 in. x 8.0 in. dia.; *airplane,* launching sequence unit 16.0 in. x 10.25 in. x 9.25 in., power unit 14.25 in. x 7.75 in. x 8.25 in., slaving unit 14.25 in. x 7.75 in. x 8.25 in.

English Electric also appears to provide all resources for the Thunderbird SAM from its extensive Guided Weapon Division at Luton and Stevenage and the associated Marconi and Napier companies. The Thunderbird, which is now officially admitted to have a solid-fuel sustainer, was actively demonstrated by an Army team of seven—it is primarily an Army weapon although the RAF has now ordered some for tactical target defence. The launcher and associated equipment are fully mobile and a model on the stand showed how the rounds are prepared and tested in a field assembly unit, then mounted with the consumable system cap and short leads on the cradle of the launcher. Also on the stand was the tail control assembly, complete with one blade, gas operated hydraulic actuating pistons. The propulsion gas passage and shielding were an interesting feature of this exhibit. Dimensions of the Thunderbird are now officially released: length 21 ft. 0 in., span (wing and blade) 5 ft. 3 in., dia. (midriff) 1 ft. 9 in., leading-edge sweep 45°.

Fairey Aviation's Fireflash exhibit consisted of the pre-flight preparation of a round, electronic testing and separate attachment of warhead and boosts prior to final assembly, by a five-man team from the RAF's Guided Weapon Development Squadron, which operates Supermarine Swift F.Mk 7's from Anglesey. Interesting, but unexplained, was a Fireflash with wings of approximately doubled area, mounted adjacent to the words "high

(Continued on page 77)

plane reached a maximum true airspeed of 670 mph and a maximum Mach number of .95. Maximum altitude was 42,500 feet and maximum gross weight of the airplane during take-off on one CAA flight was 260,000 lbs.

First Flight of Comet 3B

The Comet 3B, development aircraft for the Comet 4B, made its first flight at Hatfield in late August. Formerly the Comet 3, it was modified to approximate Comet 4B configuration by a reduction of 7 feet in the wing span. In this form the Comet 3B will embark upon a program of tests and development flying for the Continental Comet 4B jet liner now in production for BEA.

Beech Conversion

Airline Products Co. has available a new publication, "How to Modernize Your Beechcraft", which features all the firm's items designed to update and modernize the Twin Beech into a Super 18.

Britannia Simulator

CPA's new Bristol Britannia flight simulator is now in operation. The $300,000 pilot trainer was brought by sea from England where it was made, and installed in CPA's $95,000 Flight Training Building beside the company's DC-6B simulator. CPA executives calculate that the cost of training a pilot in a simulator is only one-tenth as much as it is in an aircraft.

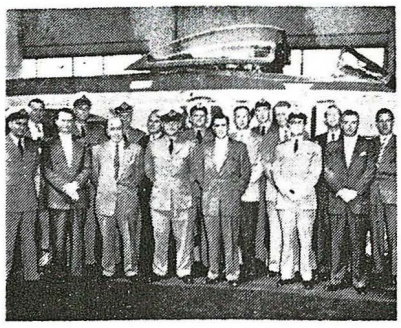
Thirty CPA pilots, some who have already flown the Britannias, some who are preparing to, are now undergoing training in the simulator.

MISSILES

(Continued from page 35)

altitude", and with a curious proboscis on its warhead. Fairey was not allowed to show the anti-tank missile which has been selected for trials by the British Army.

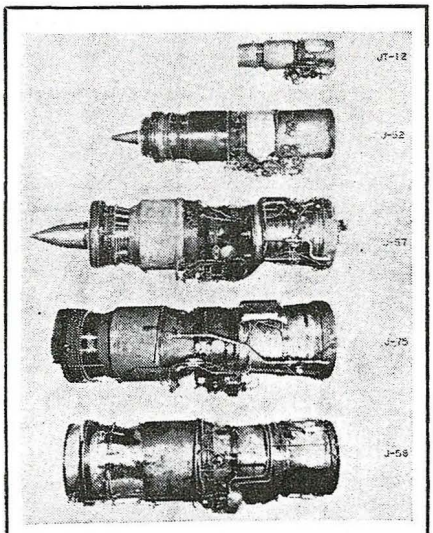
Pye Limited showed a "private venture" wire-controlled anti-tank missile which is stated to be ready for production. It has low aspect ratio cruciform wings with swept leading edges, a slender cylindrical body, with a hemispherical nose-carrying a detonator and a bolted-on rocket unit at the rear. The length is 5 ft., the span 2 ft. and it can be carried by one man. Two



FAIREY VISITORS: Shown recently at Fairey Canada plant during periodic visit by RCNHQ staff to discuss progress on Banshee repair and overhaul program, are representatives of Aviation Electric, Carriere & MacFeeters, Fairey Canada, Godfrey Engineering, and Phoenix Engineered Products.

of the wings are fitted with trace flares, the other pair having containers for the guidance wire bobbins. The missile is launched from a simple tubular zero-length support which holds it under the horizontal wings and by two bent pins on the body. Control is by jet deflection, all details being concealed. If all equipment was on show—the signal generator, control "stick" and dual-magnification binocular periscope sight were—then it is indeed a remarkably simple and compact weapon, since the high-voltage power pack is usually the massive part of the gear for these wire-controlled weapons.

Short Brothers and Harland again showed the SX-A5 "multi-purpose surface-to-air test vehicle" and the dear old RAE/Short/Elliott GVP. In connection with the former, a command guidance rocket, the company announced a Royal Navy order for a small SAM to take the place of its 40 mm Bofors guns. The GPV is a production job for basic research on homing with its Elliott Equipment radar scanner SAH system. The missile is strictly re-usable — for which reason it has a liquid rocket—and this year's display was mainly concerned with the two-stage GQ parachute recovery system; initiated by four tail doors and ending with the inflation of a buoyancy bag.



FAMILY GROUP: Photo shows comparative sizes of Pratt & Whitney's family of jet engines, ranging from the 2900 lb. th. JT-12 (top), to the J-58 (bottom), designed for Mach 3 flight.

Vickers-Armstrongs (Aircraft) Ltd. showed its tiny Type 891 Vigilant wire-controlled infantry anti-tank weapon broken down to its simple elements, assembled with its optical-guidance combination binoculars and control "pistol", in its launching canister, on a tripod launching stand, and with its various carrying bags. The weapon is 33 in. long, with a span of 12 in. and weighs, in its canister, 35 lb. to 45 lb. according to the amount of shock protection provided. V-A makes the sales points that, after smallness for genuine one-man portability, the design priorities were (1) accuracy, (2) lethality, (3) robustness; also, no warming-up is required, it gives wide-angle coverage with a shorter lethal range than most anti-tank guided missiles, and a maximum range considerably greater than that of an anti-tank gun.

WESTLAND

(Continued from page 25)

copters were particularly well demonstrated, quite apart from the effect of their graded size, Westminster (5500 shp), Wessex (1450 shp), Whirlwind (720 shp) down to Widgeon (540 shp).

Excellent team flying was accentuated by the Immelmann turns (inverted) of the Wessex and the extraordinary behaviour of the Westminster. Slim Sear started by taxying out—incidentally it has Bristol Freighter main wheels—to show ground manoevrability, followed by a backward take-off and lively air handling akin to that of the Wessex, ending with an abrupt stop in mid-air. The great drab green (Army colour) tubular framework, with its winking auto-observer floodlights amidships, cavorted with thunderous

RL. 866-0000

Missile Fails To Oust Pilot, Expert Claims

Montreal, Feb. 23 (CP)—British and Canadian aviation authorities said today the guided missile has not put the manned military aircraft out of business.

"I am sure it is wrong to assume that the guided missile has put out of business the manned military airplane," said Sir George Gardner, director of the Royal Aircraft Establishment of the United Kingdom.

"Enormous developments are in prospect in relation to both manned and unmanned flight and it will be very surprising if vital roles for each are not selected in the future."

The Canadian authority—R. J. Templin, chief of the aerodynamics section of the National Research Council — said there still will be a need for armed aircraft even if events prove the manned interceptor no longer is required in large numbers.

Their views were expressed in papers presented during the opening session of the special anniversary meeting of the Canadian Aeronautical Institute which opened here today.

"At the present time the supersonic interceptor and its successor, the manned hypersonic interceptor, cannot be completely ruled out on technical grounds alone," said Mr. Templin.

"Unarmed military aircraft are likely to be required for transportation purposes, especially in support of mobile ground forces and there may even arise a requirement for high-speed Northern reconnaissance and identification aircraft."

Sir George said the military aircraft picture in recent years has been dominated by the ability to generate nuclear explosions and by the successful emergence of the unmanned plane or guided weapon.

"There is, however, a widespread feeling that the sheer domination of these factors has tended to inhibit and confuse thought about the shape of things to come in the military sphere."

Mr. Templin stressed it is extremely difficult to predict the course of future Canadian aircraft development, but added indications are a wide range of aircraft types will continue to be required for military and civil use in Canada.

"There is even a possibility that the Canadian development of a medium-capacity supersonic transport should be seriously considered. It is therefore concluded that applied research should be pursued in a number of areas."

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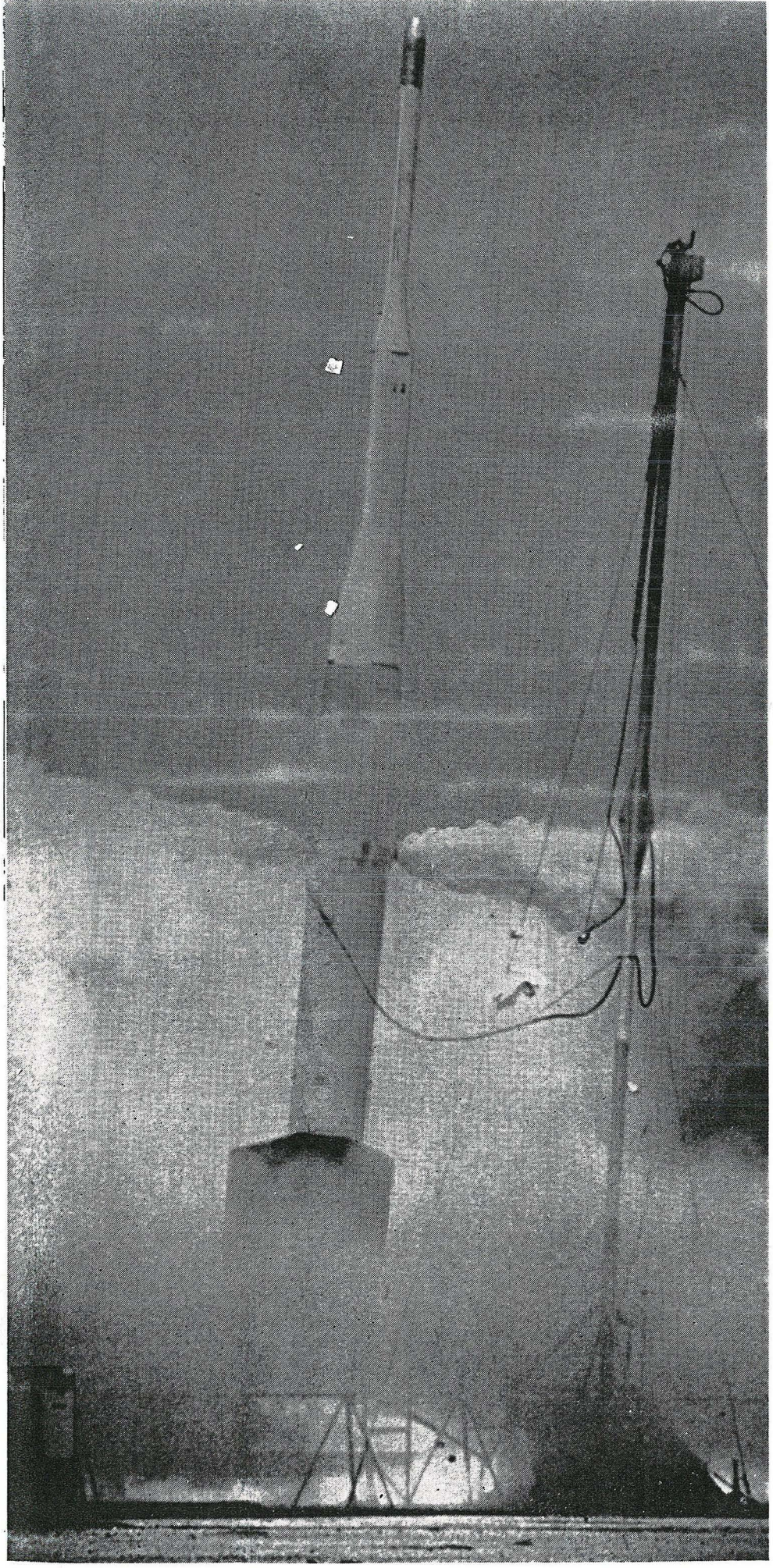
OCT 57

CANADIAN AVIATION



U.S. Bid

By Dick LaCoste

CAPE CANAVERAL, Florida—Activity is reaching fever heat on this sand-swept peninsula jutting out into the Atlantic on the east coast of Florida. Activity for peace—and for war. Activity for human survival.

For this is the home of the U. S. Air Force Missile Test Centre. The setting where weapons of the future are being checked, tested, tempered.

From here also, from a concrete launching pad set in the sand, the first artificial earth satellite, project Vanguard, will be rocketed into space.

Why has this innocuous mission taken on such signal significance? Simply because its launching paves the way for the most formidable weapon yet envisaged: the hydrogen-tipped intercontinental ballistic missile.

The pace has inevitably quickened. Competition between east and west to be first to launch an earth satellite is keen. Recent Soviet announcements of the launching of an intercontinental missile have added fuel to the fire. Indications are that Vanguard will be launched next month.

And Cape Canaveral has been closed to newsmen.

It was on July 29, 1955, that the White House announced the U. S. would attempt to launch an orbital artificial satellite. The announcement foreshadowed the era of the ICBM.

In fact, the launching of the unmanned orbital earth satellite is a mere forerunner of a later reconnaissance vehicle. Both are preliminary to the firing of the ICBM on its 5,500-6,000-mile aerial journey. Such a weapon could cross the Atlantic in 15 to 20 minutes—30 at most.

The Ultimate Weapon?

It has been labelled "the ultimate weapon." But miliary men don't consider the ICBM any more an ultimate weapon than was the first A-bomb or H-bomb, the airplane, machine gun, rifle, bow and arrow, or flinted bludgeon.

The day is fast dawning when the ICBMs will be in production and operational. Military men and scientists are now looking forward to defense against the 15,000-18,000 m.p.h. hydrogen-headed missile.

ICBM nose cones are tested on this X-17 research missile to probe heat problems of re-entering earth's atmosphere.

For Missile Supremacy

Maj. Gen. Bernard A. Schriever, the USAF's Air Research and Development Command ballistic missiles chief, stated on August 23 that defense against the ICBM is theoretically possible. In fact, the tall, slender, 47-year-old, German-born missileman underscored his awareness of the difficulties of the anti-missile problem. Further, he revealed that his organization contained an "anti-anti" section, hard at work on ways to circumvent the anti-ICBM.

U. S. and Canadian scientists and engineers are running a race against time. They are seeking to produce a practical intercontinental 5-6000-mile ballistic missile — first.

Indications are that the Russians will have the ICBM early in 1960, or before. Strength was added to this belief by the reports last month of successful Russian launching of an ICBM.

Western hopes are pinned on two thermonuclear ICBM weapons being developed by the U. S. on a "crash" basis, Atlas and Titan.

Successful U. S. Launch

On August 23, general Schriever revealed that a three-stage ICBM solid rocket missile had traveled at 15,000 m.p.h. It was launched from ARDC's Cape Canaveral. The remark went almost unnoticed in the U. S. press.

Three days later, the daily press scrambled for more details when the Soviets claimed they had an ICBM that could "hit any spot on the globe."

The successful U. S. launch announced on August 23 followed a failure some two months earlier. On June 11, the giant-size Atlas prototype plummeted ignobly into the Atlantic after a launch from the Cape.

On that fatal morning of its first test firing, the big bullet had to be destroyed after soaring to an estimated 5,000-10,000 feet. Reports are that malfunctioning of the rocket motors caused the Atlas to oscillate after launch. When the range safety officer pushed the "destruct" button, the 95-foot missile wavered like a winged bird, then plunged into the Atlantic.

U. S. scientists and engineers are running a race against time. What they are seeking is a technological breakthrough to produce a **practical** ICBM **—first.**

But they are worried.

On August 26, the Soviets announced they had fired a "multi-stage ballistic missile" which "covered a huge distance in a brief time" and "had landed in the target area."

"Crash" Development

Let's consider the five thermonuclear weapons that have been placed on a "crash" basis by the U. S. Two are ICBMs—Atlas and Titan, both Air Force weapons. Other three are intermediate range ballistic missiles (IRBMs). Thor belonging to the Air Force; Jupiter (Army) and Polaris (Navy). As of September, the U. S. ICBM effort centres around three projects. But only one of them is a true ballistic missile—the Atlas.

Atlas towers something under 95 feet from its concrete launching pad at Cape Canaveral. Gross take-off weight is from 100 to 120 tons. It will, like its predecessor the earth satellite, lift almost straight in the air, slowly at first, like an elevator. At about 20 miles, a servomechanism detaches the first unit of the three-stage rocket and the second-stage unit takes over.

Some time before the big bullet reaches 300 miles above the earth, the second-stage jettisons and the payload —or warhead—is naked and exposed. Estimated at about 30 feet in length and some four feet in diameter, the warhead skyrockets upward to its 600-800-mile apogee. Then, traveling at about 18,000 m.p.h., it re-enters the earth's atmosphere and, like a catastropic meteor, bursts over the target.

Scientists say we will literally have arrived at the age of push-button warfare when the Atlas becomes fully operational. Then the problem will be the anti-missile missile, the anti-anti missile missile, et cetera, et cetera!

Counting The Cost

Twelve years in the making, Atlas had cost more than $500-million when the last figures were released January, 1957. More than 100,000 persons—including the nation's top scientists, chemists, engineers and technicians—are devoting full time to the project. As many as 100 test versions may be launched from the Cape.

After the original costs are redlined, each Atlas, minus the blunt-shaped, ceramics, thermonuclear - tipped warhead, will cost about $1-million.

Designers are setting their sights on accuracy at two-tenths of one per cent. For an ICBM traveling a distance of 5,500 miles, that means coming within ten miles of the target.

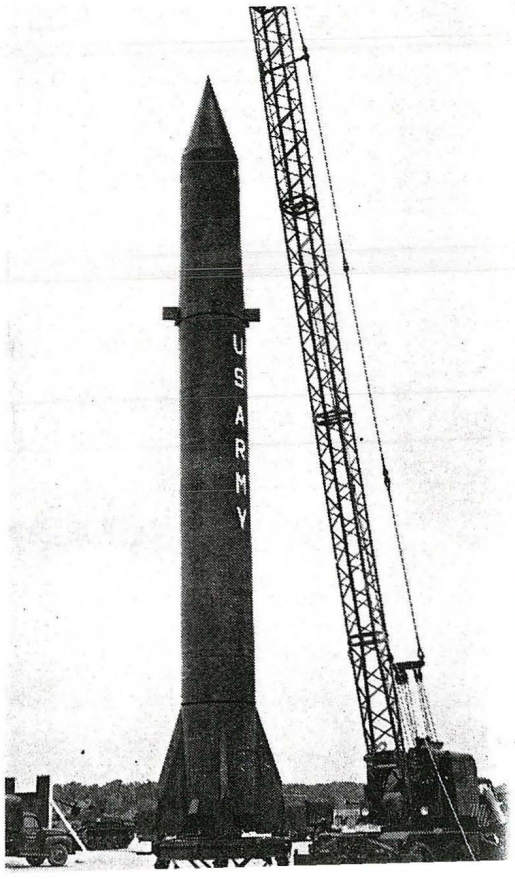
ICBMs like the Atlas are not considered true guided missiles. They are pre-set. Guidance data is fed into the weapon before takeoff. Theoretically, it will travel on a predetermined course in a set direction for a set distance. Then it will explode. Such a missile, naturally, cannot be radar-guided.

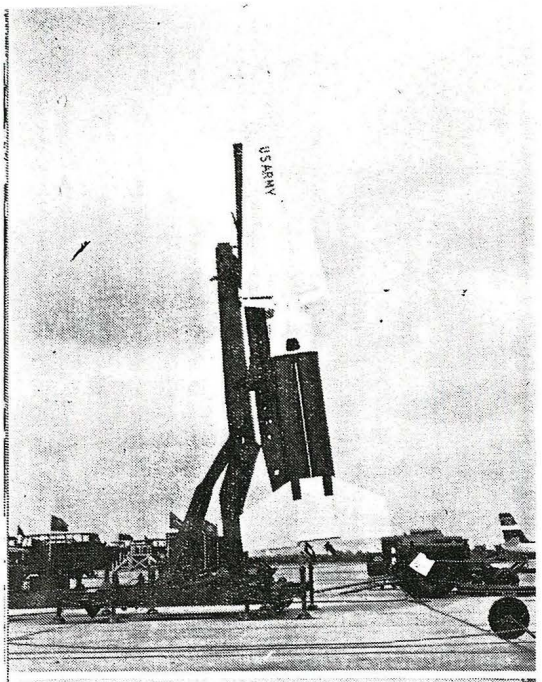
In order to get distance out of an ICBM, it must be fired high into the atmosphere. As the rocket gets high into space, there is no possibility of control because the control surfaces have no air to push against.

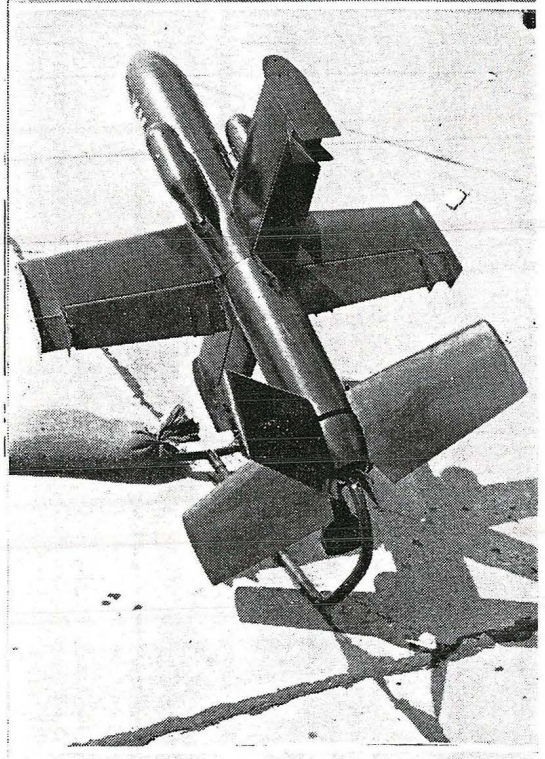
Slower, jet-propelled missiles **can** be controlled to a lareg extent. Their mechanism can check their course periodically by the stars. Errors then can be corrected.

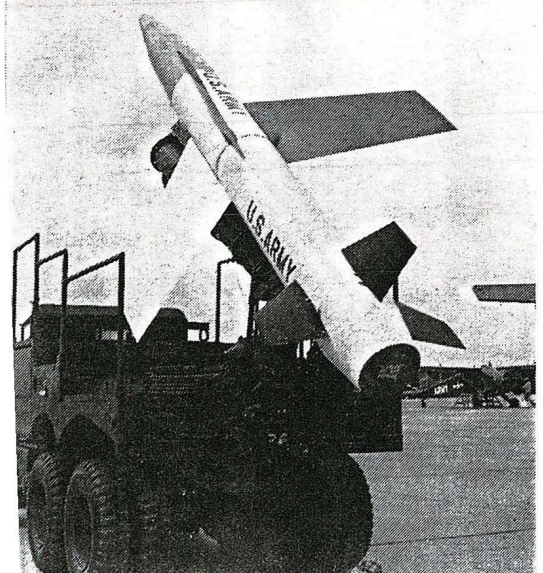
The direction of the stars is fixed in space. In the jet-propelled type of missile, a gyrocompass controls the missile's direction. The gyro takes automatic readings of the positions of the stars. But gyros have a tendency to drift off their original settings after a while. A reading of the star sights

POISED below is the U. S. Army's Redstone surface to surface missile, which is now in production. Range: 300 miles.









corrects this and turns the missile on course.

One shortcoming is that the celestial system will not work on cloudy nights. Scientists are attempting to perfect a mechanism that can be guided from time to time without checking on the stars. Then, when the missile breaks through the clouds, the course can be checked and corrections made.

Decisive Atlas

The fact that Atlas has no guidance mechanism means that it cannot be sidetracked or befuddled by electronics. Married to a hydrogen warhead it speeds to targets more than 5,000 miles away, and strikes within 10-20 miles of a pinpointed target. These facts make it temporarily a truly decisive weapon.

The 10-20-mile margin of error matters little. Destruction would be complete.

Little has been heard lately of the Titan ICBM. This tandem, two-stage, long-range missile will also mount a hydrogen warhead. The Martin Company, prime contractor, is completing manufacturing facilities at Denver, Colorado. The company received an initial contract of $358-million for the project.

Titan is a more sophisticated missile than its bigger brother, the Atlas. Although well advanced, the Titan is about one year behind the Atlas.

Late in 1955, the USAF decided to develop the Thor IRBM on a "crash" basis. Douglas Airplane Co. was awarded a contract for $67.5 million. The U. S. Navy joined forces with the army in working on the Jupiter IRBM. Missilemen believe that the U. S. Department of Defense will evaluate both IRBMs, then give genesis late this year to another weapon incorporating the best features of both.

Both missiles were fired from the Cape late in August. Army stated after firing Jupiter that it could go into production in 30 days.

The surface-to-air Nike is the U. S. Army's first supersonic anti-aircraft guided missile designed to intercept and destroy enemy targets regardless of evasive action. Two versions are in operation, the Nike-Ajax and the Nike-Hercules. The Hercules has about three times the range of Ajax. Both are expected eventually to be atomic-equipped.

U. S. Army and Air Force are competing for ICBM defense responsibility. Army has developed Nike-Zeus, a 100-200 mile anti-ICBM missile contracted by Douglas and Bell Laboratories. Air Force has countered with Wizard, reported to be a more sophisticated weapon with long-range possibilities. Conflict will be settled by the Pentagon's Weapon System Evaluation Group.

For the destruction of low-flying aircraft and short-range missiles, the Army has developed the Hawk surface-to-air missile. Some 16 feet long and only 14 inches in diameter, the Hawk is deployed on a triple launcher. With this arrangement, three weapons can be fired in rapid order against low-flying aircraft or tactical missiles. Prime contractor for the Hawk, which is in the final development stage, is Raytheon Manufacturing Company.

Hawk will be installed first at sites in the Baltimore-Washington and New York City areas. The missile will likely replace, or at least complement, the Nike chain of defenses. Highly supersonic, Hawk has a range of 15 or more miles slant trajectory.

Shaping up as two of the Army's best small surface-to-surface missiles to replace artillery are Dart and Lacrosse. Dart is a tank buster only five feet long and 8 inches in diameter. Guidance is by a wire control system. Impulses fed through the trailing wire direct the weapon to target with a high degree of accuracy and at a speed of well over 900 feet per second.

The Dart is in production and should be operational soon.

Lacrosse measures 20 feet in length with a diameter of 20½ inches. An all-weather missile, it is in quantity production by the Martin Company. It is designed to destroy enemy strongpoints in the field, supplementing air and artillery attack. Is launched from a standard Army truck. Range is estimated to be about 15-20 miles.

Army Heavyweight

Honest John is heavyweight among the Army's surface-to-surface missiles. Weighs 6,000 pounds and is 27 feet long with a diameter of 30 inches. An anemometer measures velocity of surface winds that affect the initial flight of the missile. The launcher is again mounted on the chassis of a standard Army truck. Range is 30 miles.

Little John, small brother to Honest John, is only 12 feet long with a diameter of 12 inches. Stressing high mobility, the little rocket is the ideal atomic missile for the airborne infantryman.

A possible successor to the U. S. Army's 100-mile Corporal is the 75-mile Sergeant tactical missile.

FOR THE ARMY: Nike Hercules ground to air missile at top has range of about 70 miles. Centre: Dart anti-tank missile. Below: the Lacrosse surface to surface weapon with a range of 15 to 20 miles.

Last fall, army fired a three-stage improved Redstone that skyrocketed a 150-pound warhead 600 miles high and 3,400 miles from launch. The vehicle was experimental and unguided but is now in production.

The U.S. Navy bullpup air-to-surface tactical missile is designed for light attack aircraft. Featuring movable canard control surfaces, the 11-foot, 600-pound, solid-propellant rocket is being produced at Martin's Orlando, Florida plant.

Dual Sidewinder

Originally a Navy missile, the Sidewinder will also be assigned to the "F" series of Air Force aircraft. It is already in operational use by the Western Pacific fleet. An infrared homing missile, the 9-foot Sidewinder is reported to have a 7 to 10 "kill" ratio.

Two other operational Navy missiles are the Zuni and Sparrow 1. The former is a combination air-to-air and air-to-surface weapon and is attached to fighter aircraft wings in clusters of four. At least five models of the Sparrow are in existence. Both Atlantic and Pacific fleets are, or soon will be, armed with this supersonic anti-aircraft and anti-missile missile.

The Navy ramjet-powered Talos can be launched against enemy ships and land targets, and also functions in an interceptor role. Already in use on one cruiser, the beam-riding Talos can be fitted with either conventional or nuclear warheads.

The air force has perhaps the most deadly short-range missile of all, the new infrared-guided Hughes Falcon GAR-2A. This has destroyed a score of Matadors, from five to seven QF80 drone fighters, a few drone bombers, and many balloons and parachutes. It is 6½ feet long, 6½ inches in diameter and weighs a little more than 120 pounds.

The supersonic Falcon is being used on the Convair F-102 and McDonnell F-101B interceptors. It can be fired singly or in clusters of up to six at a distance of more than five miles to target.

Boeing's Bomarc is scheduled to be one of the Air Defense Command's most important long-range supersonic watchdogs. Capable of reaching Mach 2.5 and an altitude of 60,000 feet, the 200-mile missile is homed to target by ground radar. It is now scheduled for mass production.

Rascal For Hustler

Bell's GAM-63 Rascal, a rocket-powered air-to-surface guided canard-configurated missile, is due to be assigned to Strategic Air Command's B-47 manned bomber squadrons this month. Can also be carried by the supersonic B-58 Hustler and aboard the B-52.

But the air force recently announced a multi-million dollar contract to North American Aviation, Inc., Los Angeles for a yet unnamed long-range air-to-surface missile to be launched from intercontinental bombers, supposedly to replace Rascal.

Martin's Matador is scheduled to replace manned bombers in certain areas. It was the first land-based type of missile to become operational overseas. Several squadrons are deployed in Germany. The pilotless jet Matador can carry an atomic warhead about 500 miles.

In less than a year, Northrop's SM-62 Snark intercontinental pilotless bomber is scheduled to be assigned to SAC.

Designed for a range of about 5,000 miles, the 69-foot long, 42-foot wingspan Snark heads for the target at just subsonic speed. Snark won the Air Force nod over the Navajo. Latter has been canceled.

The operational Douglas MB-1 spells out new "kill" capabilities for the F-106A fighters of U. S. Air Defense Command. Now known as the Genie, the air-to-air atomic-warheaded missile was fire-tested from an F-89J Scorpion last July.

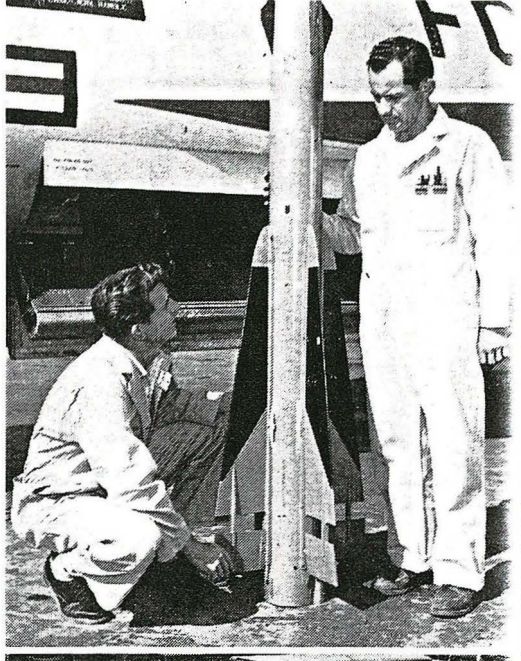
New air-to-air missile in the development and production stage is the Fairchild Goose. This is a diversionary drone. Launched from the B-52 or the Hustler, it is designed as a decoy to attract intercepting enemy planes or missiles away from the bomber strike force. It is about 20 feet long with a span of 13 feet, and will have a velocity of Mach 1.25.

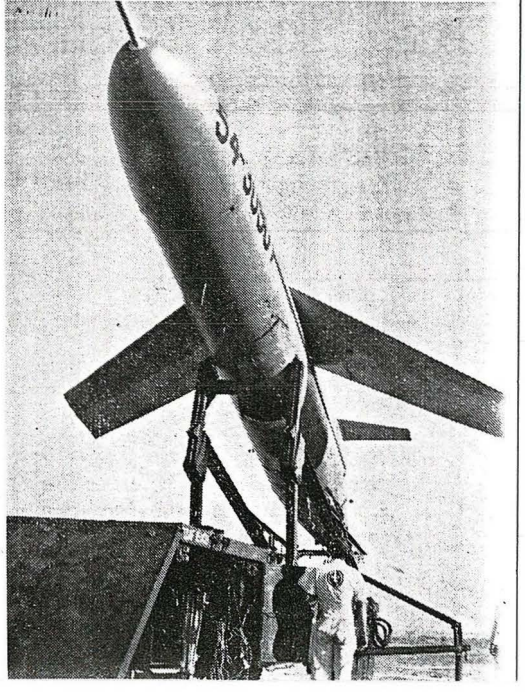
All in all, U. S. military men feel they're in good shape should an enemy strike. They're convinced of their own air supremacy. But no one will comment on how long this supremacy may last.

Time for defense must be calculated by Canada and the U. S. not in months or weeks or days—but in hours, even minutes.

Nuclear attack upon either would bring swift retaliation. The entire family of missiles would be launched—including Atlas in whatever shape it might be at the time.

The missile race is indeed a race for human survival.





FOR THE USAF: Falcon air to air missile is at the top. Centre: Mach 2.5 Bomarc pilotless interceptor. Below: Matador surface to surface missile.

Guided Missiles
FOR THE FUTURE

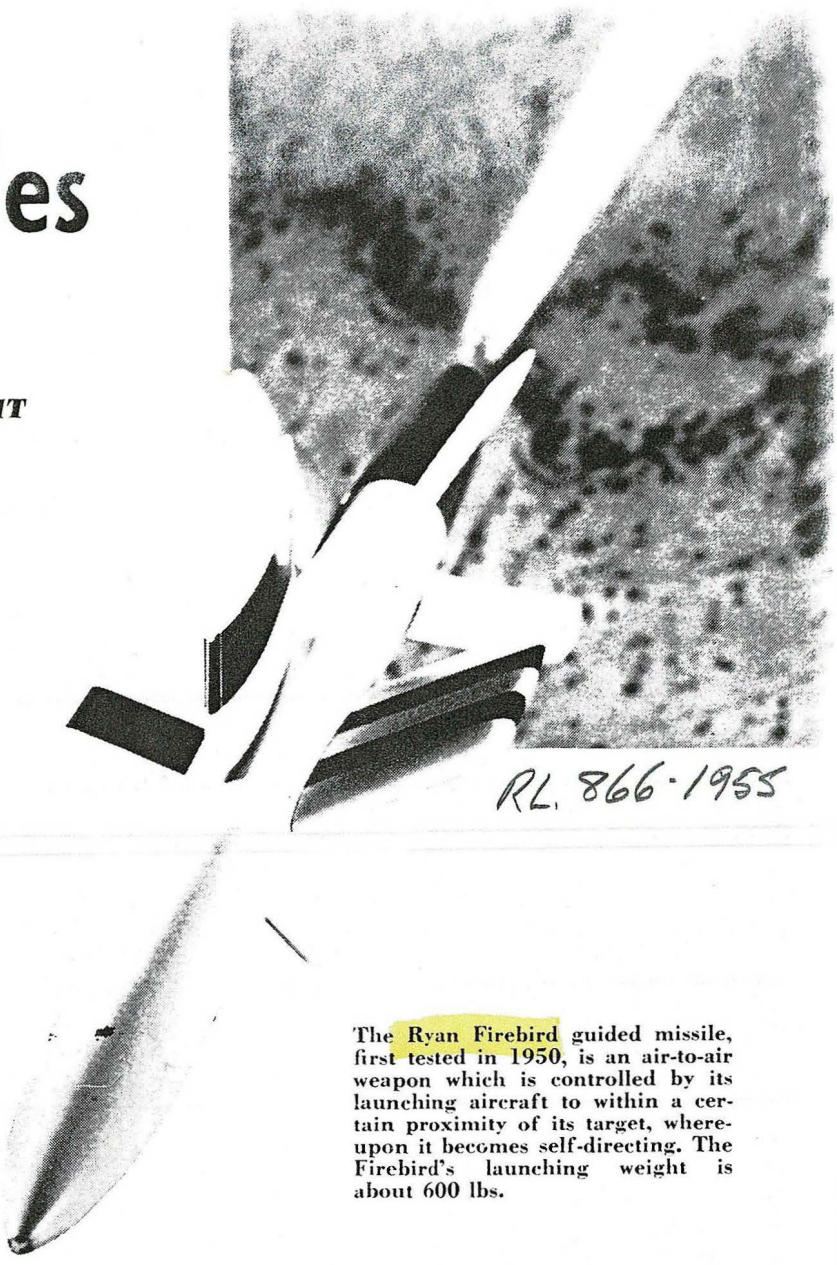
By GROUP CAPTAIN H. R. FOOTTIT

"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.



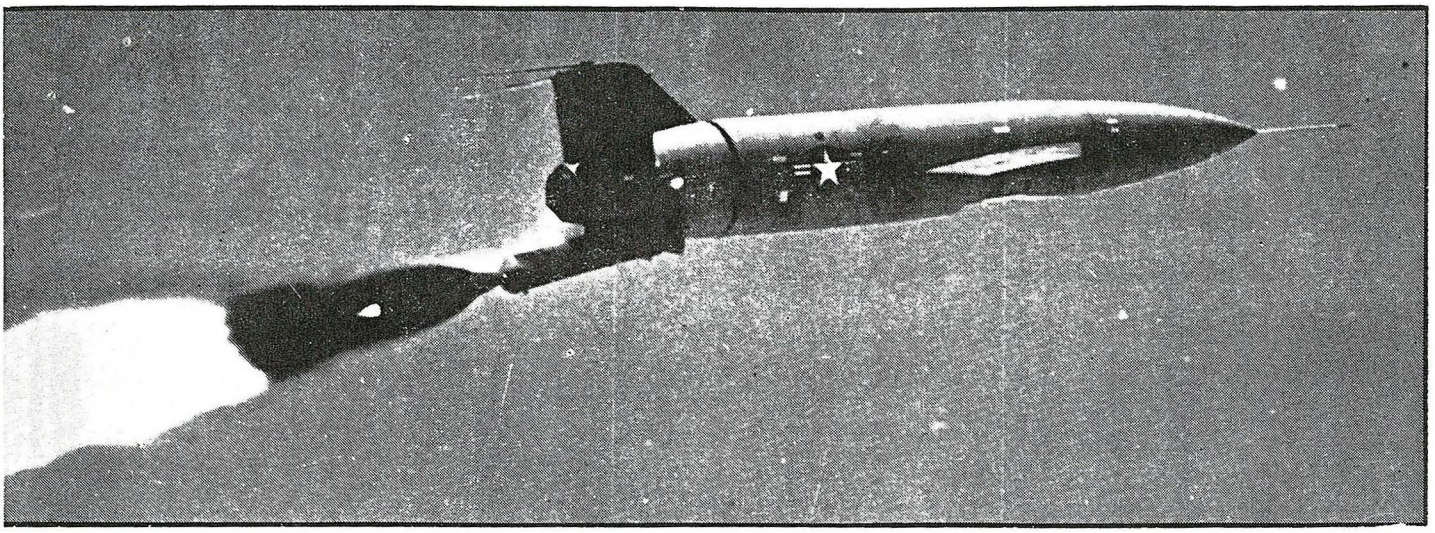
The Ryan Firebird guided missile, first tested in 1950, is an air-to-air weapon which is controlled by its launching aircraft to within a certain proximity of its target, whereupon it becomes self-directing. The Firebird's launching weight is about 600 lbs.

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.

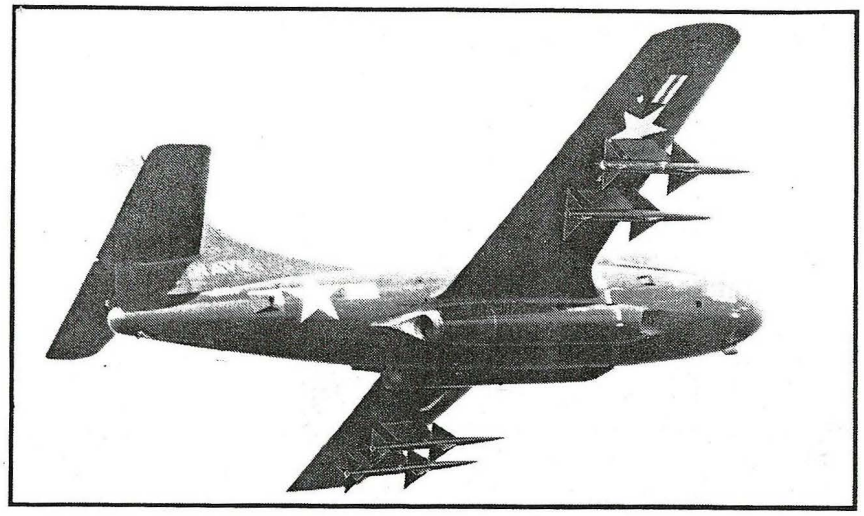
While this pre-war rocket development was proceeding apace, the British, Americans, Germans and others, had carefully tried out pilotless airplanes. Using a radio-controlled auto pilot they had successfully taken and landed such craft. Some of this work was even going on during World War I. But it was 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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YOUNG RADIATOR CO., 709 S. Marquette St., Racine, Wis. Can. Rep.: James B. Carter Ltd.
ZEP AERO, 109-116 Sheldon St., El Segundo, Calif.
ZERO MFG. CO., 1121 Chestnut St., Burbank, Calif.
ZOOMAR (CANADA) LTD., Radio City Building, 265 Craig St. W., Montreal

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)

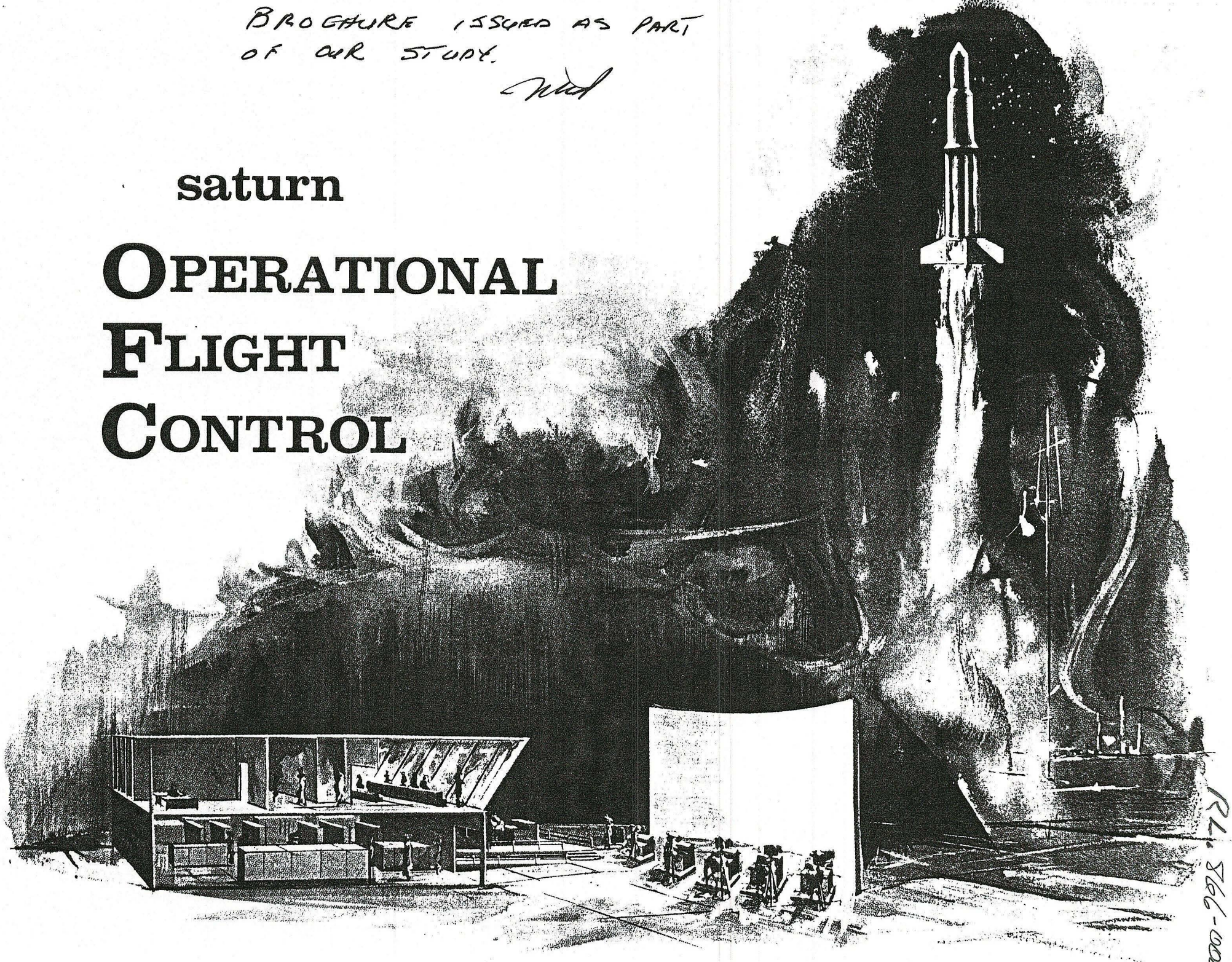
It is therefore apparent that the design, development and production of missiles systems requires the backing of a skilled engineering team. It will take us time to build up this team in Canada so that it can adequately bring forth these vital weapons for our armed services.

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.

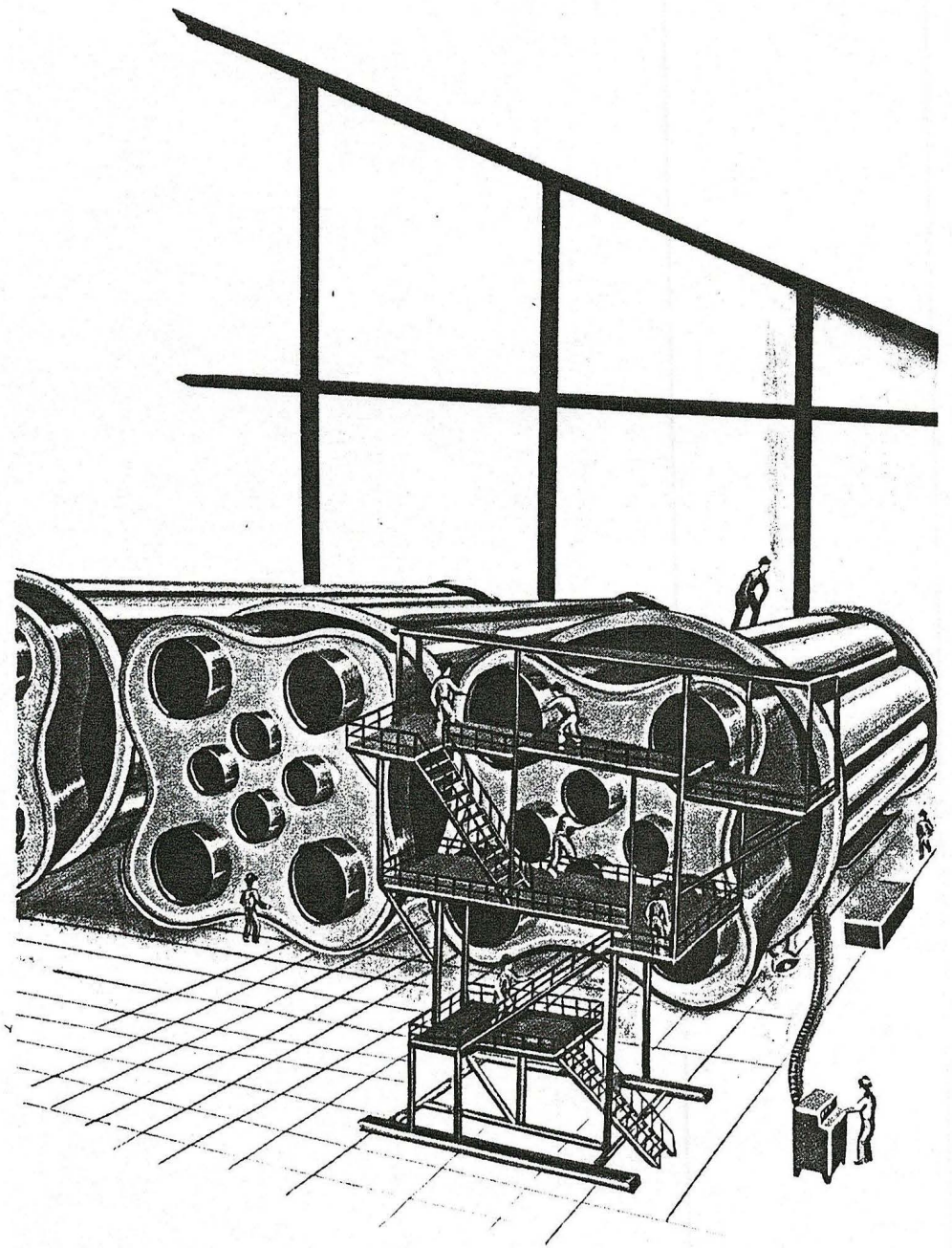
BROCHURE ISSUED AS PART OF OUR STUDY.

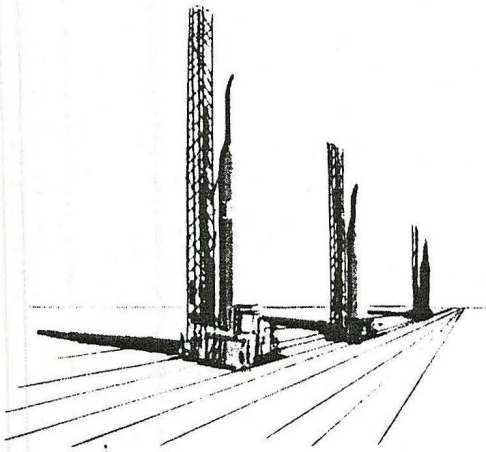
saturn

OPERATIONAL FLIGHT CONTROL



RL-SAT-000





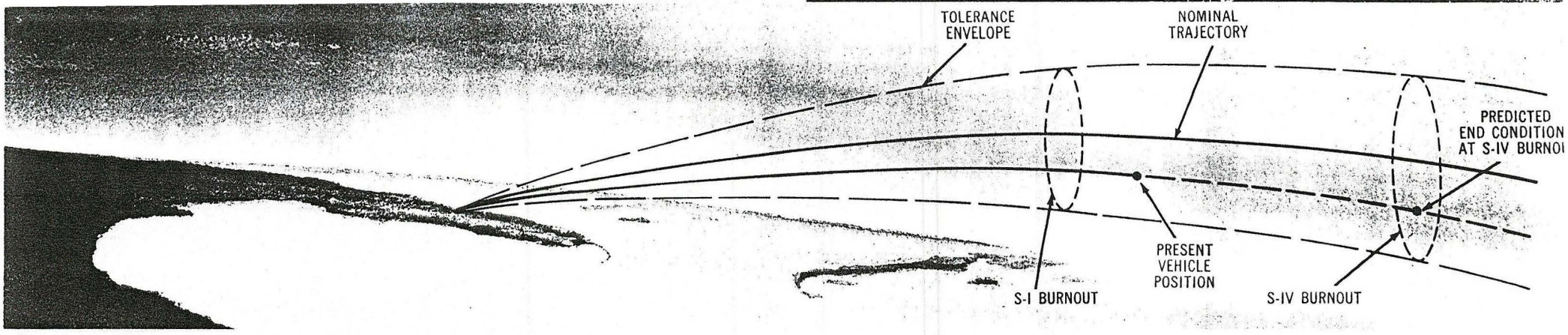
NATIONAL PROGRAM OF SPACE EXPLORATION

. . . . . *the need for OFC*

The critical schedule of the national program for space exploration demands the maximum contribution from every vehicle launching. This requirement dictates that each major system and subsystem be designed and produced to meet the most stringent performance and reliability standards in order to assure primary mission success.

With the development of multi-stage Saturn launch vehicles, and with future payloads destined for such intricate operations as rendezvous and lunar landings, the problem of achieving mission success becomes increasingly complex. Though Saturn has been designed with a high degree of simplicity and consequent inherent reliability, nevertheless the sheer magnitude of the program is such that unexpected malfunctions cannot be discounted, particularly in production-type operational vehicles. For this reason, a supplemental scheme for increasing the probability of mission success was recently investigated. This scheme, called *Operational Flight Control*, is both feasible and practical.*

*The feasibility and practicality of the Saturn OFC were established during a study program conducted by the Radio Corporation of America under joint sponsorship of the National Aeronautics and Space Administration and the U.S. Air Force. This study program was concerned primarily with Saturn C-1, Block II configurations, with application to more advanced versions such as C-5.



PRIMARY MISSION SUCCESS

..... *the objective of OFC*

Basically OFC is a *real-time* control system for monitoring and assessing Saturn vehicle performance and capability during powered flight, and for adjusting inflight parameters to compensate for subsystem malfunctions or for mission deviations caused by environmental conditions or other unforeseen circumstances.

From ignition to payload separation, OFC continuously measures pertinent vehicle and subsystem performance values and compares these values with those required for mission success as a function of elapsed flight time. No OFC action is initiated as long as the vehicle retains the capability of achieving primary mission objectives.

OFC evaluates this capability and, if a malfunction is detected which will affect the primary mission, institutes appropriate action to compensate for the malfunction. Should performance degradation be so serious as to prevent achievement of the primary mission, then OFC selects and initiates one of a number of pre-programmed alternate missions representing optimum utilization of the remaining vehicle capability in relation to payload requirements.

OFC performs these functions through onboard sensing and computing equipment in radio communication with a ground data processing and control center integrated with existing network and range facilities. Both the onboard OFC and the ground OFC have parallel, overlapping functions to enhance system reliability. Where time permits, all decisions regarding corrective action are made by personnel at the OFC ground center and transmitted to the vehicle via a command data link. In cases where there is insufficient time for a ground decision, action is automatically initiated by the onboard OFC.

Predictive techniques enable end conditions to be extrapolated, thereby providing OFC personnel with time in which to exercise best judgment in the event of a pending failure.

Use of OFC reduces *by approximately two-thirds* the number of spare Saturn vehicles necessary to accomplish a series of missions, thereby effecting significant time and cost savings to the overall space effort.

PRIMARY AND ALTERNATE MISSIONS

PRIMARY MISSION	ALTERNATE MISSIONS								
	OCEAN RECOVERY	BALLISTIC TEST S-I	BALLISTIC TEST S-IV	ECCENTRIC ORBIT	LOWER LIFE	LOWER ALTITUDE	DEVELOPMENT TEST FOR FUTURE MISSIONS	MID-COURSE CORRECTIONS	LAUNCH ALTERNAT (RENDEZVOU
100 NMILE CIRCULAR ORBIT	√	√	√	√	√	NA	√	NA	√
300 NMILE CIRCULAR ORBIT	√	√	√	√	√	√	√	NA	√
HIGH ALTITUDE AND STATIONARY ORBIT	√	√	√	√	√	√	√	NA	NA
EARTH ESCAPE TRAJECTORY • DIRECT	√	√	√	(OR CIRCULAR)	NA	NA	√	√	NA
• AFTER PARKING	√	√	√	√	√	√	√	√	NA
RENDEZVOUS WITH TANKER OR SPACE STATION • WITH SIGNIFICANT PLANE CHANGES	√	√	√	√	√	√	√	NA	√
• WITHOUT SIGNIFICANT PLANE CHANGES	√	√	√	√	√	√	√	NA	√

OFC SCHEME

. . . . . *complete system integration*

The OFC scheme for Saturn launch vehicles evolves from the basic OFC concept of real-time supervision and control during powered flight. Salient features of this scheme include:

- Greater operational flexibility for achieving mission objectives.
- Compatibility with existing vehicle, ground support, and mission control activities.
- No degradation of basic vehicle reliability.
- Selective assignment of OFC functions to onboard and ground equipment for optimum system performance and reliability.
- Pre-programmed real-time control, based on preflight statistical analysis and simulation.
- Feasibility and practicality.
- Maximum utilization of existing or planned facilities with minimal addition of new equipment.

In addition to these features, OFC provides a means of coordinating the ground activities, executing required computations and data processing, and furnishing real-time data and display information for evaluating vehicle performance and mission success.

OPERATIONAL FLEXIBILITY

The basic flight control process for Saturn launch vehicles involves the vehicle itself, a guidance system for generating instantaneous flight references, information sensors for measuring the error between the flight references and the actual vehicle flight situation, and a control system for adjusting the vehicle attitude by thrust deflection to minimize the attitude error signals. The guidance system also determines the time of cutoff of the engines, and initiates the cutoff procedure.

The guidance of the S-I stage uses pre-programmed attitude commands, which are functions only of the time from lift-off. The guidance of the S-IV stage is based on the "adaptive guidance mode" and functions by accepting instantaneous vehicle trajectory data and propulsion parameters as initial conditions and defining the optimum future flight path to meet the mission requirements. The path is normally optimized on a minimum energy basis.

In either the S-I or S-IV case, the vehicle trajectory is determined solely by onboard equipment with no provisions for alternative or remedial action (except for Range Safety commands) in the event of component failure in either the guidance or control system.

Operational Flight Control extends the principle of mission flexibility by complementing the adaptive guidance concept and enabling the vehicle to complete the primary or an alternate mission despite serious deviations due to environmental conditions or subsystem malfunctions. For example, OFC circumvents guidance malfunction problems by using an onboard backup subsystem and appropriate sensors. The backup subsystem assumes control and performs the guidance calculations required to keep the vehicle on course. If conditions prevent achievement of the primary mission, alternate sets of guidance coefficients, either pre-stored onboard the vehicle or transferred to the vehicle from the ground OFC, are used to implement the alternate mission. In the event of a malfunction in the control system, such as loss of hydraulic pressure, OFC corrective action might involve locking an engine in neutral.

Since the predictive capability of OFC enables time-to-failure to be estimated, corrective action can be delayed until the last possible moment. This feature is extremely important because a degrading parameter may continue at a level sufficient to accomplish the primary mission, in which case compensating action is not required.

COMPATIBILITY

The Saturn vehicle system and the supporting ground functions, including pre-launch checkout, post-flight evaluation, and range safety control have been carefully correlated with launch site and range facilities, as well as with related space programs. The Saturn OFC is compatible with these functions and serves to enhance the integration of the total Saturn system. Established subsystems and techniques are used wherever they are effective and efficient in the OFC scheme.

VEHICLE RELIABILITY

Because the OFC operates in parallel with the prime Saturn vehicle and ground systems, the additional hardware does not increase the probability of failure of the basic system. OFC is passive until such time as failure or inadequacy of the prime system has been positively established. Interfaces between the prime system and OFC subsystems are designed so that any interconnection failure will result in control being left with the prime system. The prime system component reliability is left unchanged; the primary-mission reliability, and the probability of achieving useful program objectives, are both greatly enhanced by the OFC.

By the synthesis of a system that diminishes the susceptibility of the Saturn boost vehicle to its own subsystem malfunctions (that is, by providing a means for selecting action pertinent to 216 separate subsystem malfunctions that can occur with sufficiently high probability during the time of flight), the OFC produces a reliability improvement of 60 percent. This set of inflight malfunctions encompasses all that are not instantaneous, that can be sensed, and for which actions can be determined. Even in the event that another malfunction not included in the listing for specific actions occurs, the OFC system assures maximum utility of the vehicle by initiating an alternative mission or by controlling recovery conditions optimally.

The OFC is designed to have a reliability goal in excess of 98 percent, this value being limited by the reliability of the Saturn prime electrical

power system and the degree of redundancy and self-checking with the OFC, as well as by the integrity of the ground tracking and communications networks. This number also includes a small probability of 10^{-4} that the OFC will command an inappropriate or unnecessary action.

SELECTIVE ASSIGNMENT

The OFC concept combines onboard and ground systems for maximum overall effectiveness. The onboard system provides maximum reliability and the shortest response time for well-defined functions affecting the vehicle subsystems (propulsion, tankage, hydraulics, pneumatics, etc.). It makes the vehicle independent of ground assistance in the event of communication inadequacies or impending catastrophic situations where an immediate reaction is required. The ground-based system has the advantage of more extensive computation facilities and multi-source data to provide the maximum level of confidence in the evaluations and decisions of the OFC system. In addition, human participation provides the important features of judgment and flexibility.

The overall system design allows for the judicious assignment of functions to the onboard and ground equipment on the basis of mission requirements, with sufficient redundancy for system checkout and to preserve essential OFC capabilities under abnormal circumstances.

PRE-PROGRAMMED REAL-TIME CONTROL

No automatic system can take effective action in a situation which is not included in its programming, and no human operator can exercise reliable judgment in situations completely foreign to his training or experience. The essence of the OFC concept is the ability to exercise efficient real-time control of the vehicle and the mission through effective evaluation techniques coupled to comprehensive pre-programming of actions to compensate for recognized deviations from acceptable conditions. Extensive pre-flight system functional analysis, statistical malfunction analysis, and mission simulation are condensed into a limited number of operational programs, which account for a multitude of inflight circumstances, and which determine the corresponding OFC action to minimize the adverse effects of abnormalities.

FEASIBILITY AND PRACTICALITY

OFC is *feasible* in that it optimizes vehicle performance and increases mission success, and *practical* in the sense of procurable hardware and ease of implementation.

Addition of the OFC is justified on the basis of reduced overall costs of the Saturn program, the saving in launch vehicles being well in excess of OFC costs. The financial value of other OFC advantages — the saving of time, reduced risk of human life, enhancement of prestige, more rapid technical development — is less easily assessed, but is certainly many times the cost of implementation.

Operational Flight Control represents an important contribution to the efficient and effective performance of advanced Saturn programs. An OFC system, developed in parallel with the Saturn vehicle so that its functions are integrated with vehicle capabilities, provides a truly powerful and flexible tool for scientific advancement in space.

Based on the reliability of the Saturn without OFC, a block of 40 vehicles would be required to successfully accomplish 34 different missions — that is, six spares would be required. However, with the addition of the OFC, the spare count is reduced from six to two, or in other words, a block of 36 vehicles instead of 40 would be required for this operation.

The OFC system cost is significantly less than the value of the four Saturn vehicles saved. An obvious additional saving would be the value of the payloads.

MAXIMUM UTILIZATION OF EXISTING FACILITIES

Existing and planned facilities, systems, and components for the Saturn program have been carefully chosen through long experience and extensive analysis and test. To make full use of this effort, to avoid unwarranted redundancy, and to preserve the simplicity and reliability of the vehicle and its support systems, the OFC utilizes existing or planned equipment wherever possible. For example, of approximately 270 sensors required for OFC use, only 45 are new to the Saturn measurement program.

The operational effectiveness of the OFC is based on the concept of making full use of the capabilities of system components. This is best illustrated in the use of sensed data at many levels for cross-correlation and analysis to establish the vehicle and mission status, and to provide backup information to the guidance and control system. Thus, use is made of information inherent in sensed data, beyond the basic parameter, and measurements are used for purposes in addition to the prime purpose for which the sensor was installed.

In terms of communications, OFC air-to-ground telemetry and ground-to-air command links handle the continuous flow of data between the onboard and ground systems. The maximum OFC air-to-ground data rate is approximately 61 kilobits per second; the ground-to-air data rate, during peak activity, is approximately 1.2 kilobits per second.

Tracking facilities and point-to-point ground communications are also utilized — the former for obtaining and verifying vehicle position and velocity data, the latter for routing data between the OFC center, the ground stations, and all other activities concerned with the mission. Adequate boost-phase coverage can be provided from Cape Canaveral and existing down-range stations. By using a combination of site data selection and compaction, existing and planned communication links have the capacity for handling all OFC data between these locations. For advanced missions involving the launch vehicle beyond orbital insertion, it appears that adequate coverage can be provided from the existing world-wide stations.

ONBOARD OFC SYSTEM

. . . . . *supervisory functions*

It is convenient to regard OFC as an inflight management system, with the onboard OFC acting as a *supervisor* under the direction of the *executive* ground system.

The onboard OFC performs the following functions:

(1) Reads sensor data at appropriate sampling rates for onboard use and for transmission to the ground OFC.

(2) Evaluates onboard sensor data by limit comparisons and logical analysis to determine abnormal situations.

(3) Performs backup guidance calculations so that it can assume control of the primary or alternate missions in the event of a guidance system malfunction.

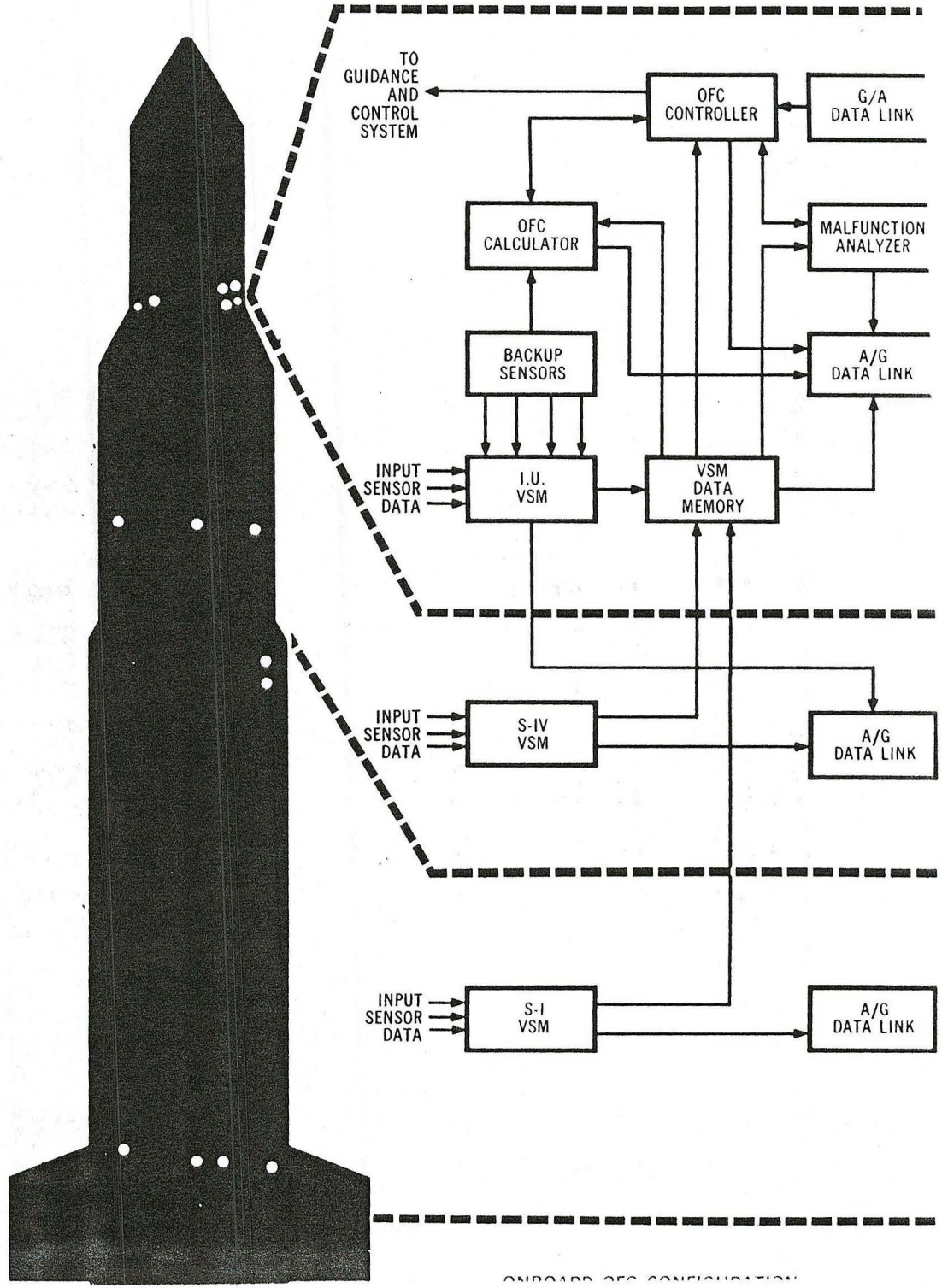
(4) Initiates commands for corrective action in those cases where there is insufficient time for ground decision.

These functions are implemented by the following onboard sensing and data processing equipment: three Vehicle State Monitors, one for each stage and the Instrument Unit; a 6000-bit magnetic-core memory (VSM Data Memory); a Malfunction Analyzer, OFC Calculator, and OFC Controller; communication data links; and interconnecting cabling and hardware. High-reliability, solid-state, modularized components are employed throughout.

VEHICLE STATE MONITORS

The Vehicle State Monitors sample and smooth input sensor data, and perform limit comparison and fault localization. Sensors are sampled at appropriate time intervals commensurate with the response time of the measurements and the control requirements.

When redundant or overlapping measurements of a system parameter are made, the Vehicle State Monitors consolidate the data into a single measure of the state of the particular parameter. The "raw" sensor data is signal-conditioned and digitized for onboard processing, and telemetered to the ground system.



ONBOARD OFC CONFIGURATION

Limit comparison consists of comparing sensor data with two sets of limits: a set of absolute magnitude limits and a set of rate-of-change limits; or in some cases, a second set of magnitude limits. These comparisons are effected with pre-stored values and indicate which measurements exceed the limits or are indicating a trend outside of normal or expected performance.

The results of each limit comparison are converted to a binary system of two bits, which represent four possible combinations (00, 01, 10, 11). The first combination indicates normal behavior, the second and third indicate behavior above and below the normal limits, and the fourth indicates incipient failure. These VSM "flags" and any data needed for subsequent onboard analysis are stored in the VSM Data Memory. The VSM "flags" are also telemetered to the ground system.

By performing logical comparisons on the "flag" bits and selected sensor data, the Vehicle State Monitors can localize fault conditions or abnormal subsystem behavior.

MALFUNCTION ANALYZER

The Malfunction Analyzer identifies existing or pending malfunctions and determines the necessary pre-programmed corrective action.

Appropriate information is extracted from the VSM Data Memory and analyzed in order to ascertain if the situation is truly a subsystem malfunction, a sensor malfunction, or possibly an effect due to variations in the external environment. In some instances, such as loss of thrust, extrapolation is performed to determine whether there is any long-term degradation which would lead to a serious malfunction.

The Malfunction Analyzer forwards data to the OFC Controller and the OFC Calculator, and also telemeters the results of its decisions to the ground. The ground OFC performs a separate malfunction analysis and then effects a comparison to verify both the onboard analysis and the potential corrective action.

Because of the critical time element, priorities are assigned to the different processing sequences in the Malfunction Analyzer. Priorities are determined by the mission segment and the seriousness of the malfunction.

OFC CALCULATOR

The OFC Calculator performs backup guidance computations continuously. In the event of a malfunction in the Saturn guidance system, the OFC Calculator assumes the guidance function.

In executing this function, the OFC Calculator computes current vehicle position, either from existing Saturn sensors or from OFC backup sensors, such as "strapdown" guidance or a simplified platform. If Saturn guidance coefficients are used to compute thrust angle and time-to-cutoff, this computation is utilized as a check of both OFC and Saturn system performance.

The vehicle position is also telemetered to the ground OFC for further correlation with ground tracking data. Variations in system performance are quickly detected and appropriate corrections calculated on the ground and transmitted to the vehicle or to other parts of the ground system for modifying the predictive calculations.

Should there be a variation in either the end objectives of the mission or in the means of approaching the primary objectives, the OFC Calculator will use alternate sets of guidance coefficients that have been either pre-stored or transferred from the ground OFC system.

An additional function of the OFC Calculator is to generate sensor data, such as a velocity coordinate, if the appropriate accelerometer or gyro is not operating properly. This is accomplished by differentiation of position data or by using backup sensor data available to the OFC Calculator.

OFC CONTROLLER

The OFC Controller coordinates the various onboard OFC functions and acts as the communicator with the ground system and the vehicle subsystems. It processes any commands from the ground OFC, and controls and inserts corrective action determined by the onboard or ground system.

The OFC Controller accommodates various types of data from the ground system:

- Specific commands, such as *initiate staging, change mission, emergency pitch over,* and *engine cut.*
- Guidance coefficients either for alternate missions or variations in the primary mission.
- Performance parameters, such as position or velocity corrections; synchronizing signals and time delays; expected failure time or time-to-action; and OFC inhibit.

To verify operation of the communication system, the OFC Controller retransmits an incoming message to the ground, intact, prior to sending any new information.

COMMUNICATION DATA LINKS

Onboard communications for handling OFC data include command receivers, 20-watt transmitters, and appropriate antenna systems. For near-earth applications (C-1 vehicles), three VHF transmitters are used, operating in the frequency range of 216-260 megacycles. For lunar/deep-space applications (advanced vehicles), VHF transmitters are used in the lower stages; UHF transmitters, operating in the frequency range of 2100-2300 megacycles, are used in the upper stage(s). Modulation is PCM-FM for near-earth, and PCM-PM for lunar/deep space. For improved reliability, the coding technique is two-dimensional parity checking, with 21-percent redundancy.

GROUND OFC SYSTEM

. . . *executive functions*

The ground OFC is the overall system *executive*. It duplicates and evaluates onboard OFC operations, and performs a variety of other operations more predictive and statistical in nature. The major ground-based element is an OFC Center, which houses a Computing Complex and an Operations Room. In addition, the OFC Center contains facilities and equipment for simulation, display, and communication purposes. Network support to the OFC Center provides tracking, telemetry, and command-link coverage.

An important function of the ground OFC is to coordinate activity with launch crews, the Range Safety Officer, network support facilities, and the payload mission control center. In this latter capacity, OFC can assume either a primary or auxiliary role, depending on mission requirements.

COMPUTING COMPLEX

To minimize the weight of onboard equipment and to provide greater control flexibility and system response, lengthy computations and data processing are performed by the ground OFC. Rather than duplexing the ground equipment, parallel multiple data processing techniques are utilized. Thus, failure in any single element of the ground system may cause only a temporary loss of partial system functions. Other advantages of multiple data processing are reduced costs, and simplified programming, checkout, timing, and operating procedures. Buffers and other OFC peripheral equipment facilitate compatibility with existing computer or data processing systems.

Interconnections between ground OFC components are illustrated in the block diagram; component functions are described below.

TRACKING CORRELATOR

This component correlates present vehicle position and velocity data obtained from ground tracking and from the vehicle in flight. It converts the data into one compatible format and then performs a data comparison.

If the ground tracking data and the vehicle data are concurrent within acceptable tolerances, a second comparison is made between the present vehicle position and velocity and the theoretically correct position and velocity for the same time after lift-off. If the results of this comparison are also within acceptable tolerances, then the present position and velocity data is forwarded to the Mission Profile Calculator and to the Mission Analyzer for use as initial points in the real-time extrapolation of end conditions. This data is also used to stimulate appropriate displays in the Operations Room.

In the event of disagreement between ground tracking data and vehicle data, the ground tracking data takes precedence. The results of the comparison are sent to the ground Malfunction Analyzer and to the ground OFC Controller for analysis and decision as to course of action.

MISSION PROFILE CALCULATOR

The Mission Profile Calculator continuously extrapolates the end conditions of the primary mission during the various stages of flight. Present position and velocity of the vehicle, as well as certain parameters which measure dynamic vehicle performance, are used as inputs for the extrapolation. The results of the extrapolation are compared with the desired end conditions and a mission success value is then computed. If this value drops below a pre-programmed level, indicating that the primary mission cannot be achieved, the ground OFC Controller is alerted in time to consider corrective action and/or choice of an appropriate alternate mission.

The current status of the primary mission and any deviations of the extrapolated end conditions from the desired end conditions are displayed in the Operations Room.

MISSION ANALYZER

The Mission Analyzer extrapolates the end conditions of alternate missions as the Mission Profile Calculator extrapolates the end conditions of the primary mission. The computation method is identical; however, the interval of integration is larger in order to keep the actual time of extrapolation the same so that both components may stay in synchronization.

If no vehicle malfunctions occur, the Mission Analyzer continues to extrapolate end conditions and to compute a mission success value for each alternate mission. However, if a malfunction or trajectory deviation is detected and some change in the vehicle status at a future time is proposed, then the ground OFC Controller can direct the Mission Analyzer to consider the effect of this proposed change at the appropriate time in the future and extrapolate end conditions from that point on in the mission. If an alternate mission is selected, then this alternate mission becomes the primary mission and is extrapolated in the Mission Profile Calculator after the new guidance coefficients are supplied to the vehicle via the ground OFC Controller.

The current status of the alternate mission is displayed in the Operations Room.

VEHICLE STATE MONITOR

The ground-based Vehicle State Monitor performs comparisons on the sensor data similar to those performed by the onboard Vehicle State Monitor. However, a more elaborate and dynamic limit analysis and comparison are performed on the ground because more sophisticated computation facilities are available.

MALFUNCTION ANALYZER

The ground-based Malfunction Analyzer evaluates the out-of-tolerance measurements received from the ground Vehicle State Monitor and Tracking Correlator along with pertinent raw sensor data, and determines whether an abnormal situation exists in the vehicle. The ground Malfunction Analyzer also determines the course of action that can take place from a particular combination of malfunctions as related to a particular flight segment. In addition, the ground Malfunction Analyzer monitors the performance of the onboard Malfunction Analyzer. If an erroneous malfunction is indicated by the onboard system, the ground Malfunction Analyzer notifies the ground OFC Controller, and an "OFC inhibit" can be commanded, thereby overriding the onboard decision.

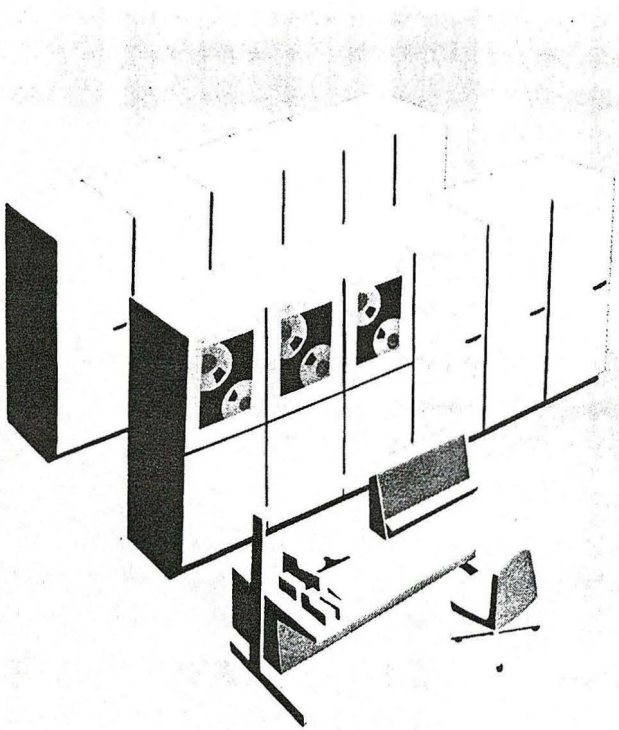
OFC CONTROLLER

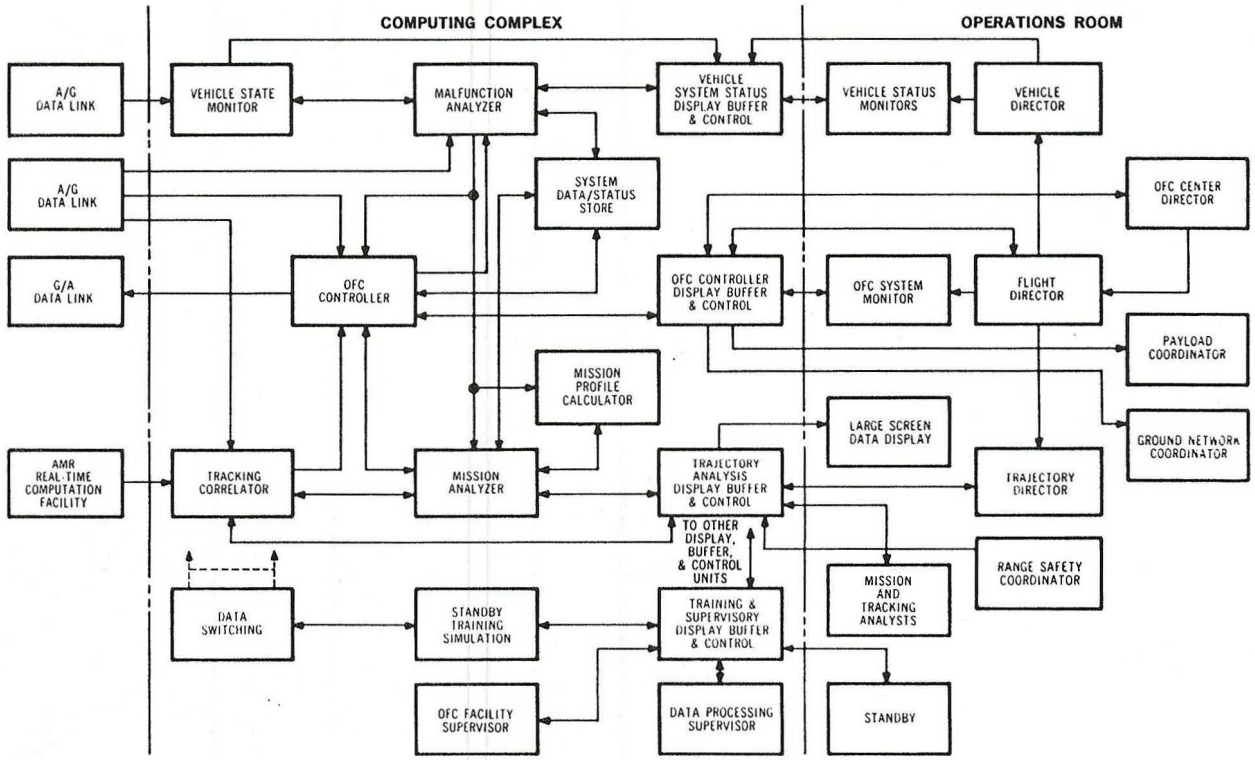
The ground-based OFC Controller (Control and Decision Operation) makes all ground OFC decisions and initiates all ground-originated OFC actions and commands. It is the point in the ground OFC where the status of the vehicle and the mission are brought together for final performance evaluation and for determining their overall effect on the mission objectives. Since the same data for the onboard OFC Controller is made available as input to the ground OFC, the ground OFC Controller can verify the actions of the onboard equipment.

By considering (in advance of any launch) the effect of possible malfunctions as a function of flight segment, a list of recommended courses of action is pre-computed and stored in the ground OFC Controller. When a malfunction is presented to this component, a table look-up routine is performed and, if one or more solutions are found, this information is displayed with time at which corrective action should be initiated. If no manual intervention occurs, the OFC Controller automatically selects the most likely solution found from its diagnosis and initiates appropriate action. There is one exception — any mission change must be commanded by or via the OFC Center Director.

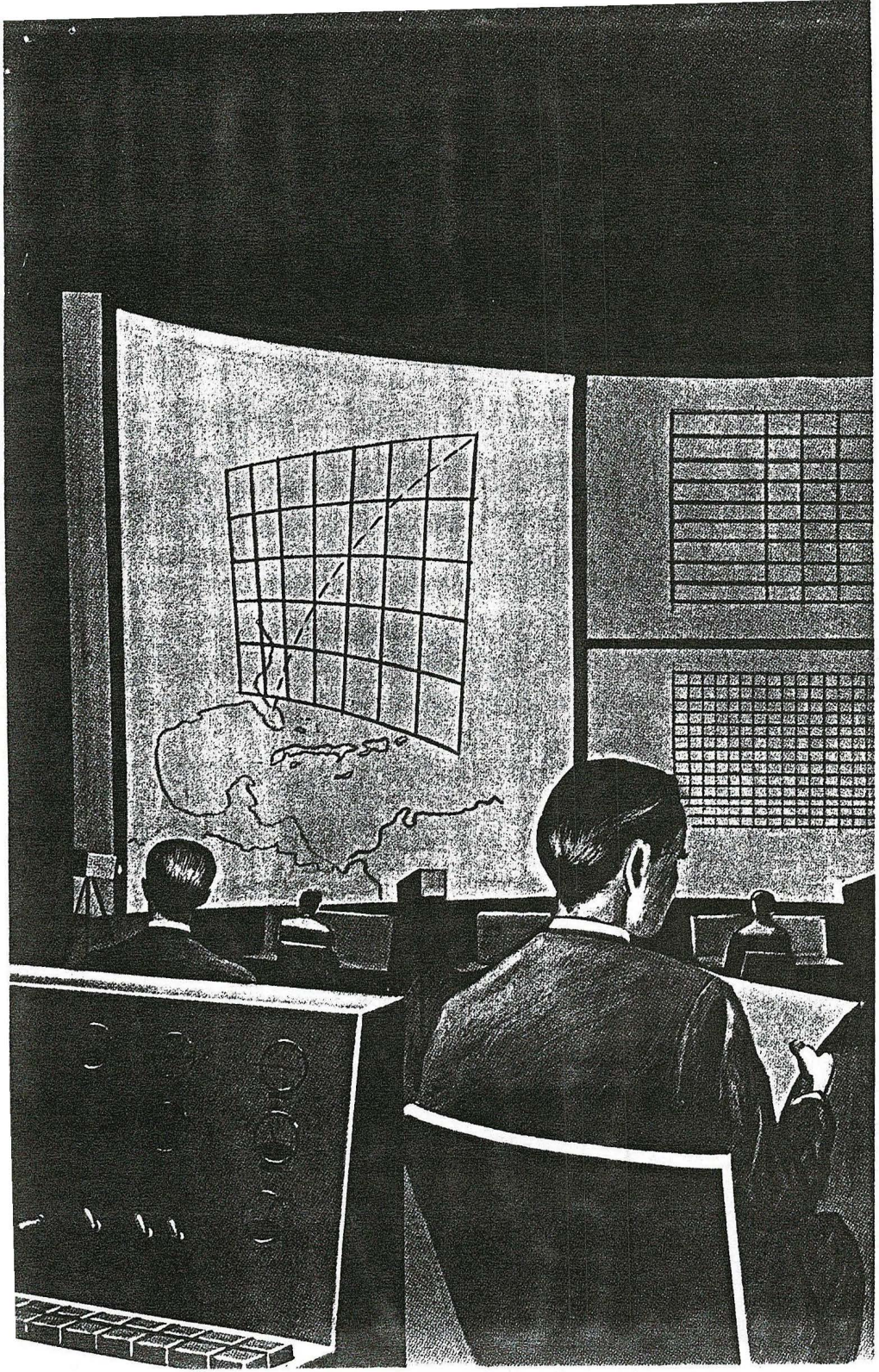
STANDBY EQUIPMENT

This equipment is used for simulation and training exercises, and for backup during an actual mission.





GROUND OFC CONFIGURATION



OPERATIONS ROOM

The Operations Room is the nerve center of the OFC. It contains appropriate displays, controls, and auxiliary equipment for monitoring vehicle performance, for displaying pertinent flight data, and for effecting major decision functions. Interconnections between the various consoles and the ground data processing are illustrated in the simplified block diagram of the ground OFC system.

For highly effective control, the Operations Room is organized according to personnel functions; that is, individuals performing interrelated or interdependent tasks are essentially in physical proximity. This arrangement allows maximum benefit from group displays and allows economy in the utilization of common equipment and data by personnel charged with different but related responsibilities.

The first echelon includes an OFC Center Director, Flight Director, Ground Network Coordinator, Payload Coordinator, and Range Safety Coordinator. Supporting these personnel with special information are a Vehicle Director and a Trajectory Director. Providing vehicle status summary data is the key function of a Guidance and Control Systems Monitor, Propulsion Systems Monitor, and Electrical Systems and Communications Monitor. Flight data to the Trajectory Director is provided by a Track Analyst, Primary Mission Analyst, and Alternate Mission Analyst. Data combined from both subgroups provides an integrated picture of overall flight progress. Three additional functional positions are provided, however, to maintain integrated control within the OFC Center itself. These positions include an OFC System Monitor, OFC Data Processing Supervisor, and OFC Center Facility Supervisor.

In addition to the above personnel, there are experts on propulsion, electrical, guidance, and flight control systems to facilitate group interpretation of appropriate actions. Their roles in monitoring and controlling both the S-I and the S-IV stage functions, particularly in the transition from S-I to S-IV, are coordinated to take full advantage of display, control, computing, and communications equipment. In future multi-stage Saturn configurations, such as C-5, the criticality of such transitions as well as the quantity of input data to be handled will naturally increase.

OFC ADVANTAGES

The advantages of Operational Flight Control can be summarized in relation to the various agencies directly concerned with the Saturn program:

- Marshall Space Flight Center
- The Launch Operations Center
- The Air Force Missile Test Center
- The using agencies, including the Jet Propulsion Laboratory and the Office of Space Sciences as well as the Manned Spacecraft Center and the Department of Defense.

The major advantages, in common for all of these groups, is lower total cost, which is accomplished by achievement of two major purposes:

(1) Increased vehicle reliability for a given mission.

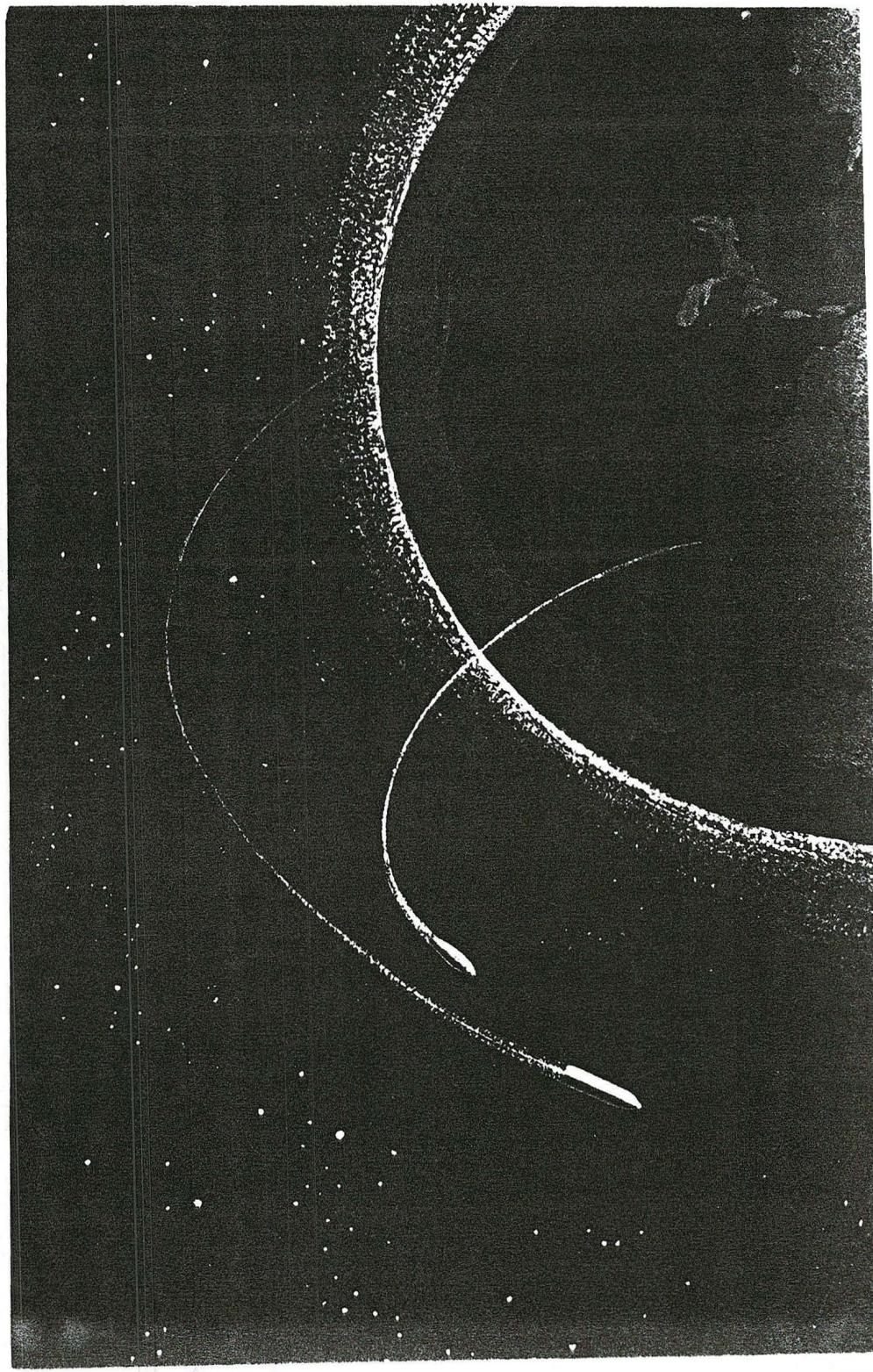
(2) Increased flexibility of Saturn vehicles to diverse missions.

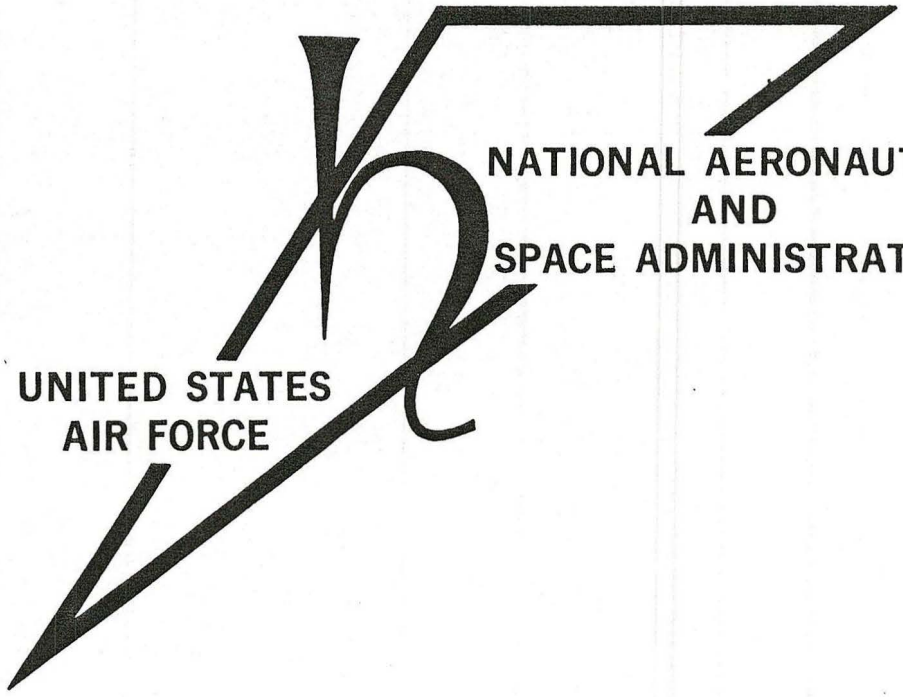
Further advantages include:

- More effective management and control of the development and production processes through the continuing malfunction analysis required to support the OFC.
- Capability of providing real-time launch vehicle control actions during the various stages of powered flight.

For the Air Force Missile Test Center, advantages are more effective integration and utilization of range capabilities into the Saturn program. Of nearly equal importance is improved coordination with the Range Safety Officer thereby providing greater safety and reduced hazard both to the immediate launch area and to critical land mass areas.

The using agency derives the greatest benefit because a more reliable vehicle is obtained for lower cost, both direct and indirect. Fewer payloads are required as a result of the higher probability of mission success. The higher success ratio also means that the high rates of launching can be met more effectively. The OFC, coupled with the inherent capabilities of the adaptive guidance mode, offers the brightest prospect for achieving critical launch windows to satisfy the needs for advanced missions such as rendezvous. With OFC, the using agency can specify a wide range of alternates between accomplishment of the primary mission and the only present alternative — abort.





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