



BOMARC. Two squadrons of Bomarc B's for bases in N. Ontario and Quebec.

Family of Weapons Concept Key to Bomarc Decision

On the first count, the Air Force has never viewed Bomarc in other than the family of weapons concept, an assessment of capabilities which recognizes the advantages of an area defence missile system as part of Air Defence Command's firepower, without losing sight of the essential requirement for manned interceptors in the North American air defence complex.

On the Bomarc failures, it is now apparent that what were in fact normal teething troubles with a new weapons system of extremely advanced design were exaggerated out of all proportion as a result of attention focused on the program by the interceptor/missile debate referred to above. Further, from the Canadian point of view, the Bomarc as our only current missile acquisition was fair game for news desks throughout the country. The Bomarc has since come

through its test program in an extremely satisfactory fashion and is now building up a score of long-range hits on supersonic targets, an indication that it is as good a weapon as the RCAF's evaluation team thought it would be when the equipment decision was made.

The present Bomarc program for Canada calls for the establishment of two launching sites, one in the vicinity of North Bay, Ont. and another at La Macaza, Que.

The weapons to be supplied to the RCAF sites are the IM-99B version of the missile, which is specified with a kill range in excess of 400 miles. The missile is launched by solid fuel rockets which accelerate the vehicle until sufficient speed allows ram jet engines to cut in. It does its run to target area under guidance from the radar-system informed SAGE system, which is being incorporated into Can-

ada's Pine Tree radar network in conjunction with construction of the Bomarc bases. The missile makes its final run on target under guidance from a self-contained system independent of ground control.

The Bomarc is designed to carry either a conventional or a nuclear warhead. To date there has been no definite indication from government, which must make the final decision in connection with over-all policy on nuclear weapons, what warheads the Canadian missiles will carry.

Whatever the decision, it is obvious that Bomarc with a nuclear warhead is a much more effective weapon.

The precise date on which Canada's Bomarc squadrons will become operational is classified, but initial announcements on the program were to the effect that 1961 was the general target date. The program has been delayed slightly since that time, but not drastically.

Training in Progress

Training of a nucleus of technicians on the weapon and its related systems is now in progress. The training program is to be carried out in the United States.

At present eight RCAF personnel are taking the Bomarc courses. The basic trades involved are aero engine and airframe technicians, instrument and electrical technicians, armament system technicians, communications (ground) technicians and radar (air) technicians. To a large extent the Bomarc is being treated as any other weapons system with experienced personnel being given the special training required. The full complement of technicians to be trained for the Canadian bases is just over 80. Fully manned, the Canadian sites will require about 200 personnel — around 100 at each including technical and operations branches.

While Bomarc provides the rapid fire, area defence weapon which would be most suitable in repelling a concentrated stream of attackers type of assault, the manned interceptor is still the cornerstone of North American air defence. Key to the interceptor's crucial value in the system is the requirement for identification of targets picked up on the radar network.

Early, positive identification of an enemy assault force is fundamental to the West's nuclear deterrent strategy. The CF-100s now in service with

aviation intelligence

SAGE Development Contract Award

RCA Victor Co. Ltd., Montreal, Que., has been awarded a \$2 million contract by the parent RCA company for development and production work in connection with NORAD's SAGE and Bomarc systems. RCA's Montreal laboratory is developing an automated process for the production of security sealed circuits which will be employed in the SAGE data handling program. J. L. Burns, president of RCA, said the Montreal laboratory where the work was being done was the largest non-government activity in Canada engaged in basic electronic research.

J. D. Houlding, vice-president and general manager of the Canadian company, told Canadian Aviation that the capability they had developed was "in some demand" and could result in a great deal of defence production sharing and other work, long term.

Ghana Beavers Boost Backlog

An order for 14 DHC Beaver utility transport planes from the Government of Ghana brings de Havilland Aircraft of Canada's backlog up to around the \$25 million mark. Tempo has risen visibly at the Downsview plant in recent months following several good orders in rapid succession. On the books now for delivery are the following: 36 Beavers for the British Army (rough value \$2 million), 14 for Ghana (\$1 million) and two for the Argentine Navy (\$130,000); 27 Otters for the RCAF (about \$2,500,000), three for Chile and four for Burma (together worth about \$780,000); 22 Caribou for the U. S. Army (\$15 million), and four for the RCAF (\$3 million).

CL-44 Overhaul in the U. S.

Flying Tiger Line Inc., U. S. freight carrier which has 10 Canadair CL-44 swing-tail freighters on order, announced a contract with Pacific Airmotive Corp., Burbank, Calif., for the overhaul of the fleet's Rolls-Royce Tyne turboprop engines. Effective July 1, 1961, the contract provides for the overhaul of a minimum of 300 engines and accessories over a four-year period. Flying Tigers' executive vice-president, operations, Frank B. Lynott, anticipates that overhaul production requirements will be in excess of 100 Tynes a year, based on expected CL-44 utilization. Contract provides for a 21-day overhaul cycle time and is worth more than \$6 million. Roy Backman, PAC vice-president, said this was the largest award of a commercial turbine engine overhaul contract to a private maintenance company.

Selling to the States

Canadian Flight Equipment (Cobourg) Ltd., Cobourg, Ont., has been successful in four out of the five bids they were invited to tender as a preferred supplier to the U. S. Defence Department. As a result they have contracts totaling \$120,000 for the supply of cartridge actuating devices—a specialty of the Cobourg firm, headed by R. A. J. (Bob) Murison. CFE has produced these devices for various escape mechanisms of aircraft for the RCAF for several years, and is presently working on a \$750,000 order in connection with the Canadair CF-104 program. Firm is building up its staff again following a period of reduced backlog and presently employs 60 people engaged 100 percent on aviation work.

Plea for Fare increase

American Airlines has asked the CAB to approve increased jet tourist fares on several long-haul routes—"to bring about a more realistic fare level for jet coach travel as compared to first-class travel on the same airplane." Quoting present first-class fares between New York and Los Angeles at 59 percent higher than coach fares on the same aircraft, the company said present long haul coach fares were "unduly depressed." No change is proposed in any U. S./Canada transborder routes.

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Current & Candid

by Veni Vidi

Sometimes it seems that the script writers for the Marx Brothers must have found their way into the employment of Canadian-United States defense planners. There doesn't seem to be any other explanation for the slapstick statements that have been made in recent months.

I presume that neither government expects anyone to believe most of what they have to say on the subject. But let's, just for summer relaxation, examine the situation on its face value.

Imagine, if you will, that the dreaded moment comes when the Kremlin decides to unleash a nuclear attack on this continent. Let us assume it happens before both sides are fully missile equipped and the main brunt of the attack is carried out by bombers of the Soviet Air Force.

At a moment chosen carefully to assure the maximum confusion — say 2 a.m. on a Sunday morning — the first wave hits the DEW line. Contact is lost with the northern shield and the duty officers at NORAD must assume the worst has started to happen.

Within moments a strong force of Soviet bombers, some no doubt flying at 1,000 mph, would be winging south over Canada. American bombers would be sent racing for Russia. Then the Marx Brothers' part of the act would come into its own.

If we are to believe what we are told, the President of the United States would get on the phone to our Prime Minister. A "free and frank" discussion would no doubt follow in which the President would request permission to send interceptors into Canadian skies armed with nuclear-tipped missiles.

And if by that time we have settled the thorny problem of nuclear tips for our Bomarcas (if for that matter we've settled the thorny problem of our Bomarcas), I presume a further "free and frank" exchange of views would follow on the advantages of releasing these to Canadian control so they could be shot off.

All the while it isn't unlikely that the British Prime Minister, the head of SAC and several thousand others would also be in the mood for a word with the U. S. top man.

Providing our Prime Minister just says "yes" all would be well. But we are asked to believe that Canada at that terrible moment in time retains the right to agree to, or refuse, the Americans' permission to "go nuclear" over our country.

Can you imagine it? Can you seriously see the President sitting down to argue the issue with Canada?

I doubt very much that any Canadian would get so much as two minutes of the President's time under these conditions.

If Canada decided it didn't want to get involved that would be just too bad. Quite rightly the U. S. would throw its full defensive force into our skies and would use everything it had to bring the enemy down. Our co-operation would be welcome but certainly not essential.

So let's fire the funny men who draft these statements on unfunny subjects. We are talking about a possible war that would make all talk of sovereign rights utterly obsolete. The only defense policy that makes any sense is to do everything possible to help the U. S. move its defense line as far north as possible — and then to sit down and shut up.

If the balloon goes up nobody will have time to listen to a voice in Ottawa.

Readers' Reaction

(Continued from page 68)

Light Requirement

Editor,
Canadian Aviation.
Dear Sir:

Congratulations on your editorial in CANADIAN AVIATION of June, 1960. Your comments on the requirement for a light aircraft that is inexpensive to run should not have passed unheeded.

As a matter of interest, I would like to inquire as to readers response to your plea. I feel that this market is neglected and would like more knowledge about the status of a small aircraft from the point of view of individuals and flying clubs. I gather from your editorial comments that no accurate market survey has been made in this field.

Using your experience as a barometer, what kind of a market could you foresee for, shall we say, a single seat, inexpensive and simple to operate aircraft, costing less than \$4,000, operable at about \$4 per flying hour, based on five years depreciation and 1,000 flying hours per annum? Is this in keeping with your thoughts? Or perhaps you had in mind a two-seat version with about a 25 per cent increase in the aforementioned costs?

Looking forward to further enlightening articles in your magazine and hoping to hear from you soon.

Yours very truly,
Frank Rixen,
Avian Industries Ltd.,
Georgetown, Ont.

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Reply Code No. 309

We Don't Want to Flog a Dead Horse . . . But

From the beginning, this column has inveighed against BOMARC, not because its "B" version refuses to fly properly (this certainly can be put right), but because the strategic concept into which it is supposed to fit is almost certainly wrong and because the tactical usability of the missile is very much in doubt. We do not want to flog a dead horse, but there is one more point which must be made in connection with the unfortunate BOMARC affair.

The layman is always inclined to underestimate the "lead time" in the development of modern weapons. He will say: "Gosh, this aeroplane flew two years ago, and it has beaten the world speed record — now I read that the air force hasn't got it yet. That's the damndest inefficiency, if you ask me."

Alas, there is a long and thorny road between first flight of an empty shell of an aeroplane and production of a usable piece of military equipment. This goes even more for the complex and thus more delicate missiles. Newspaper reports that an "A" version of the BOMARC intercepted a target while under direction of a control post 1,000 miles away should not have been taken as proof that the West now had an operational, unmanned interceptor.

There is a general tendency to overestimate the present-day capabilities of missiles. Some of them, it is true, have proven themselves already, and others have very great potentialities. It must be always borne in mind, however, that we are still only in the very first stages of missilery.

So an occasional cold shower is very much needed to bring the wild missile enthusiasts down to earth.

Take the ICBMs. The public seems to think that even now the United States with its "ATLASES" and "TITANS", and the Soviet Union with its T-3s, could engage in a slugging match in which intercontinental missiles would fly hither and thither, thick and fast. We do not profess to know much about Soviet development, but what the real situation is on our side was clearly expressed by an experienced technical writer (in *Space-Aeronautics*, April, 1960) who had this to say after he had visited Vandenberg AFB (the USAF's first operational ATLAS-base).

"In fact, after going all through the complex, seeing the tremendous number of gadgets and check-outs required for each, and considering the fact that once a missile is launched it will take days of reworking the pad before another can be launched, you start to wonder . . . So the thought struck me that we're crazy as can be to depend on ICBMs alone at this point . . . It will be several years, perhaps many, before ICBMs are out of the horse-and-buggy stage. Seems to me we ought to push production programs of reliable B-58s and other advanced aircraft in the interim."

Well, the recommendation in the United States is that the money saved by burying BOMARC be put into more F-106 manned fighters (armed, of course, with proven air-to-air missiles).

"But look what happened to an American reconnaissance aircraft over Siberia, the other day," the missile enthusiasts will object. "It was quite helpless against a single surface-to-air missile."

That incident, in fact, proves absolutely nothing. Even if the Russians had nothing better in surface-to-air missiles than the T-6 which they have shown quite openly (estimated performance figures, slant range 15 to 20 miles, speed M2.3, ceiling 65,000 ft.), they should have had no trouble knocking down a single aircraft streaking merrily across alien skies. NIKE or BLOODHOUND would undoubtedly have been equally successful. Things would be quite different in a real attack, with air-to-surface missiles homing onto the ground radars, and the latter blanketed by ECM. It would not then be a case of "one shot-one hit."

All this does not mean, of course, that the development of missiles should not be pressed with the greatest energy. We just should be careful not to credit them with qualities which they do not yet (or, as in the case of BOMARC, which they will probably never) have.

Thus, in the field of ballistic missiles, it would be most important to bring POLARIS to operational status as soon as possible. Not only is it among the mobile ballistic missiles on our side the one which seems to be farthest advanced in development, there is also the probability that the Russians have, or at least are close to having, a similar weapon. We would deduce this from the fact that they have for years had an underwater-to-air missile, the "Golem-3," on which they could have studied many of the problems attendant to the operation of such weapons from submerged submarines.

"Golem-3" is, of course, quite a different thing from POLARIS. It is an anti-aircraft weapon to resolve the crucial dilemma which, in the last war, confronted submarines when they came under aircraft attack: Whether to dive and be safer but defenceless; or to stay on the surface and fight it out, but then be very vulnerable. With "Golem-3" — estimated to have a slant range of about eight miles, a speed of less than M 3, a warhead weighing something like 175 lbs. and to use infra-red guidance (passive homing) — a submarine could supposedly remain safely submerged and still fire at an aircraft overhead. We would doubt that the weapon proved successful against aircraft flying low over the water, but it must have led the Soviets to the development of other missiles fired from beneath the surface of the sea, and thus probably to one equivalent to POLARIS.

Readers' Reaction

Bomarc System Rebuttal

Editor,
Canadian Aviation.

Last week I was shown a copy of the column "Summing Up" in the 1959 annual of Canadian Missiles and Rockets commenting on the Bomarc area defense system. I am head of the IM-99B Systems Performance Analysis Unit at Boeing, and since the article drew harsh, erroneous conclusions based on an apparent lack of accurate information, I will attempt to explain some of the Bomarc characteristics.

I agree with the implication that the Bomarc is ingenious, but it is also certainly **useful** for defense of our countries. It definitely is not a dud. The really amazing thing about the IM-99 missile is its use of relatively simple, well-developed, and reliable components and techniques cleverly combined into an effective weapon system. The flight test results of even the early version of Bomarc, the IM-99A, have demonstrated time and again its high reliability and its ability to make kills.

Your article referred to the tactical ideas that gave birth to Bomarc as being wrong (but did not specify what tactical

ideas were in mind). The concept of an overlapping area defense in depth surpasses isolated point or line defenses in effectiveness. Because of its high speed and long range, the Bomarc system can cover large areas with a single base remote from regions of large population. Moreover, because of its ability to work with SAGE (Semi-Automatic Ground Environment of radars and direction centres) direction, giving a combined "Scramble time" of seconds instead of minutes, the system effectiveness is high throughout its extensive coverage area.

Technical study of the predicted battle situations indicates Bomarc has greater capability against the concurrent ASM threat, before and after ASM launching, than to the concurrent manned fighters. (Bomarc design is based on threat information from U. S. Air Force, U. S. Government, joint Canadian and U. S. agencies and continental commands.) Short-range ballistic stand-off bombs (ASM), highly touted in the article, are useless against an area defense weapon that has a range of over 400 miles.

ECM is presented in the article as "the

real bugbear" to a missile defense "entirely dependent on radio and radar for guidance." Bomarc is not entirely dependent on radio or radar for guidance, but on radar only for target information and it can operate with complete lack of radio communications. ECM and counter-ECM techniques and actions are a battle of wits the armed forces and equipment designers on both sides must wage continuously. Each side tries to predict the probable actions of its opponent so there is no such thing as a clear cut advantage to either aggressor or defender. The advantage will go to the side that advances the state of the art more significantly.

"ECM" is not a nasty word; it simply represents one of the problems to be coped with in the design. Bomarc was designed with ECM firmly in mind and as a result is highly invulnerable to the anticipated ECM. Security prevents my going into detail. However, the statement is technically unsound that a manned fighter can cope more readily than a missile with the interception of high-speed bombers employing ECM.

1. The few manned fighters already in the air ready for battle at any one time is negligible, and the scramble time is much longer than Bomarc.

2. The fighter also depends on a ground system, which may employ search planes for "alert" commitment and vectoring information.

3. The voice communications employed by a fighter are more easily jammed

Continued on page 60

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THE PLACE TO STOP
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PLANE PATTER

by Ernie Hampill



Transport Minister George Hees last month had some enthusiastic comment on the future of the air transport industry in Canada. As reported elsewhere, his forecast is for continuing spectacular growth:

Great possibilities lie ahead for those nations able to reap the benefits the jet age makes possible. Aviation will be both profitable and practical if sound planning is combined with imagination. By its geography, both domestically and internationally, Canada is a natural for the jet age. Department of Transport will do all it can to make the partnership a most fruitful one - to paraphrase a few of the Minister's remarks.

There are some quarters in which this latter commitment will have evoked something less than wild exultation. On the record to date, some feel, there can be little assurance DOT will be partial to programs involving the sound planning of which the Minister speaks. Or if partial, will carry them out with the dispatch and imagination essential for their completion in time to "reap the benefits which the jet age makes possible".

Some criticism is no doubt legitimate.

But we do not subscribe to the sport of making DOT the public whipping boy, the sort of arch villain of the piece responsible for everything which goes awry.

In the matter of air terminals, for example, the extremely bitter controversy which has arisen over what might be described as "the Montreal fiasco", tends to obscure the fact that while we do face a period of overcrowding at airports in the major centres, the department has made commendable progress in providing first line terminal facilities in other communities.

It is perhaps significant that where the department has been able to proceed in a comparatively unfettered and straight forward manner, without a number of interests to cater to and masters to serve, it has been possible to complete facilities in a fairly reasonable period.

The Montreal terminal, admittedly, is a sorry example of bungling and unwarranted delay. But even here, the evidence is that in the initial stages at least, responsibility for indecision and delay should not be laid to DOT alone.

There is a credit side, as witness the extensive navigation and traffic control facilities the department has provided. In this regard, DOT can offer systems on a par with any and in advance of most other nations.

Readers' Reaction

(Continued from page 59)

than any of the command links used in modern missiles such as Bomarc. Even where secure links are used on fighters, the pilot or crewman can only give partial attention to the data furnished.

4. Only reliability would limit the percent of missiles available for immediate battle, but fighter availability depends on problems associated with ground and flight personnel.

5. More, more-rapid, more-sensitive senses are built into counter-ECM equipment as compared with human operators. The range of logic of man is all-encompassing whereas that of a black box is limited to a specific job; however, the black box can apply its logic tests at a tremendously greater rate and its attention is not divided. All military systems include humans to make the important final decisions, and all such decisions depend on mechanical aids to the human sensibilities. The system design choices regarding the functions of men in a system must be based on minimizing the cost effectiveness ratio.

In addition to its greater technical capability, the Bomarc is much less expensive to provide than the fighter weapon with its greater real estate (runway) requirements, personnel (training and operations) requirements and the weapons themselves.

Bomarc has intercepted supersonic targets, contrary to the statement in the article. Now let us examine the statement that in the recent controversy between proponents of Nike and Bomarc the subject of ECM was hardly mentioned, and your explanation that the two systems are equally vulnerable. Even to one not thoroughly familiar with Nike, it is evident that the Bomarc and Nike concepts, design and hardware, are so different that anywhere near equal vulnerability would be the greatest of coincidences. Nor should it be concluded that lack of open public discussion of the ECM capabilities of these systems signifies a lack of capability. It is impossible to debate sensibly, counter-ECM ability without going into details which would do the enemy more benefit than the citizens these systems defend. Obviously, even if good judgment did not limit the public debating to generalities, security restrictions would and did.

I have no intention of entering your political controversy regarding particular defense systems but it is pertinent to observe that missile systems are replacing manned aircraft throughout the world, including the recent cancellation of the F-108 by the U. S. Air Force.

I realize the difficulty you must encounter in obtaining information about a classified weapon system. No doubt the article was prompted to take advantage of the extreme interest in the Bomarc in Canada. Considering the factual data included above, it is hoped you will see fit

Continued on page 62

Current & Candid

by Veni Vidi

It won't be long now before one might be found comfortably seated in a spanking new TCA DC-8, soft hi-fi music competing with the far off rumble of the Rolls-Royce Conways. Ah, that's the way to travel!

It's not unlikely that we will be stopping enroute. Winnipeg, perhaps?

In all probability we will be pulling up on the ramp beside one or more TCA Viscounts, either just arrived or preparing for departure. It is possible that CPA may have a Britannia on the ground enroute east or west. Northwest is a regular caller at the Winnipeg field, and it is not unusual to have one of the over-the-Pole operators drop in.

The doors of our DC-8 open and we head for that breather and relaxing stroll about the air terminal. Any relaxing will likely be short-lived, confined perhaps to the walk from aircraft to terminal. Inside, we will be exposed to a brand new chaos even Dante in his wildest moments hardly envisaged for the occupants of Hades. There just won't be enough room.

Now if Winnipeg was an isolated case — or if this was an emergency situation expected to last a couple of months — it would be unreasonable to take issue. But this is not the case. New terminals at Winnipeg and Edmonton are at least five years away, Toronto three and Montreal at least another year.

It seems inescapable that for some reason the Department of Transport has bungled the matter of Canadian terminals in a truly shocking fashion.

Not long ago I took advantage of an invitation to accompany Mr. Hees — and about fifty other press, DOT and the odd local politician — on a tour of the new, roughly \$30 million, Dorval terminal. We marched up and down, and around and around.

Finally, almost drooping with exhaustion, we arrived in a room set aside for a question and answer session.

We heard some amazing things that afternoon. For my money — and come to think of it, it is our money — the dialogue could have been lifted straight out of the Mad Hatter's Tea Party.

In a nutshell, the minister and his party informed us that back in 1955 there was no way of knowing that the big jets would be along so quickly; that compared with other countries our air terminal situation was as good as, if not better; that there had been no real "delays," and that if there had been it was DOT's desire to make sure that the best and latest equipment was installed that caused them; and — to top it all off — that there had been no demand that Mr. Hees knew of for facilities in Canadian airports.

Now this is largely nonsense; the DOT ought to know it!

Anyone who doubted that big jets would be using Canadian airports by 1960 could have dropped in on TCA planners and asked them — they knew. Certainly it costs a lot of money to build these terminals, but if the airlines are right in what they say, the cost could have been a lot lower than at Dorval. They just have to be comfortable and efficient, there is no need to compete with the Taj Mahal or the Moscow underground system.

If since the war more half decent interim terminals had been built, we might have cheerfully survived the discomforts awaiting us for the next four or five years. But everything seemed to freeze as the air age swept onto the Canadian scene.

It seems to me that as a nation we are very lucky that the same unthinking bureaucracy that planned our terminals has not yet got control of the operational side of things.

Continued from page 60
to amend the conclusions in the recent article and bring your readers up to date.

Very truly yours,
G. Wayne Van Winkle,
Bellevue, Wash., U.S.A.

Man-Powered Aircraft

Editor,
Canadian Aviation.
Dear Sir:

It is not often that I disagree with Oliver Stewart's opinions or reports, but I cannot agree with some of his statements in your issue of Dec., '59.

He says that at the recent inaugural meeting of the Man-Powered Aircraft Group of the Royal Aeronautical Society "there is a distinct swing toward flapping wing machines..." The four short talks given at that inaugural meeting by Naylor Nonweiler, Wilkie and the present writer under the chairmanship of H. B. Irving gave no such impression. In fact all the serious technical thought in U. K. is in the direction of propeller-driven man-powered aircraft for the first generation at least. The point is quite clear: Too little is known about the aerodynamics of flapping flight. We know a lot about fixed wings and propellers. If one wants to do something new, the best way is to use all the existing knowledge before venturing into the unknown. There is reason to believe there is just about enough knowledge available to enable a two-seater man-powered aircraft to be designed and built and flown. In spite of the efforts of Filter in Germany and Hartman in U. K. on flapping wings, they are shots in the dark. The best of luck to all such ventures, but as an engineer I prefer to see my target, and so do my associates in our group.

It is worth noting that instigated by Noweiler, the Department of Aeronautics of Queen's University, Belfast, have put forward a serious proposal for the development of a man-powered aircraft including design, wind tunnel and strength testing, manufacture and flight testing. This is a design for two, with a pusher propeller aft of the tail unit. Perkins of Cardington has actually built a single seater with an inflated wing of 40 ft. span and a pusher propeller. This has not yet flown.

In writing to you I am not trying to discredit any efforts in flapping wings, but I did not want your readers to think we were all doing it the hard way. We are trying to do it the easiest way we can, as engineers have always been taught to do.

I am also not trying to discredit Oliver Stewart. I did not see him at the meetings referred to, so it was clearly reported to him inaccurately.

In case your readers are interested, we feel that with about \$30,000 a prototype man-powered aircraft could now be designed and built. Everything is available except the \$30,000.

Yours sincerely,
B. S. Shenstone,
Weir House,
Wraysbury, Staines,
England.

X-15 Damaged

The second North American X-15 research plane sustained a broken back during a recent emergency landing. Test pilot Scott Crossfield jettisoned fuel and made an emergency descent following an explosion and fire in one of the aircraft's two XLR-11 rocket engines. The incident occurred very shortly after release from the B-52 mother plane. Research program will continue with the No. 1 X-15 following investigation of the failure, and it is likely that the damaged No. 2 aircraft will be repaired. Thiokol recently announced new performance records for the advanced XLR-99, which will be used to power the X-15 in subsequent tests. In a 16-hour test sequence, the 50,000-lb. thrust motor was fired successfully 29 times in a series of rapid start-stop operations.

Missile Scholarships

Daniel and Florence Guggenheim Fellowships are being made available for 1960-61 graduate study in space flight, rockets, jet propulsion and flight structures. Up to 18 fellowships will be granted in the spring for study at the Guggenheim Jet Propulsion Centres at Princeton University and California Institute of Technology, and the Guggenheim Institute of Flight Structures at Columbia University. They are open to qualified science or engineering students resident in Canada and the U.S., and will provide tuition and a stipend ranging from \$1,500 to \$2,000 depending on the stage of advancement of the student.

Mantrac for Bomarc

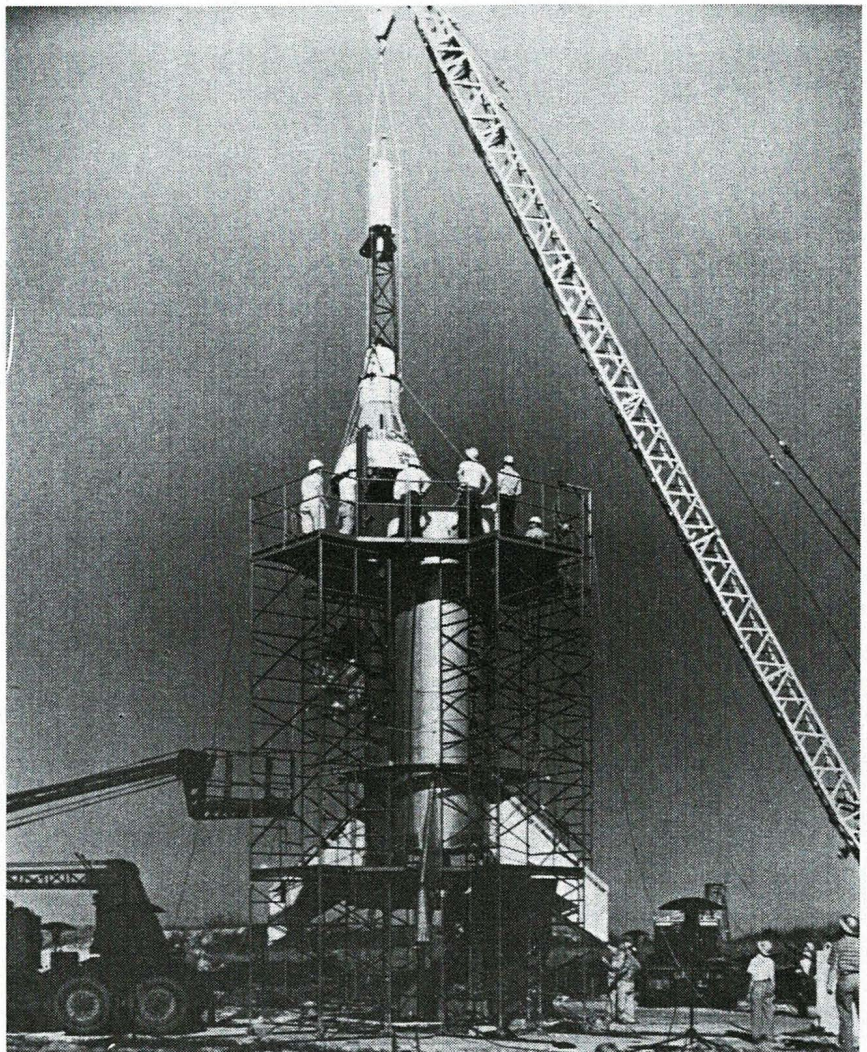
Boeing Airplane Company's Aero Space Division has developed a manual tracking system (MANTRAC) to provide an accurate and economical means of tracking and intercepting hostile airborne weapons. This is intended for use in areas where SAGE or alternate electronic systems are not available, and is designed to work in conjunction with the Boeing IM-99 Bomarc weapons system. Mantrac employs a transparent plotting board upon which operators work with protractors, rulers and grease pencils. Successful tests are said to have been conducted in co-operation with the USAF.

Bloodhound Ordered

The Bristol - Ferranti Bloodhound ground-to-air missile has been ordered for use in Australia. Already in service with the RAF, and chosen also by Sweden for anti-aircraft defence, the Bloodhound is powered by two Bristol-Siddeley Thor ramjet engines and four jettisonable wrap-around solid fuel booster rockets. It is claimed to have the longest range of any semi-active homing missile in the free world.

Astronautics Meet

Sixth annual meeting of the American Astronautical Society will be held at the Statler Hilton Hotel, New York, Jan. 18-21.



LITTLE JOE test capsule in process of installation at NASA launching site, Wallops Island, Va. Capsule will collect data required before attempt is made to launch man into orbit around the earth in a recoverable space capsule.

Minuteman Awards

Three companies recently awarded contracts by the Boeing Airplane Co. for work on the Minuteman ICBM, are Cessna Aircraft Co., Wichita, Kan.; General Motors Corp., Detroit, Mich.; and Bendix Pacific, Hollywood, Calif. The contracts, together worth about \$2,300,000 are for research and development of portions of the system. Minuteman, which is expected to be operational "in the early 1960s", is designed for a range of more than 6,300 miles, will carry a nuclear warhead, and will have a speed of more than 15,000 mph. It is planned as a major economic breakthrough—the first more effective missile to be produced at a lower cost than its immediate predecessors.

Lacrosse Support

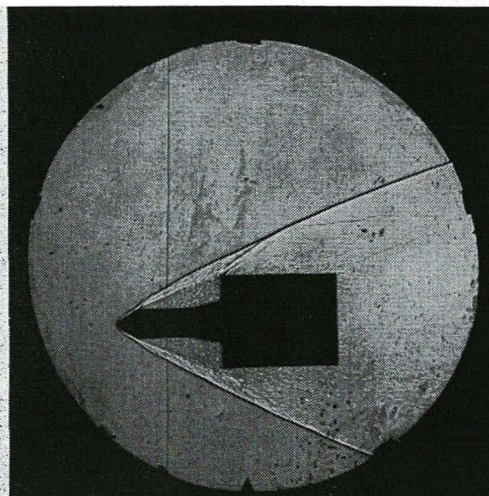
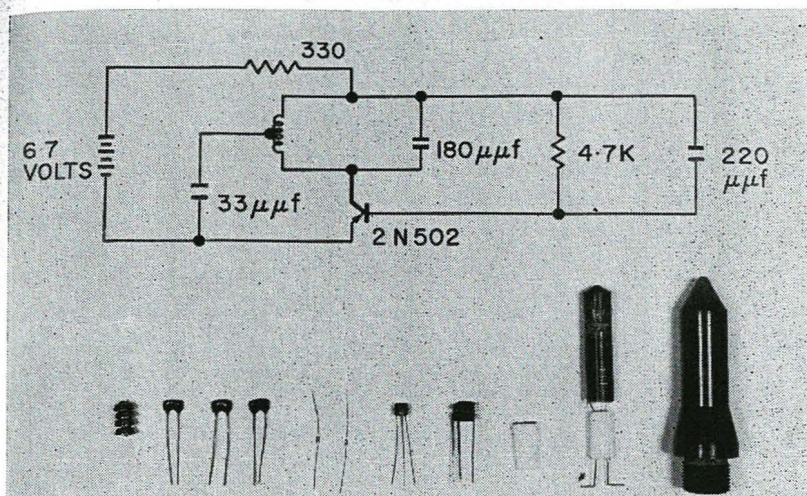
Follow-on orders for hydraulic services consoles to be used in connection with the U.S. Army's Lacrosse missile have been received by test equipment division of Consolidated Diesel Electric Corp.

Ramjet Co-operation

Technical collaboration agreement between the Royal Swedish Air Board and Bristol-Siddeley Engines Ltd., covering the development of ramjet engines, is revealed. Signed in 1957, it has hitherto been classified. Under the terms, Svenska Flygmotor AB were designated as agents of the Swedish Air Board, for the exchange of technical information between Flygmotor and Bristol-Siddeley. Flow has been two-way; research by the Swedish company has influenced the design of Bristol-Siddeley ramjets, and development of Swedish ramjets has been accelerated through Bristol-Siddeley's experience. The Bristol Ferranti Bloodhound ground/air missile, ordered by Sweden for anti-aircraft defence, is powered by Bristol-Siddeley ramjets.

Reactor Space Power

A compact 220-lb. atomic reactor, designed to operate continuously and unattended in space for a year, is being developed for the U.S. Atomic Energy Commission, by Atomics International, a division of North American Aviation Inc.



HIGH G TRANSMITTER. Picture on left shows the circuit and component parts of a high-G transmitter developed at the Canadian Armament Research and Development Centre (story on page 37). The 6.7 volt battery power supply cells are at the extreme left, and to the right, the completed circuit package, and the finished projectile. The right hand picture shows the projectile in flight, before the separation from its 3.125 in. bore launching carrier.

Testing Bomarc B

Once again a B-57 Canberra bomber has had the nose and part of the guidance section of a Boeing Bomarc missile grafted on to its own for test purposes. The Bomarc A was checked out in this way in the early stages of its production, and now the IM-99B nose section has been added to a USAF Canberra, giving it an "anteater" appearance. Purpose of the grafting operation is to check out the capacity of the Elgin Gulf Test Range to handle flight tests of the 400 mile range Bomarc B. Air to ground transmission of the signals from the missile package will also be tested by the B-57/Bomarc vehicle. Testing of the earlier Model A Bomarc by a similar device included a check out of the missile's guidance system and ability to overcome electronic countermeasures.

Atom Rocket Proposal

Design for construction of an atomic-powered rocket, outlined in a scientific paper by Gordon H. Miller, of New York, has won for him the second annual graduate student award sponsored by the American Rocket Society and the Thio-kol Chemical Corp. The proposed rocket would be 150 ft. long and weigh 314 tons at take-off, including 274 tons of ammonia. It would have a payload of over seven tons. Component parts, the nuclear character of the reactor and safety consideration are covered in detail in the award-winning paper.

Little Joe Gets Off

Launch of a solid fuel rocket-propelled Little Joe capsule earlier this month by the National Aeronautics and Space Administration marks a significant step forward in the Project Mercury program, scheduled to culminate in manned space flight. Carried out at NASA's Wallop's Station, Wallops Island, Va., this launching of a full-scale capsule successfully tested escape equipment for the satellite. The capsule was 9½ ft. tall, 6 ft. across the base, and 20 in. across the top.

U. S. Space Simulator

A two-man space cabin simulator has been delivered to the USAF school of medicine at Brooks Air Force Base, San Antonio, Texas, by the Aeronautical Division of Minneapolis-Honeywell, parent company of Honeywell Controls Ltd., Toronto, Ont. Weighing seven tons, the device will be used to test man's reaction to 30 days of simulated space flight. Volunteer "space pilots" will live in the eight feet high, 12 ft. long cabin, accompanied by most of the comforts of home and a complex of scientific instruments to control environment and record their reactions. The space cabin is designed to be virtually self-sustaining, through various Minneapolis-Honeywell developments; the astronauts will rebreathe the same air and drink and re-drink the same water. Urine and all other forms of waste water are purified by chemical treatment and filtering. Solid wastes will be dehydrated and burned in an incinerator, and the gases produced disposed of through an afterburner.

Hit-and-Run Missile

Early flight testing of the Martin Pershing two-stage ballistic missile for the U. S. Army is anticipated following the completion of a special blockhouse and launch complex at Cape Canaveral. The solid-propellant Pershing is being designed to operate on a "shoot and scoot" principle and the system will be ground, plane and helicopter transportable. Plans include mobile transporter-erector-launchers and a built-in guidance system for the missile to enable it to direct itself on to a target so as to overcome outside jamming.

Rescue By Missile

A guided missile fire-fighter that can be despatched to the scene of a crash by rocket propulsion, then hover over the crash and spread extinguishing fluid, has been proposed by Solar Aircraft Co., San Diego, Calif.

Solar Observation

Twelve Nike rockets were fired at the U. S. Naval missile facility at Point Arguello, Calif., during the second phase of Project Sun Flare, man's investigation of solar phenomena. Cooper Development Corp., handled the firings (the first phase of the project was undertaken as part of the IGY program) supervised by Dr. Talbot A. Chubb of the U. S. Naval Research Lab. The 50-lb. payload of the rockets consisted of scintillation and Geiger counters, and ion chambers, to survey the sun's x-ray emissions. Telemetering equipment transmitted the data to ground stations.

Gyro for Subroc

Goodyear Aircraft Corp. plans a feasibility study of a two-axis free gyro developed by Lear Inc., for possible use in the Subroc missile now under development by Goodyear in conjunction with the U. S. Naval Ordnance Lab, White Oak, Md. The device is required for use in the arming and fusing system. Subroc is a tactical missile designed to be launched from a submarine either as a surface to surface or surface to underwater weapon. It will carry a nuclear warhead and is expected to have a much greater range than current submarine attack weapons.

CHARM Progress

The CHARM project of the Canadian Astronautical Society (Canadian high-altitude research missile) is nearing the free firing test stage, and it is hoped that the first launch will be made during the coming summer. Members hope during the winter to produce the final grain configuration for the first stage.

Astronautics Meet

The sixth annual meeting of the American Astronautical Society is to be held in New York, January 14-20, 1960.

PLANE PATTER

by Ernie Hampill ✈



"Much to do!"

"Nothing but opportunity!"

To many of the members of the Canadian Aeronautical Institute who heard them spoken the above phrases must have rung less than realistic. Yet they are the messages brought to Canada's aeronautical engineering fraternity last month by the presidents of the British Royal Aeronautical Society and the U. S. Institute of the Aeronautical Sciences.

Royal Aeronautical Society President Peter G. Masefield, managing director of Bristol Aircraft, Ltd., and Institute of the Aeronautical Sciences President William Littlewood, vice-president Equipment Research of American Airlines, delivered their words of encouragement at a Toronto dinner meeting presided over by CAI President Dr. D. C. MacPhail, director of the division of mechanical engineering of the National Research Council.

Don't, cautioned RAS President Masefield, permit concern with space projects to get out of proportion in assessing over-all future of the aviation industry. There is still much room for fruitful advance in realizing the full potential of air breathing vehicles. A reliable blind landing system; efficient, economical city-centre to city-centre air transport; adequately performing short range transports—are a few among the many items on which there is still much to be accomplished.

There are, IAS President Littlewood agreed, many areas in which aircraft operators are not satisfied with the state of the art. Ground handling; power available for take-off; landing speeds; noise; traffic control; cargo handling and cargo transport—leave much to be desired. There is still a big premium on originality and imagination in increasing efficiency on these and many other aspects of current operating problems.

There were no doubt many who heard Presidents Masefield and Littlewood's version of the road to stability in the aviation industry with polite skepticism. But it would be a great pity if the Canadian industry dismissed these sincere, authoritative observations as mere words in the wind, engagingly offered to suit the occasion, though without real significance.

Canada has in the past decade amply demonstrated the ability to keep pace and in some instances lead in technical advances in the aviation field. More recently, however, the long lead times to production, the possibility of swift obsolescence and continually rising cost in major research and development programs, appear to have priced us out of the full project field.

The Canadian industry could do much worse than dig in hard and apply its wealth of ready experience on problems denying full, efficient utilization of air transport at its current level of development. It is an area in which successful effort can reasonably expect a speedy demand for hardware.

Readers' Reaction

Bomarc's Effectiveness

(The following are excerpts from a letter received by CANADIAN AVIATION addressed to Wing Commander John Gellner, RCAF (Ret.), the author of the new Summing Up column which now appears regularly in the magazine's Missiles & Rockets section.)

I have just completed reading with great interest your "Summing Up" column in CANADIAN MISSILES AND ROCKETS entitled "The GAM Controversy."

The subject of countermeasures is a difficult one to discuss on a non-classified basis. However, I should like to tell you what little I can about it with respect to BOMARC because I am quite sure from your published comments that you have been misinformed about BOMARC's effectiveness in a countermeasure environment.

I do not believe anyone would claim there is a weapon that is one hundred percent "ECM-proof." BOMARC, operating under SAGE control, comes about as close to measuring up to such a label as any air defense weapon can. Its effectiveness in ECM conditions is very high.

In the first place, SAGE is a netted system, as you know, and as such it has the ability to absorb a great deal of countermeasure activity without becoming saturated. Just like people, you can fool some radar sets which are the eyes of SAGE all of the time with countermeasures, but you can't fool all of them by this means any of the time. Those portions that remain effective will be able to direct BOMARCs effectively.

Another of BOMARC's abilities to combat countermeasures are its range and speed. These can force the enemy to employ his countermeasures at a great distance from his target—a bad practice from his standpoint—or, if he chooses to conserve his countermeasure capability intercept him before he uses his ECM effectively.

In your column you indicated that BOMARC's target seeker would be particularly vulnerable to ECM if the missile were fortunate enough to get within lethal distance of its target. All I can say is that this is not true. As a matter of fact, BOMARC's airborne target seeker, along with range, speed and SAGE, is one of the weapon's principal advantages in an ECM environment.

The BOMARC has been much maligned in the Canadian press. In most instances I have felt that discerning readers would be able to separate fact from fiction with no help from me so I have made no attempt to point out misstatements about the weapon's capability. In this case, it is apparent your column was written most conscientiously and there-

(Continued on page 80)

Current & Candid

by Veni Vidi

This is the 12th Current & Candid column — marking a full year in which this writer has been given a free hand to praise, comment and sometimes lampoon the Canadian aviation scene.

It would be remiss for me not to say I've enjoyed doing it. Some of the resulting letters sent into this magazine have been encouraging, and all have been interesting.

Looking back over the year's crop of columns, a certain message seems apparent in most of them. In a nutshell: Things are pretty serious in the business right now; let's get out and do something about improving them.

Well, fair enough, a column must keep plugging away at some things. But as this is something of an anniversary for Current & Candid it seems only appropriate we have a look at some of the better things that have happened. Those of us who live in — or close to — aviation perhaps tend to be a little too much up in the clouds one day and six feet under the next.

The Golden Anniversary year gave us a lot of opportunities to accept the latter outlook. But let's remember:

- This year saw Canada break into the world airliner market in a very promising way with Canadair's sale of 15 CL-44Ds to two American air freight carriers. This was a significant break for Canada; and let's not forget that much-maligned Ottawa did all it could to help by guaranteeing the necessary loan for purchase. By doing that it assured the Canadian industry the sort of support other nations have enjoyed for years. It seems certain the Forty-Four will go on now to become a world standard.

- It isn't easy to conjure up much bright news for Avro. In retrospect it now seems clear that Crawford Gordon and team were guilty of a serious miscalculation in their handling of the Arrow business. There is always a risk — one that we should never for a moment overlook — that soldiers and arms manufacturers will begin to dictate policy to the government in power. If Mr. Diefenbaker et al decided that the Arrow had to go, well that was that. They were voted in to do a job and they were doing it. Perhaps Avro can build a new future around its saucers that will profit both the company and the country far more than pressing on with a plane that was becoming unrealistic.

- *On the airline front it has been a fascinating year. For one thing we have had a look at competition. It's too early to learn much from it yet, but already some trends are appearing. There can be little real doubt that the entry of CPA into the trans-continental race has certainly led to a general sprucing up of TCA's service. I believe TCA brass are quite genuine when they deny that competition caused it—genuine that is that they believe themselves. But from my experience as a passenger on both lines this summer, I am sure that the burning desire by employees to show that theirs is best, profits the passenger and in the long run will profit both carriers.*

- Canadian Pratt & Whitney, in many respects the silent dark horse of Canadian aviation, has quietly come up with a new small turbo prop that has world engine circles buzzing. It's again too early to predict exactly what future it will have, but it looks like a bright example of the sort of work we can and should be doing in Canada.

All things considered 1959 was a year of great change for aviation in Canada. We saw old policies change, old faces go. In the long run, if we face the challenges presented, the future can see us set on a practical and workmanlike footing.

I hope this column can report as much in the issues ahead.

Readers' Reaction

(Continued from page 78)

fore it has a ring of authority which is very convincing. It is because the column was so well done that I write this letter. . . . it is our wish to discuss the weapon (BOMARC) just as freely as security restrictions permit. Our viewpoint is hardly that of a disinterested observer, of course, but our approach is as candid as it can be under the circumstances, we feel.

Yours very truly,

Peter Bush,
Public Relations,
Boeing Airplane Company,
Seattle, Wash.

IATA Fares Disagreement

W. Gordon Wood, vice-president of Trans-Canada Air Lines, who is serving as chairman of the Traffic Conference of the International Air Transport Association, announced the adjournment of the annual fares and rates conference at Honolulu after only partial agreement had been reached on international fares and rates to be charged for the year beginning next April 1. During a three-week session delegates agreed on cargo rates throughout the world and on passenger fares in Europe, the Middle East, and on the South Atlantic. Rates for remaining international routes remain in dispute.

Mr. Wood said the airlines considered the lowering of fares for mass travel incentive, but had widely differing views as to the extent this was economically feasible. He was hopeful for agreement, but said there would have to be "more give and take" than there had been at Honolulu. Disagreement had arisen over the basic ingredients of the fare structure on long-haul routes from Europe south to Africa and east to India. This in turn made it impossible to reach effective agreement on interrelated routes across the Pacific and North Atlantic.

The problem of selling both jet and propeller-driven services over the same routes had become global and many carriers believed that a differential must be maintained between faster and slower aircraft. But there were differences of opinion about both the desirability of a differential, and whether it should be one of price or service. The elimination of the tourist class leaving only economy and first was also in dispute. Carriers agreed that percent low-fare services on the American continent should remain unchanged and that some first class fares should bear a nominal increase.

Normal cargo rates on all international routes were revalidated with some changes, but provision was made for drastic reductions in a series of specific commodity rates to encourage volume traffic over the North Atlantic. These would bring air cargo down to as little as 70 U. S. cents per kilogram for shipments over 45 kilograms in many commodity brackets.



LIGHTWEIGHT'S PUNCH. The lightweight Northrop N-156F Freedom Fighter packs a formidable punch by the addition of two Sidewinder missiles.

Polaris Sub Launch

USS Theodore Roosevelt, the second of the Lockheed Polaris carrying nuclear-powered submarines, was launched last month at Mare Island Naval Shipyard, Calif. Bearing a full-scale model of the Polaris 1,200-mile-range missile, the new submarine revealed to public view for the first time, the two major components of the U. S. Navy's deterrent weapon system. The Roosevelt will carry 16 Polaris missiles and will be able to launch them while submerged for indefinite periods.

Pinpoint Guidance

Long-range automatic airborne guidance system developed by Goodyear Aircraft Corp., is claimed to periodically erase the missile flight errors generated by its inertial and dead-reckoning subsystem. Accuracy is said to be independent of both range and velocity of the vehicle. Designated Pinpoint, the new system is a refinement of the Goodyear Atran system developed for the USAF's Mace missile.

Bomarc Contract Award

Entry of Aeronca Mfg. Corp. into the missile field is marked by the award of a contract for manufacturing Bomarc IM99A master chassis assemblies, by the Boeing Airplane Co. Contract, worth about \$500,000, goes to Aeronca's Longren-California Division, at Torrance, Calif.

Minuteman Awards

Six companies have been awarded study contracts by Boeing Airplane Co., involving launch control system communications techniques for the Minuteman intercontinental ballistic missile. Contracts total more than \$1 million. Companies concerned are Raytheon Co., Waltham, Mass.; Hughes Aircraft Co., Culver City, Calif.; Philco Corp., Philadelphia, Penn.; Hermes Electronics, Cambridge, Mass.; General Electric Co., Syracuse, N.Y.; and Westinghouse Electric, Baltimore, Md.

Boeing Consolidation

Consolidation of three organizations into a single division has been announced by Boeing Airplane Co. The company's Seattle and Pilotless Aircraft divisions and its Systems Management Office will join forces as the Aero-Space Division. Lysle A. Wood, Boeing vice-president, will be general manager of the new division. The company will now be composed of four divisions—Aero-Space, Transport, Wichita and Industrial Products—and a headquarters organization.

New Lear Facility

New facility to house the Instrument Division of Lear Inc., at Grand Rapids, Mich., was opened last month. It was designed for the delicate manufacture and assembly operations of precision components and systems for aircraft and missiles. The additional 172,800 sq. ft. facility doubles the capacity of the division, which employs about 2,200 workers. The opening was signalled by an impulse from an orbiting U. S. satellite, picked up by the U. S. Army's astro-observation station at Fort Monmouth, N.J.

Costly Drone

Lockheed Aircraft's Georgia Division was awarded a \$5-million contract for the conversion of 12 Boeing B-47 Stratojet bombers into pilotless drone aircraft. Used for the evaluation of the North American air defence system, the converted 47's will be able to simulate an attack by Russian medium bombers Bison, Beagle and Badger. They will take off, fly the target range, and land on UHF radio and radar signals from a director aircraft and ground control station.

Bomarc Base Activated

The 22nd U. S. air defence missile squadron, equipped with Boeing Bomarcs, was activated at Langley AFB, Virginia, last month, as part of the Washington Air Defence Sector. This was the fifth Bomarc base to be activated in the U. S.

Missile Safety Meet

Representatives of the RCAF and Canadian companies, met with representatives of the U. S. forces and corporations, and the RAF, in Los Angeles recently for an air force and industry conference on missile safety. Papers were presented on a number of missiles, including one on the Boeing Bomarc, read by J. H. Zabriskie, systems manager of Boeing's Pilotless Aircraft Division. In keeping with the missile safety theme, the U. S. Directorate of Flight Safety Research, at Norton AFB, Calif., was recently renamed the Directorate of Flight and Missile Safety Research.

Tethered Minuteman

A full-sized model of the USAF's Minuteman ICBM was test fired from an underground silo at Edwards AFB, Calif., last month, while tethered by a 2,000-ft. nylon cord. Only the first stage of the missile was live, and its solid-propellant rocket engine, built by the Thiokol Chemical Corp., was designed to burn only a few seconds. The 6,000-mile-plus missile returned to earth after a flight of only a few hundred feet having checked out the launching silo.

Silica Missile Shapes

Technique for producing high purity fused silica in widely varied shapes and sizes has been developed by Corning Glass Works, Corning, N.Y. It can be formed into cylinders, domes, crucibles, rods and slabs making it possible to exploit the unique thermal and electrical properties of silica glass in many flight vehicle applications. Called Multiform fused silica, the material is undergoing evaluation for use as a flush-mounted radome in a military missile. It can withstand long-term use at temperatures over 1,700 degrees Fahrenheit and intermittent use to 2,250 degrees. Softening point is 2,880 degrees Fahrenheit.

Polaris Sub Gets Scope

Periscope nearly fifty feet long and weighing more than a ton has been delivered by the Kollmorgen Optical Corp., Northampton, Mass., to the Electric Boat Div. of General Dynamics Corp., for installation in the George Washington, first Polaris missile launching submarine. One of three to be installed in the sub, this periscope will monitor the vessel's inertial navigation system by tracking a star, thereby checking the accuracy of a battery of equipment designed to keep the sub' on course when submerged for prolonged periods.

Small Firm Award

North American Aviation's Missile Division, Downey, Calif., awarded sub-contracts totaling more than \$400,000, for equipment to be used on the Hound Dog missile program, to the 400-employee company of Space Corporation, Dallas, Texas. Contracts cover production of engine test stands, accessory kits and control cabinets.

aviation intelligence

Slick Orders "Forty Fours"

Slick Airways, Inc., has ordered two and optioned four hinged-tail Canadair Forty Four air freighters. The Burbank, Calif., carrier is the third major U. S. air freight specialist to re-equip with Canadair's Rolls-Royce Tyne turboprop powered cargo vehicle. The value of the new order, if Slick exercises its option and purchases the six aircraft, is about \$24,000,000. It brings the firm orders on Forty Fours to 17 aircraft—10 to Flying Tigers and five to Seaboard and Western. (The first of 12 military Forty Fours, without the hinged-tail, being built for the RCAF is scheduled for initial flight this month). Slick's Forty Four purchase indicates an airline decision to bypass Lockheed's proposed 207 Super Hercules commercial freighter, a project which was conditioned on military support for development on airframe and the Allison turboprop engines. The Slick move could precipitate action by Pan American, long a potential Forty Four customer, at present committed to the 207 project.

TCA Jet Service

Trans-Canada Air Lines will inaugurate domestic jet service on April 1 and will introduce its Douglas DC-8 on the North Atlantic route June 1. The airline takes delivery of the first of its six 127-passenger Douglas jet airliners in December. Announcing the company's plans for introduction of the DC-8s, TCA President Gordon R. McGregor said the proposed schedule called for a flight time of four hours, 55 minutes, Vancouver-Montreal with a half-hour stop at Toronto. The TCA aircraft will be the first DC-8s powered by Rolls-Royce Conway by-pass engines.

New Bomarc Order for Canadair

A further contract, amounting to about \$2 million, for the production of Boeing Bomarc missile wings and ailerons, has been awarded the missiles and systems division of Canadair Ltd., Montreal. This is for components and the tooling necessary to build the advanced B Model Bomarc wings. Canadair is already producing components for the earlier mark of the missile, and in fact has become the sole source for Bomarc wings and ailerons, under two contracts received last year totaling about \$5,200,000. Work on both types will continue through most of 1960, the work on the B Model extending into 1961. Although Canada has ordered the Bomarc for two Canadian bases, all of the components now on order are for missiles earmarked for the U. S.

Canada Sponsors Mekong Survey

A \$1,300,000 hydro-power and irrigation survey of the Mekong River, in Southeast Asia, is to be financed by Canada under the Colombo Plan. All of Canada's principal air survey companies will be employed on the job, scheduled to begin this month and to last two years. Work will include air photography, ground survey and map compilation. The Photographic Survey Corporation Ltd., Toronto, has been awarded a contract to act as management engineers for the project. Companies participating will include: Aero Surveys Ltd., Vancouver; Canadian Aero Service Ltd., Ottawa; McElhanney Nelson Air Surveys Ltd., Vancouver; La Compagnie Photo-Air Laurentides, Quebec City; and Spartan Air Services Ltd., Ottawa.

Swing Tail From Boeing

A turbofan-powered hinged-tail freighter version of the Boeing 707, announced by the Boeing Airplane Co., is said to be capable of transporting cargo for as little as three cents a ton-mile. Designated the Boeing 735, and based on the intercontinental version of the 707 the new airplane is offered for delivery in 1961. J. B. Connelly, vice-president-general manager of Boeing's Transport Division, said the Pratt and Whitney turbofan-powered freighter would carry 100,000 lb of cargo, 3,000 miles non-stop, in five hours.

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Bomarc Subcontract

Contracts totaling \$4.5 million for equipment to be used in the Boeing IM99B Bomarc have been awarded by Boeing to the Kearfoot Co. Inc., Little Falls, N.J. Kearfoot will supply unlimited attitude coordinate converters systems and related equipment used to provide the Bomarc with directional control signals useably by the flight control and target seeker radar control systems.

Boost For Explorer

The first stage booster that launched the U.S. NASA's Explorer 6 satellite from Cape Canaveral, Fla., was powered by a Thor propulsion system built by Rocketdyne, a division of North American Aviation Inc. The booster generated about 150,000 pounds of thrust, equivalent to about four million horsepower during high altitude flight.

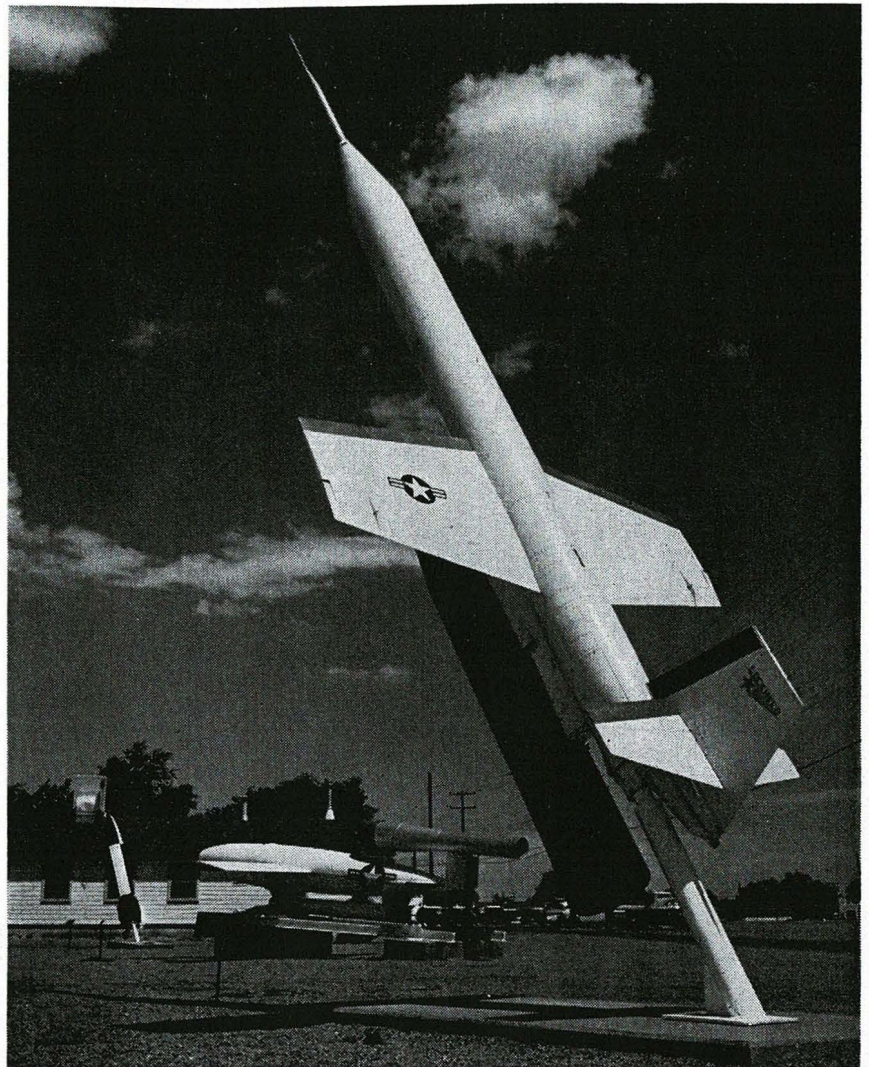
Pictures From Space

Highly versatile radar system developed by Sperry Gyroscope Co. and manufactured by Sperry Gyroscope Co. of Canada Ltd., for the Royal Canadian Navy's CS2F-2 Tracker anti-submarine aircraft, has been identified as that used by the U.S. Air Research and Development Command to demonstrate how radar operates at extreme altitudes.

USAF reported that radar pictures were taken from the gondola of an unmanned 2,000,000-cubic-foot free balloon 100,000 feet up, and returned safely to earth. The flight was conducted for ARDC by the Goodyear Aircraft Corporation and the Winzen Research Corporation. The pictures taken will extend man's limited knowledge of radar characteristics at stratospheric altitudes, according to an ARDC official. To obtain the radar impressions, a camera trained on the radar scope recorded the changing display on film. Simultaneously, another camera recorded aerial views to provide exact identification for co-ordination of the radar picture and the land below.

The navigation type radar, employed as standard equipment aboard the USAF's troop, cargo and jet tanker planes, displays a visual, map-like scope picture. This shows cities and smaller terrain features, rivers, islands, mountains, shorelines and ships at sea. When used as a weather radar, it displays less substantial objects such as storm fronts, heavy rainfall and other turbulent weather features with precipitations.

The small lightweight radar used in the recent tests is employed by the USAF for search and surveillance, storm detection, and other all-weather navigation purposes, while the Canadian built systems are utilized by the RCN in an ASW role on the Tracker. This radar set development was the result of an engineering and flight research program undertaken jointly by USAF and Sperry's Air Armament Division.



MISSILE CHAMP. Holder of world's speed and altitude records for an air-breathing vehicle, Lockheed's ramjet X-7 has won an honored spot on display at Air Force Missile Development Center, New Mexico, where it set records.

Explorer's Sun Power

All electrical power for the heavily-instrumented Explorer VI satellite is being provided by solar energy converters. The converters consist of 21,000 silicon solar cells that convert light energy directly into electricity to charge the satellite's chemical batteries. Hoffman Electronics Corp., Los Angeles, developed and produced the converters, providing 210 modules consisting of 100 silicon cells each. Mounted on the satellite's paddle shaped fins, the modules are constructed with 50 cells on each side. Each module produces about $\frac{3}{4}$ watt of electricity under direct sunlight. This is the second satellite containing Hoffman solar energy converters to go into orbit. The first, Vanguard I, launched March 17, 1958, is still transmitting from outer space after more than 16 months of continuous operation and its solar cells are expected to continue to provide power for the life of the satellite, estimated at from 200 to 1,000 years.

Telemetry Demonstration

Advanced telemetry system for missiles and space vehicles, capable of transmitting 40,000 samples of information per second over a single channel, was publicly demonstrated by the Lockheed Missiles and Space Division in San Francisco last month. Known as the pulse amplitude modulated-frequency modulated (PAM-FM) system, it formed part of a display at the annual U.S. Wescon show. Display included a Lockheed developed solar cell panel and a presentation of the Lockheed automatic check-out and readiness equipment designed to provide instant and continuous operation checks on Polaris missiles carried aboard submerged submarines. Key to the system is the Lockheed-designed multiplexer which can combine eight channels of information at 5,000 per second and transmit it over one channel at 40,000 per second. With this system it will be possible to transmit four times as much information as presently possible with a standard FM-FM telemeter, according to Lockheed scientists.

PLANE PATTTER

by Ernie Hampill



The Bomarc-Nike controversy with which the United States Defence Department is beset raises vital problems for Canadian defence officials. This despite the denial of Defence Minister George Pearkes, VC, that the assault on the Bomarc program and subsequent reduction in immediate U. S. funding has had any effect on Canadian plans.

Our feeling is that if the current U. S. soul-searching has not been taken into consideration by Canadian planners it should be—and right now, before we become immersed for several unrecoverable millions of dollars.

This is not to say that the Bomarc is an ineffective weapon. At least it was not considered so as relatively short a time ago as last October when it was chosen by Canada's defence planners as the prime weapon in our NORAD arsenal.

We must assume this choice was made with full knowledge of the capabilities of the other weapons available to Canada through its NORAD partnership; and with no illusions as to the fact that in its current marks at least, the Bomarc is intended for defence against air-breathing vehicles and is not generally considered an anti-missile weapon.

The crux of the problem appears to be that Canada, in limiting itself to the products of other nations in its choice of weapons of the future, has left itself open to a situation in which it may not be able to obtain the hardware that it feels is best suited to the nation's defence requirements. Or at best may not be able to obtain the weapon of its choice without paying the same premium that would apply if we developed and produced it ourselves.

In the Bomarc situation, for example, is there any guarantee that the U. S. companies engaged in the prime development work on this system are prepared to continue the project if the potential Canadian order represents their total market?

And if they are, and the Canadian requirement for this particular weapon remains valid, is its procurement likely to be more economical, in terms of effective hardware for defence dollars, than a continuation of the Avro Arrow project would have been?

The big attraction about defence production sharing, in its broadest application, is that the forces of both Canada and the United States draw their weapons from a common production pool. In this way Canada gets the advantage of weapons suited to its requirement without the economic penalties which accompany limited production runs.

It now appears that we may no more have our cake and eat it under defense production sharing than we could when we went our own way.

Readers' Reaction

Turnbull Propeller

The Editor,
Canadian Aviation.
Sir,

On page 67 of your issue for January 1959 there is an illustration of the Turnbull variable-pitch airscrew fitted to an Avro 504K. I am about to write a book on the Avro 504, and my aim is to include as many illustrations as possible of variants, experiments and modifications. Your Turnbull prop photo is just the sort of thing I am looking for, and I wonder whether it would be possible for me to obtain a print of the photograph from which your illustration was made.

Just one small point — the Turnbull wasn't the world's first variable pitch propeller by quite a long way. Early in 1918 a B.E.2c (No. 4122) was fitted with the first Royal Aircraft Factory variable-pitch airscrew at Farnborough.

Later that year the R.E.8 B. 738 was fitted with a supercharged RAF 4d engine and later an RAF v.p. prop', and no fewer than three S.E.5As were also fitted with v.p. prop's. The first of these had the Hart v.p. prop' in 1918, but apparently was unsuccessful and not flown. The third was flown not later than 1920.

The RAF prop' fitted to the B.E. 2c may not have been a very good one, but it was the first! (See page 368 of my book "British Aeroplanes 1914-18", published in 1957 by Putnam.)

J. M. Bruce,
Birmingham 32,
England.

Defense Spending Doubts

The Editor,
Canadian Aviation.
Sir:

Your Current and Candid column in the May issue (regarding production sharing) prompts me to make a rejoinder.

In common with the contemporary magazines covering the small Canadian aircraft industry—so small one would think one sound trade magazine plus a technical journal like that issued by the CAI would amply cover the lot—your paper seems to have turned with the tide quite easily. But I can assure you that more and more people, and particularly those with an engineering background and some perceptive powers of observation and thought, are questioning the validity and true worth of the massive Defence contracts that you seem to hold so dear to your heart.

Maybe you, like many Avro employees (I was one of them) were able to earn a satisfactory income and enjoy a pleasant occupation due to the steady flow of taxpayers' money for the 692 CF-100 aircraft that I believe were built. But do

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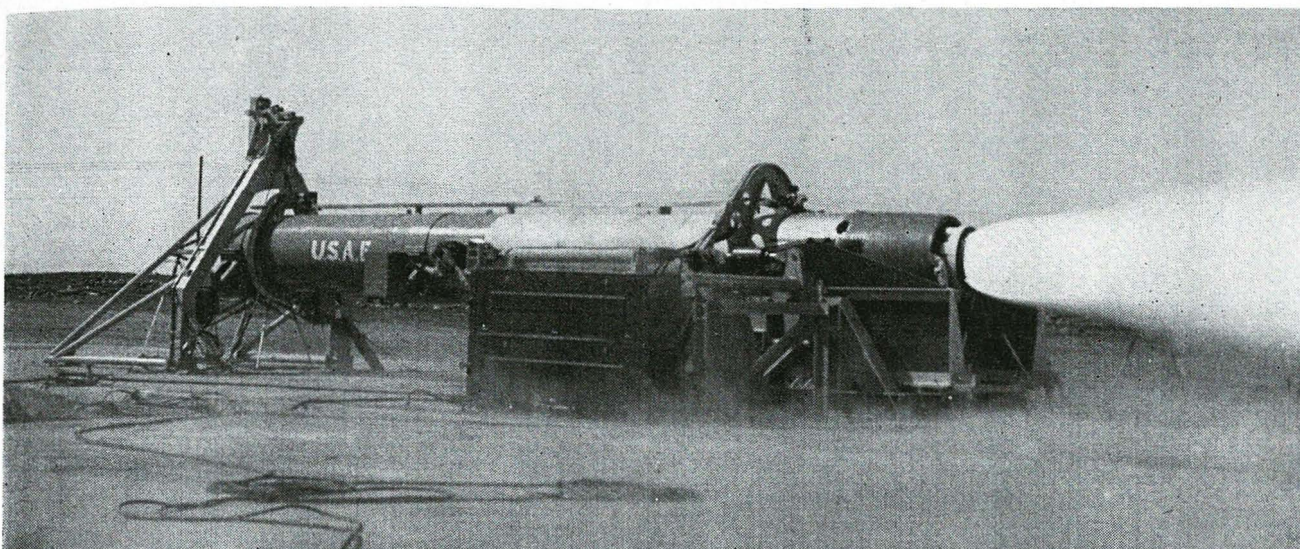
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BOMARC B TESTING. The solid propellant boost rocket motor of the advanced Boeing Model B Bomarc got its first test run recently. This was termed "very successful." The solid propellant motor replaces the liquid propellant of the Model A Bomarc currently in production. Canada will probably get the Model B missile for her two sites.

For Anti-ICBM Research

The new Defence Research Board radar research station near Prince Albert, Sask., was opened officially last month. Sponsored jointly by the DRB and the United States Air Force, the new facility will investigate problems of radar detection of aircraft and missiles entering the auroral zone. The aurora borealis or northern lights are associated with radio disturbances, and it is necessary to find ways to reduce the effects of this on the detection of intruders. The programme will be an extension of collaboration between the DRB and USAF over the past few years relative to continental ballistic missile defence and results are likely to make a substantial contribution to a successful system. Prominent feature of the site will be a 84 ft. radar dish loaned by the USAF, mounted on a concrete base and extending 125 ft. into the air. This will be a twin of the radar installation at Millstone Hill, near Boston, Mass., and will be one of the largest of its kind in the western world.

Bomarc Shelter Details

Design details of the shelters under construction at four U. S. Boeing Bomarc missile bases, and plans for another 10 or more sites, have been revealed by the Boeing Airplane Co., Seattle, Wash. The flat-roofed concrete and steel structures are designed to be ready for instant use. The six-ton slabs of concrete that form the roof, loaded with maybe twice that weight of snow, can be opened in three seconds. The buildings are 60 feet long, 20 feet wide, and almost 12 feet high. At least two bases will have 56 such buildings to house a full squadron of missiles. Each is designed for push-button operation from remote control SAGE centres, miles from the base. Pressing of a button at the centre will cause the roof sections to roll apart, the missile to rise into position, and to fire.

Bomarc B Launching

The first flight test of the advanced Model B Boeing Bomarc took place at the Atlantic Missile Range, Cape Canaveral, Fla., at the end of May. The launch was intended as a test of the B Model's flight and aerodynamic characteristics, as well as performance of the solid propellant rocket booster, developed by Redstone Division of the Thiokol Chemical Corp. This replaces the liquid rocket used in the A version, and more powerful twin ramjet engines, produced by the Marquardt Aircraft Corp. The missile carried an airborne programmed unit which controlled it through a series of planned manoeuvres. No target plane was used in the test.

Space Engine Research

Contracts totaling \$193,000 have been placed with Republic Aviation Corp., by the U. S. Office of Naval Research and the USAF Office of Scientific Research, for experimentation in two areas of development of a magnetic pinch plasma engine. The engines would use a heavy gas like oxygen and turn it into ions and electrons. These are compressed in an invisible cylinder of magnetism and shot out of the rear of the vehicle being propelled, at tremendous velocity. Research under the contracts will be carried on into 1960. By that time Republic estimates that major problems of the space engine can be solved, and a production model to power a flight to Mars or Venus can be accomplished by 1964.

Guiding Polaris Subs

Sperry Gyroscope Co. of Canada Ltd., Montreal, Que., reports that the U. S. Navy has named the parent company, Sperry Gyroscope Co., Great Neck, N.Y., as navigation systems manager for its new 608 class Polaris submarines.

Lacrosse Follow-On

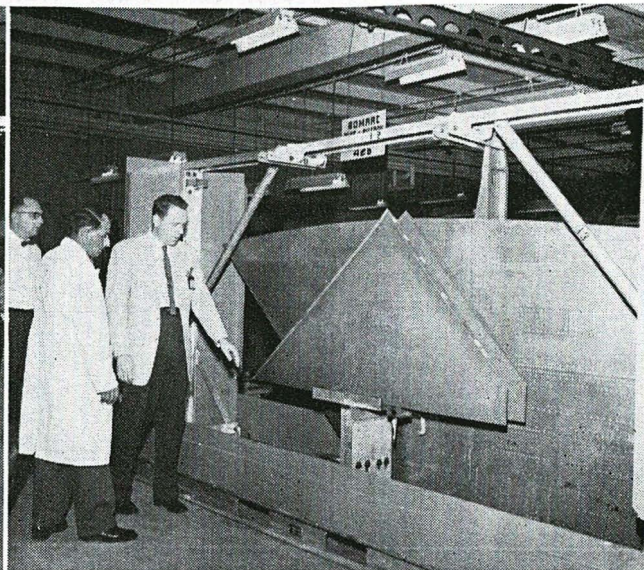
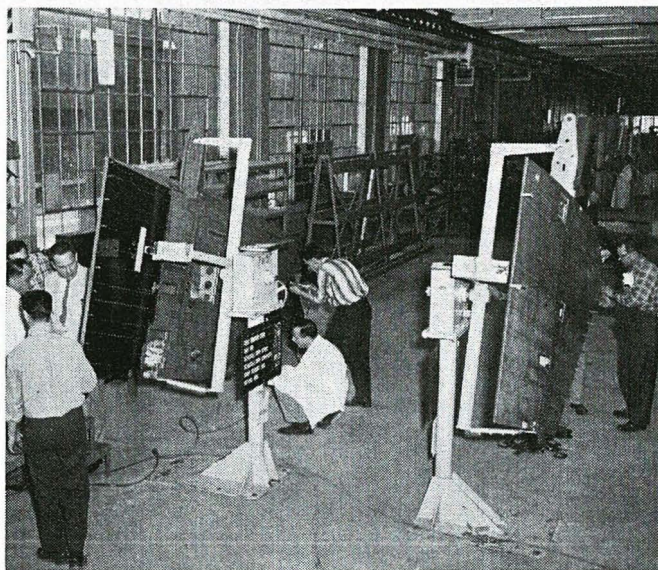
The U. S. Army has awarded further contracts totaling \$15,181,000 to the Martin Company's Orlando Division, for additional production of Lacrosse missiles and engineering services. Contracts awarded to the company for the Lacrosse program since January 1959 now total \$25,181,000. Production missiles have been coming off the assembly line at Martin-Orlando since August 1957. The Lacrosse is on order for the Canadian Army, and Canadian troops have been trained in handling the missile at the U. S. Army's Ordnance Guided Missile School at Redstone Arsenal (Huntsville, Ala.), and at White Sands.

Radio Link Through Space

Recent experiments on reflection of radio waves from the moon have led to the use of the moon as a reflector of radio waves for long distance radio communication. A successful link has been established via the moon between the telescope at Jodrell Bank, England, and the USAF Research Centre at Cambridge, Mass. Preliminary lunar link was established at the end of May, and scientific measurements have been carried out using various audio tones. First, messages in Morse, and then intelligible voice transmissions were established. This type of communication is free from many of the usual disturbances and from ionospheric fadeouts.

Nike In Alaska

Following its cold weather testing trials at Fort Churchill, Man., the Nike-Hercules surface to air missile is now in service in Alaska as part of the NORAD defenses. The first Army Nike battery there has been set up to guard the Fairbanks-Ladd AFB and Eielson AFB area.



BOMARC PRODUCTION. Production of wings and ailerons for Bomarc missiles is well under way at Canadair Ltd., Montreal. The first units to come off the line are shown undergoing final inspection (left) and packed for shipment.

Space Exhibits at IRE

Space research projects of the U.S. Army will again be displayed at the IRE 1959 Canadian convention and exposition, to be held in the Automotive Building of the CNE, October 7-9. These will form part of the Canadian Astronautical Society's exhibit and will include duplicates of the talking and cloud cover satellites launched early this year, solar cell assemblies and other electronic equipment used in space exploration. Discussions between A. E. (Mick) Main, secretary of the CAS, and the chief of research and development for the U.S. Army resulted in the decision to send the exhibits. An earlier U.S. Army space project, the Explorer III satellite, was the subject of a CAS exhibit at the IRE's 1958 Canadian convention. More than 10,000 scientists, engineers and businessmen are expected to attend this year.

Building Space Chamber

Details of what was described as the first space-environment chamber, capable of taking men into a simulated ionosphere 150 miles above the earth, have been released by Republic Aviation Corp. The chamber, which will be built by Tenney Engineering Inc., Union, New Jersey, at a cost of \$500,000, is to be installed in Republic's new \$14 million astronautics research centre early next year. The chamber will be used to test space suits and to investigate the physiological and psychological reactions of man in space conditions. It will also assist in the development of materials and components for space vehicles. Measuring 14 feet in diameter and 30 feet long, the chamber will weigh about 30 tons. Republic's new centre will house seven space laboratories and accommodate 400 scientists and engineers working on problems ranging from satellites to interplanetary travel.

Polaris Launching

All primary test objectives were reported satisfied in the latest firing of an advanced Polaris test vehicle at Cape Canaveral. Stanley Burriss, Polaris system manager for Lockheed, making the announcement said primary objectives were general missile performance, stage separation and structural integrity during flight. Range and impact accuracies were "most satisfactory", also, though they were not primary test objectives. The test vehicle was the tenth in a series of advanced development type Polaris missiles, launches of which began last September.

Weather Rocket

Development of a lightweight meteorological rocket system, said to be capable of obtaining accurate wind velocity and direction information at heights up to 240,000 ft., is reported by BJ Electronics division of Borg-Warner Corp., Santa Ana, Calif. Named the Owl meteorological rocket system, it is designed to support major ballistic missile test programs. Weighing 29 lb., the rocket utilizes a solid propellant rocket of three inches in diameter. Timing device within the rocket causes ejection of radar reflective materials at desired altitudes. These are tracked by ground radar as they fall and the resulting information provides reading of wind behaviour.

Advanced Firebee Order

The Q-2C, most advanced version of the Ryan Firebee target missile in use by the RCAF, is the subject of an \$8,667,000 contract awarded Ryan by the U. S. Air Force. This assures production well into 1960. An additional spares and ground support contract for more than \$2,250,000 is under negotiation. In all over \$14 million in orders has been awarded Ryan by the USAF for work on the new Firebee. Powerplant is the Continental J69-T-29 turbojet.

Rocket Winners

Winners of the MacBrien Trophy at the third annual Air Defence Command rocket meet held at Cold Lake, Alta., were 433 Porcupine Squadron, from RCAF Station North Bay, Ont. The station's ground crew technicians and CF-100 aircrews also won their individual competitions. The North Bay team made a score of 85.6%. No. 416 Lynx Squadron, St. Hubert, Que., was second, and 414 Black Knight Squadron, North Bay, came third. Winner of the Tyndall Trophy, was F/O Douglas Law, RCAF Foynmount, Ont., who completed three successive perfect intercepts and ended the meet with a 98.4 average. Meet was held over the Primrose Lake range, largest in Canada, with an area of 4,400 sq. miles.

SAGE-Bomarc Award

Contract worth \$2,200,000 for operation and maintenance of power facilities for SAGE-Bomarc bases in the Northeast Air Defence District has been awarded to Vitro Engineering Co., a division of Vitro Corp. of America. Defense area covered in the contract includes New York and Washington.

New Beechcraft Drone

Beech Aircraft Corp., Wichita, Kansas, has won a joint U. S. Navy and Air Force competition for a new high speed missile target. It will be a low-cost operational missile-target with speed and altitude performance said to match capabilities of potential enemy aircraft. The award was made, according to Beech, on evaluation of design proposals submitted by 18 guided missile and airplane manufacturers. A developmental contract will follow. Designation of the target is KD-2B-1. It will have a canard type stabilizer at the nose, and a delta wing with extreme sweepback at the rear.



WORKING ON BOMARC. Some of the Canadian engineers from de Havilland Aircraft of Canada Ltd. (left) and Canadair Ltd., working at Boeing Airplane Co. on the Bomarc program. At left are: L. Perkins of Boeing and H. S. Kerr, Dr. P. A. Lapp and A. C. Stonell, of de Havilland; and on the right: H. Dally, J. Green, D. Armstrong and W. Greenwood, all of Canadair. Canadians are providing engineering-consulting services under contract.

Joint Space Projects

(Continued from page 21)

rocket data will be relayed.

Acceptance of the DRTE proposals for joint rocket vehicle and satellite experiments by the NASA was announced by Dr. A. H. Zimmerman, chairman of the Defence Research Board. Canadian participation in the satellite, to be launched some time during or after 1961, will take the form of ionosphere-probing instrumentation.

Site of the launching will be the Vandenberg Air Force Base in California, but the date will depend upon technical and other considerations.

The DRTE instrumentation will direct radio pulses downward as the vehicle pursues a polar orbit. These will be reflected back to the satellite from the upper layers of the ionosphere and the information received will then be relayed to the ground at a suitable radio frequency.

Object of the experiments will be to obtain information complementary to the mass of scientific data about the ionosphere and upper atmosphere collected during past years by means of ground-based research facilities. This information is believed to be valuable in the development of an ICBM defense system.

The tool used most widely for the past studies has been the ionospheric sounder. It transmits short radio pulses from the ground to the ionosphere. The time interval between their transmission and their reception back from the ionosphere is measured at various frequencies. The results

provide data on ionospheric conditions which can then be studied in the laboratory.

Use of the ground-based ionospheric sounder is limited. The results relate only to the lower regions of the upper atmosphere because the radio pulses are reflected back to the ground from the lower boundaries of the ionized layers. Some penetrate through the ionosphere and are lost in outer space.

The ionosphere is influenced almost entirely by radiation and particles which enter the atmosphere from above. Lack of knowledge about conditions in the upper regions is severely handicapping present understanding of the processes involved. If the top-side sounder experiment is successful, the results should fill an important gap in scientific information.

Lacrosse Units Activated

The first two units to employ the Lacrosse surface-to-surface guided missile will be activated at Fort Sill, Okla., by the end of this month.

The Lacrosse, which has been ordered for the Canadian army, is in production at the Martin Company, Orlando, Florida. The solid propellant Lacrosse missile will give the front-line infantrymen a rugged tactical support weapon capable of doing a variety of jobs. It is claimed to deliver numerous types of warheads including nuclear and shaped-charges with pin-point accuracy up to ranges of conventional artillery. All components of the Lacrosse system—19 foot missile, launcher, and guidance elements—can be mounted on a standard 2½ ton Army truck. The equipment and crew can be easily airlifted to battle areas, if necessary.

Canadair Division

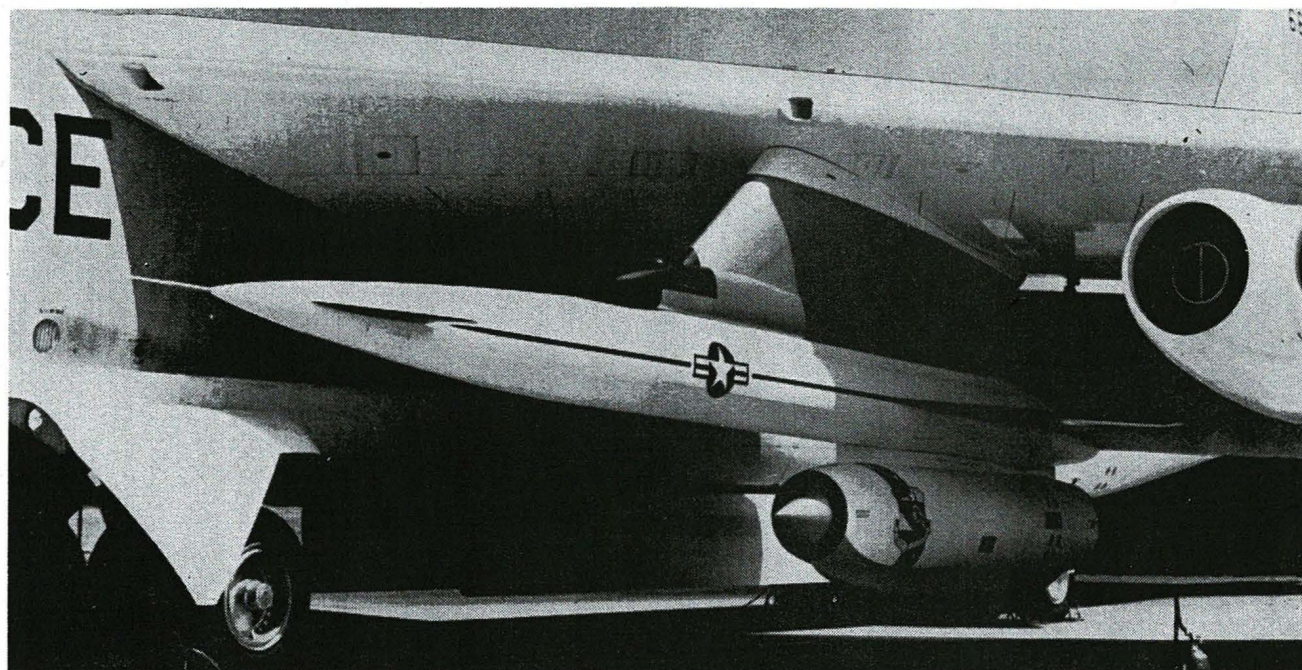
Canadair Ltd. has announced creation of a new Missile and Systems Division under Robert D. Richmond, former chief engineer of the company's Special Weapons Division. Mr. Richmond also becomes a vice-president of the Montreal company. The move represents consolidation of Canadair's Special Weapons Division and Special Projects Department into the single, autonomous Missiles and Systems Division which will concentrate on supplying Canada's missile requirements and also make firm bids for business from the United States under the recently proposed defense production sharing plan. In addition to work in the missile field the new division will also undertake special projects in the automatic function category.

Bomarc Figures Disclosed

North America's first Bomarc missile bases, each guardian of an area greater than 100,000 square miles, will be armed with from 30 to 60 missiles each. Two of the bases, at Suffolk Air Force Base, Long Island, N.Y., and McGuire Air Force Base, New Jersey, will have 60 of the Boeing-built ground-to-air missiles and a complement of less than 300 men. Twelve others which have been authorized for construction in the United States will have 30 missiles. Canadian bases will have an, as yet, undisclosed number of the 400 mile range Bomarcs.

Ion Research Venture

Research into, and development and manufacture of ion propulsion devices for space vehicles will be the function of Goodrich-High Voltage Astronautics, Inc., a new company in Burlington, Mass. The company was formed as a joint venture by the B. F. Goodrich Company and the High Voltage Engineering Corp., and work will commence at the latter's Burlington plant.



ATTACK potential of the U. S. Strategic Air Command will be increased by this North American Aviation GAM-77 Hound Dog, seen below wing of a Boeing B-52. Launched from B-52, the missile extends the bomber's normal range.

Missile Bugs to Beat—in

By Wing Commander
John Gellner, RCAF (Ret.)

When the interested layman thinks of defense against the ICBM, the picture which probably comes to mind is that of the much discussed anti-ballistic-missile missile.

The latter is under development. We have heard from the United States of the Air Force "Wizard" and the Army "Nike Zeus" which come into this category. To make a contra-missile which could actually intercept an ICBM must be a formidable task. From among the many difficulties that will have to be overcome, we may mention one of the less obvious but most perplexing, that of discrimination.

The weapon-carrying nose cone of an ICBM, for example, could be made to descent amid a shower of fragments from the last stage rocket, or of decoys such as metallized balloons. The contra-missile then would have to sense which are the inoffensive fragments and which the deadly warhead — an impossible task at the present state of the art.

The most promising method of countering the ICBM seems to be a blast-and-heat barrage from a nuclear weapon exploded in the missile's path. This would have to be done in the very

last stage of its flight, high up, but still in the atmosphere. A considerable number of anti-ICBM rocket sites would be required to cover the aerial approaches to the principal targets in North America, and an early warning, reporting, and fire control system so automatized that it would be capable of reacting within the less than 10 minutes an ICBM would take from its "acquisition" by improved DEW Line radars to a target at the latitude of Chicago.

It is quite likely that an ICBM warhead could be made to break up or burn up even by a comparatively distant nuclear blast. That it would burn up is perhaps the greater probability. Even if, as has been reported, the re-entry problem has been licked (there is still much doubt that the solution includes a satisfactory functioning of the delicate trigger mechanism on the nuclear device in the nose cone), an ICBM must be very close to its

thermal tolerance when it bores its way through the thickening atmosphere. A flash of intense heat added to the frictional surface heating would as likely as not bring it beyond the critical point.

Nor would radio-active fall-out be in this case too serious a problem. The starting of the atomic (fission) chain reaction which in turn triggers off the devastating fusion stage in a thermonuclear blast, is a very intricate operation. It is difficult to imagine that it could be brought on by an outside blast, whatever its force.

In any event, even if a thermonuclear explosion should ensue, it would be so high up that it would probably produce only stratospheric fall-out. This is the variety which has the least immediate effects, and which is equally dangerous to friend and foe and non-belligerent. The same goes for the explosion of the anti-ICBM rocket. Here, the production of "clean" (that is, fall-out free) nuclear weapons, forecast by President Eisenhower for 1961 or 1962, would eliminate even the danger of stratospheric fall-out.

Defense Within Reach

Problems are obviously still plentiful in connection with this type of anti-ICBM defense, but it looks feasible and even within reach. The two

This is the second in a series of missile commentaries written for Canadian Aviation by Wing Commander Gellner, recently retired from the RCAF, where his last post was as instructor at the service Staff College. He provides an authoritative and up-to-the-minute view of the international missile state.

rocket-borne warheads exploded at high altitude above Johnstone Island in the Pacific during last summer's United States nuclear test series, were almost certainly experimental weapons of the kind just described.

Another method of defense against ballistic missiles was given a preliminary test in Operation Argus, conducted by the U. S. Navy in the South Atlantic, in August and September, 1958. Rocket-borne nuclear warheads were exploded at a height of approximately 300 miles, an altitude that would be close to the zenith of the path of a ballistic missile.

The theory is that such an explosion would create a short-lived shield of neutrons (lasting about 15 minutes) in which the incoming missiles would be prematurely detonated.

Experiments following this line of enquiry are to continue. An anti-ICBM barrage laid down in outer space would be much safer, as far as fall-out is concerned, than a similar barrage in the upper atmosphere. On

said that bombers were obsolete and already had been replaced by long-range missiles, he was contradicted by a number of leading Soviet air force officers.

Among those who with suitable caution and deference, stated that Khrushchev was all wrong, were Marshals of the air force Rudenko and Skripko (the former is SAF Chief of Staff and Deputy Commander-in-Chief), and Major-General of Engineer Technical Services Pokrovskij, a leading missile scientist.

The United States is still very much in the bomber business. The budget for fiscal 1960 should provide funding for some 140 heavy bombers (B-52G's and B-58's); for over 90 KC-135 jet tankers; and for development of the B-70 chemical fuel bomber. This would be more than a threefold increase in bomber procurement compared to fiscal 1959.

Great Britain, after proclaiming that no more bombers would be built after the Vulcan and Victor, is re-

Attack & Defense

the other hand, the missile warhead could perhaps be made impervious to the heaviest outside radiation by particularly massive shielding.

Furthermore, nuclear blasts in outer space could conceivably defeat their purpose by disrupting the defender's own radar and radio communication system, necessary for the detection and tracking of ballistic missiles.

In the meantime the threat of the manned bomber continues. While some scientists are working feverishly to overcome the inherent unreliability of the ICBM, others are perfecting a family of missiles to combat the manned bomber. The transition will be gradual.

Soviet Manned Bombers

It is fashionable for news commentators to discount Russian statements about the effectiveness of Soviet missiles. The same commentators, however, do not examine what the Soviets are doing overall in the military field, nor read Russian professional literature.

If they did, they would learn that the Russians are working hard on the development of supersonic bombers and that they have recently come out with one in the Mach 1.3 class, the YAK-42. They would also find that when, a year or so ago, Khrushchev

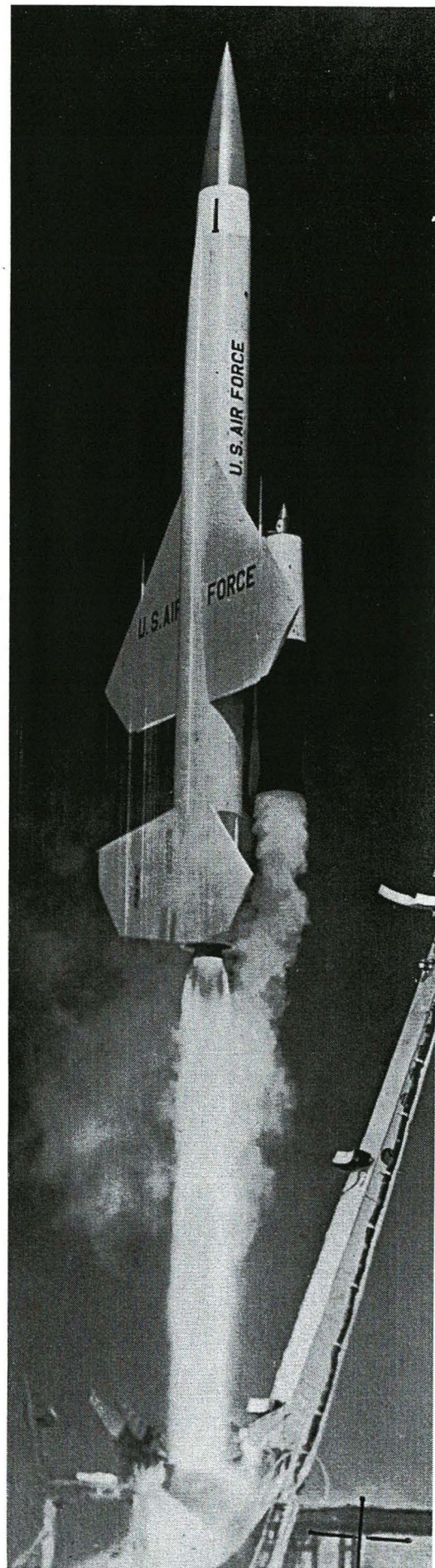
ported to be well advanced with a supersonic bomber project.

The best means of combating the bomber is still the manned fighter. Important developments in the field of electronic counter-measures (ECM) make it doubtful that defensive missiles, guided by electromagnetic radiation, will have much chance of reaching their targets.

As is generally known, radar is comparatively easy to jam because it can be detected beyond its own range, and because the reflected pulse or echo is comparatively weak and can be blotted out by a jammer of quite modest power.

The member of the bomber crew operating the ECM equipment reconnoiters the ether for radar emissions. He determines the characteristics of the latter (e.g. frequency, pulse, length, repetition rate) and then decides on his counter-measures. He may resort to passive ECM like the dropping of "chaff," tin foil cut to the pulse length of the enemy radar which "blot out" the picture on the radarscope.

It is more likely that he will use active ECM. He may, for instance, mimic the enemy radar by sending out radar pulses of similar characteristics. This gives false range information to the directional radars on the ground, causing the latter's computers to come



DEFENSE of North America against manned aircraft is role of the Boeing Bomarc, shown in this latest NORAD picture with a new white paint job.

Washington report suggests USAF considering cease-production of the Bomarc

up with wrong guidance instructions for the missile.

Missiles with organic radar may lock on to the false signal. This would be most probable in cases when the ECM transmitter is carried in a decoy drone, launched from the bomber after the ECM operator has determined the characteristics of the enemy radar. The McDonnell Green Quail is a drone of this kind, which serves both as a means of active and of passive ECM (with the help of such devices as corner reflectors or Luneberg lenses a decoy can be made to appear on the radarscope as a big aircraft).

Any modern bomber force would undoubtedly include a number of aircraft assigned to combat the defenders' early warning, directional, and fire control radars. Apart from ECM receivers and transmitters these aircraft would carry decoys, and air-to-ground missiles designed to home on ground radars. The Northrop Crossbow is an example of such an antiradar missile.

In the light of these developments there would seem to be some doubt about the effectiveness of the defense missile adopted by Canada,

Bomarc Versus ECM

In flight the Bomarc is command-guided by two ground radars. Both can be subject to interference. So can the missile's active homing radar which takes over for the last stage of the flight. In recent tests a Bomarc was guided to a target by instructions from a SAGE control centre more than a thousand miles away. This is an impressive achievement, but clearly of little practical significance unless we are told that a hit was scored in spite of determined ECM.

Reports from usually well-informed sources in Washington indicate that the USAF wants to have another look at the Bomarc to determine whether it is worth while continuing with its production. If there are doubts, they could stem from the fact that Bomarc is vulnerable to ECM.

There is a good deal that can be done to counteract ECM. A whole science of counter-electronic-counter-measures has developed, based on progress in radar design in recent years.

The ECM battle is one of wits. The intelligent ECM operator in a bomber has a definite advantage when working against missiles — but not necessarily when his adversary is an equally skilled and intelligent radar operator in a fighter. For just as a missile has no tolerance for malfunction of any

of its parts, so it cannot tolerate equivocal guidance instructions.

An aircraft crew can often make-do without a piece of equipment that has gone wrong. The crew can also interpret, and draw correct conclusions from, quite a confused picture on the radarscope. Apart from this a fighter can operate, if need be, under broadcast control, which can only provide crude instructions but is practically unjammable. Finally, visual interception is still possible, especially in daytime when condensation trails can be followed.

The air-to-air missile (AAM) is today the only useful fighter weapon. With it, the chances of hitting a bomber on the first pass are great. And a hit is a kill. An added advantage is that many modern AAMs are unjammable. In this category are the U. S. Genie, a free-flight (unguided) rocket relying for effectiveness on the wide area covered by the blast and heat from its nuclear warhead; the U. S. Sidewinder and the British Firestreak, which have heat-seeking (infrared) passive homers.

It is true that an infrared-homing AAM can be diverted by the release of a decoy, such as a high-intensity flare.

But in practice this will hardly be possible.

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These can be launched from beyond the range of present-day anti-aircraft rockets. SAMs could be given a new lease of life by using them in an outer defense screen — so far away from likely targets that the bombers could not launch their ASMs from outside the defended zone.

In other words, while a ring of Nike sites around Washington, D.C., does not seem to make much sense, except as a short-term measure, a line of sites in the Canadian North might serve a purpose. SAMs will continue to be useful against unmanned bombers, such as Snark or Matador. The U. S. Hawk reputedly has proved its worth against low-flying aircraft.

The Summing-Up

Let us return briefly to the unmanned fighter, and specifically to the Bomarc. Compared with the best manned fighters now flying, Bomarc has the advantages of being faster, cheaper to build, and cheaper to maintain.

On the other hand it has a shorter range, it is a much less flexible weapon and, above all, it lags behind in intercept capabilities.

There may be a place in the air defense scheme for unmanned fighters, but as things stand, in view of ECM, they cannot be a substitute for manned fighters for as far as we can see into the future.

Just as today a retaliatory attack could effectively be made by manned bombers alone, but not by ballistic missiles alone, so active air defense, within its present limitations, could be conducted with manned fighters alone, but not with missiles alone.

Nike-Zeus Guidance

Contract amounting to \$6.7 million has been awarded Lear Inc., Grand Rapids, Mich., for development of an advanced gyroscopic system for guidance of the Nike-Zeus anti-missile weapon. Contract was awarded by Bell Telephone Laboratories which is developing the Zeus in association with the Western Electric Co., prime contractor. Douglas Aircraft Co. Inc. is developing the Nike-Zeus airframe.

Washington report suggests USAF considering cease-production of the Bomarc

up with wrong guidance instructions for the missile.

Missiles with organic radar may lock on to the false signal. This would be most probable in cases when the ECM transmitter is carried in a decoy drone, launched from the bomber after the ECM operator has determined the characteristics of the enemy radar. The McDonnell Green Quail is a drone of this kind, which serves both as a means of active and of passive ECM (with the help of such devices as corner reflectors or Luneberg lenses a decoy can be made to appear on the radarscope as a big aircraft).

Any modern bomber force would undoubtedly include a number of aircraft assigned to combat the defenders' early warning, directional, and fire control radars. Apart from ECM receivers and transmitters these aircraft would carry decoys, and air-to-ground missiles designed to home on ground radars. The Northrop Crossbow is an example of such an antiradar missile.

In the light of these developments there would seem to be some doubt about the effectiveness of the defense missile adopted by Canada.

Bomarc Versus ECM

In flight the Bomarc is command-guided by two ground radars. Both can be subject to interference. So can the missile's active homing radar which takes over for the last stage of the flight. In recent tests a Bomarc was guided to a target by instructions from a SAGE control centre more than a thousand miles away. This is an impressive achievement, but clearly of little practical significance unless we are told that a hit was scored in spite of determined ECM.

Reports from usually well-informed sources in Washington indicate that the USAF wants to have another look at the Bomarc to determine whether it is worth while continuing with its production. If there are doubts, they could stem from the fact that Bomarc is vulnerable to ECM.

There is a good deal that can be done to counteract ECM. A whole science of counter-electronic-counter-measures has developed, based on progress in radar design in recent years.

The ECM battle is one of wits. The intelligent ECM operator in a bomber has a definite advantage when working against missiles — but not necessarily when his adversary is an equally skilled and intelligent radar operator in a fighter. For just as a missile has no tolerance for malfunction of any

of its parts, so it cannot tolerate equivocal guidance instructions.

An aircraft crew can often make-do without a piece of equipment that has gone wrong. The crew can also interpret, and draw correct conclusions from, quite a confused picture on the radarscope. Apart from this a fighter can operate, if need be, under broadcast control, which can only provide crude instructions but is practically unjammable. Finally, visual interception is still possible, especially in daytime when condensation trails can be followed.

The air-to-air missile (AAM) is today the only useful fighter weapon. With it, the chances of hitting a bomber on the first pass are great. And a hit is a kill. An added advantage is that many modern AAMs are unjammable. In this category are the U. S. Genie, a free-flight (unguided) rocket relying for effectiveness on the wide area covered by the blast and heat from its nuclear warhead; the U. S. Sidewinder and the British Firestreak, which have heat-seeking (infrared) passive homers.

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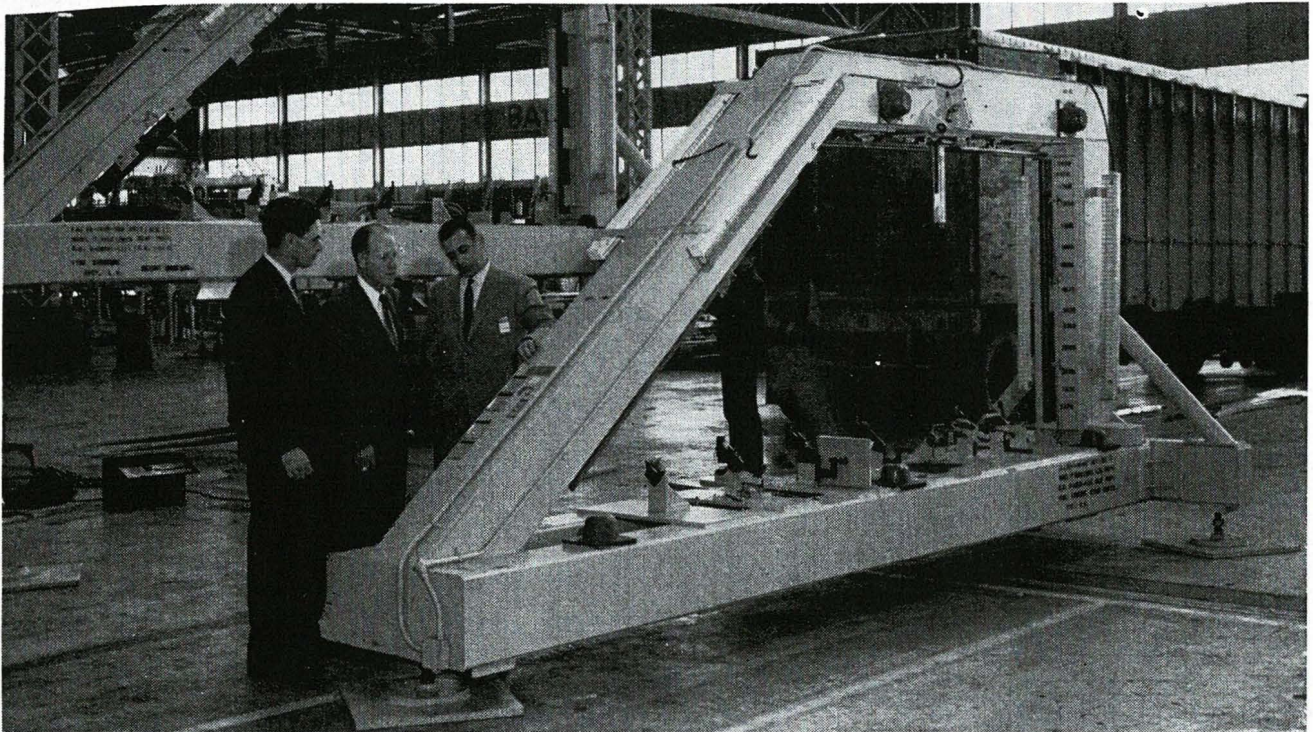
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BOMARC PRODUCTION JIGS being shipped from the Seattle plant of the Boeing Airplane Co., for Canadair Ltd., Montreal. In the foreground is a Bomarc wing jig being examined by (left to right); J. E. Shaw (Canadair), with R. A. Neale and L. DeDonato (Boeing). Canadair has a \$1,702,000 contract to build wings and ailerons for 78 Bomarcs.

Bomarc B Testing

The Model B Bomarc, advanced 400-mile-range version of the Boeing ground-to-air missile, is being subjected to component reliability tests at Larson AFB, Moses Lake, Washington. A dozen or so of the interceptor missiles, produced at the Seattle plant of the Boeing Airplane Co., will be fired while locked in a special harness at the test station. The test site is owned by the USAF and operated by Boeing. For the first of the test firings of the solid propellant rocket engines, a test vehicle will be used; then the actual missile will be used for the remainder. The firings will create about the same amount of noise as an 8-jet B-52 bomber taking off with water injection, and will each last for about half a minute. The tests will duplicate as far as is possible the conditions under which the missile's components will have to operate during the initial boost or rocket phase of its flight.

Direct Hit Hawk

A Hawk ground-to-air missile carrying an explosive warhead scored a direct hit on a Lockheed XQ-5 Kingfisher target missile traveling twice the speed of sound, in a recent test over the White Sands, N.M., desert proving ground. In fact, a direct hit is not necessary for destruction of the target. The Hawk is built by Raytheon, as prime contractor, with Northrop Aircraft as a major subcontractor. The Kingfisher, one of the fastest U.S. target missiles, is built at the Lockheed Missiles and Space Division, at Van Nuys, Calif.

Minuteman Jobs Going

A contract for \$77 million for a subsystem in the USAF's Minuteman program has been awarded to the Thiokol Chemical Corp., Bristol, Pa. It calls for research and development of three stages of the Minuteman solid propellant rocket propulsion system. Thiokol president Joseph W. Crosby said that some 61% of the work under the contract would be subcontracted with a large portion going to small business concerns employing 500 or fewer people. Minuteman is the USAF's second generation ICBM, now in its early development stages.

Rat Eliminated

The U.S. Navy has canceled its Rat rocket-propelled torpedo program before it had reached production stage. Elimination of the Rat, according to the navy, was due to the fact that superior anti-submarine weapons are under development. Rat was designed to be launched from a destroyer and propelled to the vicinity of the target by rocket motor. Then it would drop to the surface of the sea by parachute and seek out its target beneath the surface by means of a homing device.

Better Mouse Trap!

An air-conditioned and pressurized capsule suitable for carrying a mouse into orbit in space has been built by the AiResearch Mfg. Div. of the Garrett Corp., Los Angeles, Calif. Weighing five pounds and carrying a 30-day supply of pure oxygen, the capsule has been designed in anticipation of future missile industry requirements.

Commonwealth Space Meet

From August 27-28 this year, a Commonwealth Space Flight Symposium is being organized in London, England, by the British Interplanetary Society. This is the first meeting of its kind and follows a suggestion at the 9th Congress of the International Astronautical Federation, held at Amsterdam last year. There it was decided to set up a Commonwealth Astronautical Committee to assess the possibilities of Commonwealth countries engaging in joint activities in the astronautics field. The Commonwealth symposium precedes the 10th Congress of the IAF, to be held at Westminster, London, England, from August 31 to September 5 this year. The Canadian Astronautical Society is represented on the Commonwealth Astronautical Committee, along with societies from Britain, South Africa and India.

Rapid-Fire Atlas!

Line of mechanical ground support and launching equipment for the Atlas ICBM, which eliminates the need for the familiar 13-story gantry tower, has been designed and phased into production at Goodyear Aircraft Corp.'s Arizona Division. The new equipment is to be used at Atlas bases being readied for operation by SAC. Goodyear developed the equipment under a series of contracts let by the Convair Astronautics Division of the General Dynamics Corp. It permits rapid erection of an Atlas to the launch position and quick positioning of the next missile following a firing.

Canadian

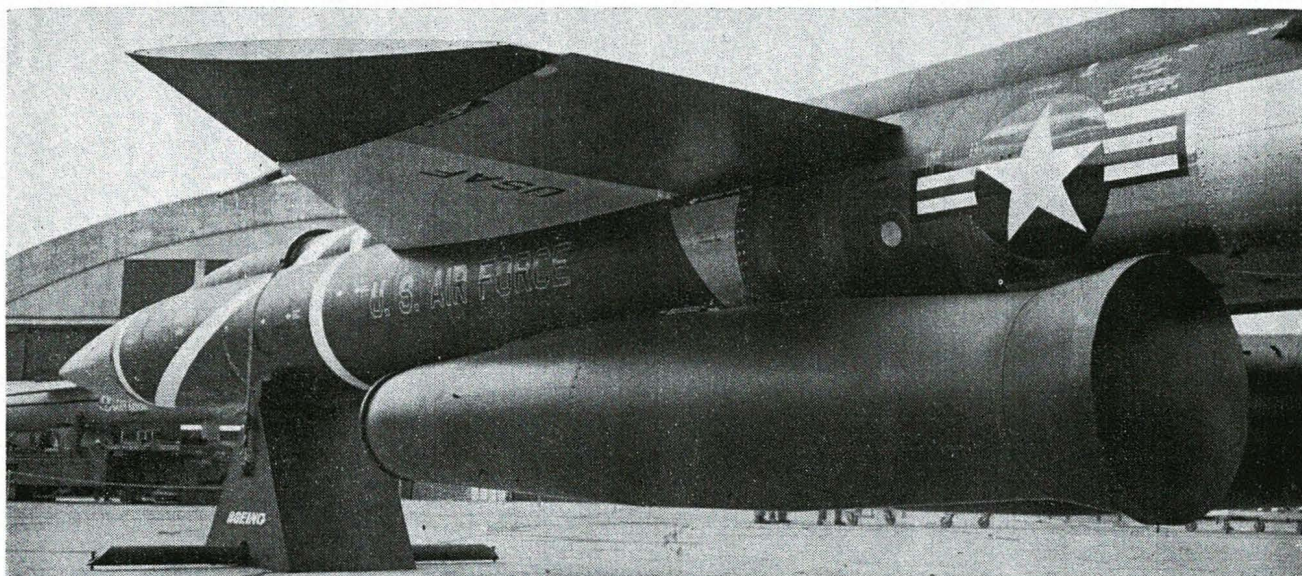
MISSILES and ROCKETS

Serving the Astronautics Industry

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Tomorrow's Weapon
Today

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MISSILE WING CONTRACT. This view of the Boeing Bomarc shows details of the wing and aileron, subject of a \$1,702,000 contract awarded to Canadair Ltd., Montreal. The blunt-edged wingtip type aileron is painted black.

Missile Parts for Canadair

The recent discussions held in Ottawa with a view to Canada obtaining a larger share of the manufacture of equipment for the North American Air Defense Command, have apparently borne the first fruit.

To Canadair Ltd., Montreal, has gone the first Canadian contract, worth \$1,702,000, to build parts for Boeing Bomarc ground to air missiles.

The Bomarc is the unmanned interceptor slated for use by the RCAF, and there are plans for two missile launching bases in Southern Ontario and Southern Quebec under a plan announced by Prime Minister Diefenbaker last September. But it is understood that the missiles involved in the Canadair contract are consigned to the USAF, and do not include any destined for the RCAF.

The contract is for wings and ailerons for 78 Bomarcs, which are being built by the Boeing Aircraft Company,

of Seattle, Wash. Under the terms of the contract, 15 of the 78 sets are to be sent to Canadair in sub-assembly form and six as detailed parts. The rest are to be produced entirely by the Montreal company. Wiring and moving parts are included in the contract.

The tooling for the project is being supplied to Canadair by Boeing, and is due to arrive in Montreal early this month. The completed components are to be delivered progressively from May to November.

Canadair, which is a subsidiary of the General Dynamics Corp., Wash., D.C., estimates that the \$1,702,000 contract will occupy an average of about 150 of the plant's 9,500 present employees for seven months. No new employees will be required.

Under an earlier contract, Canadair assigned about 180 of its missile engineers and technicians to the Boeing

company for a year, to work on the Bomarc project in Seattle and in Florida.

Canadair has had experience in the missile field since 1951 when it undertook development of the all-Canadian Velvet Glove air-to-air test vehicle, and assembled an expert team of several hundred scientists and technicians from various countries. In 1957 the company received a contract for production of the Sparrow II for the RCAF, but that plan was terminated last September.

The USAF Bomarc, a missile designated IM-99A, is 46 ft. 7 in. long and 3 ft. in diameter. It has two wings of semi-Delta shape, each with a maximum fore-and-aft length of 12 ft. and width of about 4 ft. 7 in. From these are extended the ailerons with a maximum length of 6 ft. 9 in. and width of 3 ft. 4 in.

Canadians Boost Bomarc

The team of about 180 Canadian missilemen loaned under contract from Canadair Ltd., Montreal, to Boeing Airplane Co., Seattle, Wash., are working on the advanced model "B" of the Bomarc anti-aircraft missile, which it is assumed the RCAF will receive for NORAD duties.

Robert H. Jewett, chief engineer of Boeing's Pilotless Aircraft Division, said the company was enthusiastic about the increased ability the Canadair men had given them. He said they were "extremely capable" and were "making their weight felt in increasing the tempo of our productivity."

Jewett said that even more important than the direct Canadian contribution to the Bomarc program was the talent-sharing agreement itself. "I think all of us appreciate the significance of the international agreement under which Canadians and Americans joined forces to defend our continent within the North American Air Defense Command," Jewett added. "But while NORAD gives us a strategic and tactical operational unity, the Canadair-Boeing contract is an extension of that military partnership principle into the industrial field. Now we can pool the technical knowledge of the two countries in the development of weapons for NORAD."

The Boeing chief pointed out that Canadian engineering help with the Bomarc program is by no means a one-way street. "The arrangement, we feel, is equally helpful to Canadair and the Canadian defense effort," he said. "Canada has no defensive missile weapon system comparable to Bomarc. Consequently, there is little opportunity for the Canadian aircraft industry to gain experience in this field. Working with us on Bomarc provides this experience. Furthermore, the experience gained by those engineers in development work on improved components might be useful to Canadair later. It would give Canadair better chances to bid on the development and production work of the advanced components."

Jewett emphasized that the Canadian scientists and engineers in no way lose their Canadair identity. They are paid by Canadair and will return to that company at the expiration of the contract. This extends through Dec. 31, 1959, and can be kept in effect after that date by mutual agreement. Canadair is being reimbursed by Boeing for the services of the Canadians.

The work of the "lend-lease" engineers is in virtually all fields associated with missile development and operation. The largest group, 102 engineers and scientists, will work in Seattle on design and analytical elements of the program. The Bomarc target seeker group, flight control, stress, applied physics, system performance, electrical power, hydraulic

control, autopilot and base design are typical of the units in which these engineers are assigned.

The test phase of Bomarc operation is the task of 61 of the Canadians. Many of these men are assigned to Florida for Bomarc firing activities. They are serving as firing engineers, data system designers, telemetry engineers and weapon control equipment specialists, to name just a few of the assignments. Engineering phases of production work round out the duties of the remainder of the Canadians. Tool planning, quality control and manufacturing liaison are typical of the responsibilities in these areas.

Investigating Mars

An electronic tube developed by International Telephone and Telegraph Corp., an associate company of Standard Telephones and Cables Mfg. Co. (Canada) Ltd., Montreal, Que., will be used in an effort to determine whether there is enough water on Mars to support life. The tube is of the multiplier phototube type, which converts light into an electrical signal and amplifies the signal about two million times. It has been installed by the U. S. Office of Naval Research in a 16-in. telescope scheduled to be trained on Mars from a balloon laboratory 80,000 ft. above the earth, where the atmosphere will not interfere with the measurements.

The multiplier phototube will amplify sunlight which has been reflected off the surface of Mars and has therefore passed through the Martian atmosphere. Scientists will study the infrared portion of that light to determine what part of it has been absorbed by water vapor, if present, in the Martian atmosphere.

Speeds Atlas Countdown

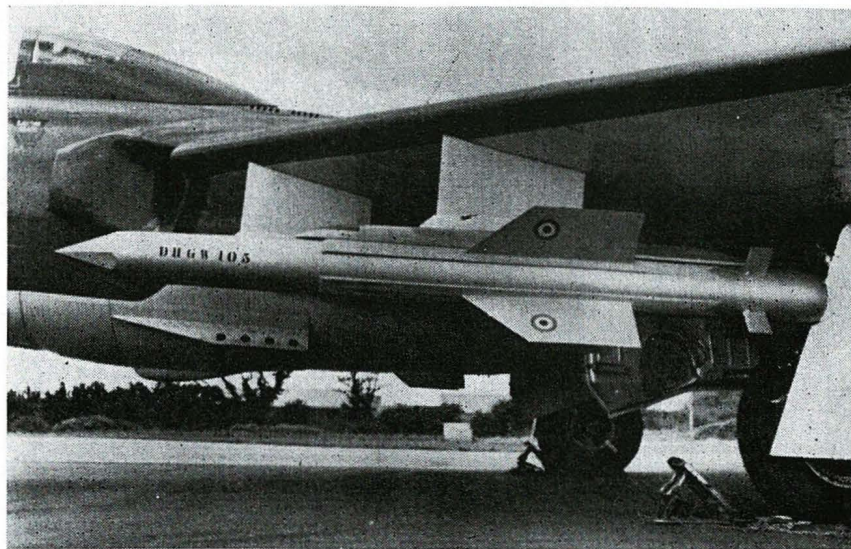
Development of a propellant-loading system claimed materially to shorten the countdown time in firing liquid fuel missiles is announced by A. D. Little, Inc., Cambridge, Mass., and Honeywell Controls Ltd., Toronto, Ont. The system, first used for any U. S. missile and developed primarily for the Air Force's 100-ton Convair Atlas ICBM, makes possible the rapid automatic transfer from launching-base storage tanks of propellants with which the huge vehicles are charged. Human error is eliminated by the instrumented system, considerably increasing accuracy and reliability in fuel transfer, according to its developers. Honeywell's Missile Equipment Division in Pottstown, Pa., took a prominent part in development of the control system under contract to A. D. Little, a prime contractor to the USAF Ballistic Missile Division.

Tests Bomarc Parts

Lockheed Missile Systems division has been awarded a USAF contract to continue flights of the recoverable X-7 ramjet test vehicle through 1959. The amount of the contract is expected to be in excess of \$8 million. The X-7 tests out ramjet engines and other components used on advanced interceptor missiles such as the Boeing Bomarc. Built at Lockheed's Van Nuys, Calif., plant, the X-7 is the fastest (more than four times the speed of sound) and highest-flying air-breathing missile in the U. S. It is launched from an aircraft and is guided in flight from a ground command post. Most of the ramjet engines tested by the X-7 are produced by Marquardt Aircraft in Van Nuys.

Automatic Regulus

The Bell Aircraft Corp.'s automatic all-weather aircraft landing system, developed for use aboard aircraft carriers, has successfully landed the Regulus II recoverable surface-to-surface guided missile.



VIXEN'S BITE. The infra-red homing air-to-air Firestreak missile, designed by de Havilland Propellers Ltd., fitted to an all-weather de Havilland Sea Vixen.

editorial

Public Grievously Misled About Cost of the Bomarc

There was speculation in British newspapers last month that the Canadian CF-105 Arrow might be bought for the Royal Air Force. This was flattering and encouraging to Arrow supporters, for it served as an endorsement of the airplane's suitability for a modern defense system.

But no one connected with aviation in Canada or in Britain took the rumor seriously. They realize that to any mature and seasoned government matters of defense and economics are inseparable.

Much as the British government might be impressed with the Arrow, they are also conscious of the necessity for a healthy defense industry within the U. K. And the British aviation industry is hungry for military aircraft orders.

Mr. Diefenbaker would do well to study the attitude of the British govern-

ment in this respect—and to think again on the Arrow and the Bomarc. He should look particularly at the cost of the two systems. For if he has been advised that the Bomarc will be cheaper he has been grossly misinformed. And as a result the public has been grievously misled.

The figures below show our estimated costs for the different systems to give comparable defense coverage. That is for substantial equipment of RCAF squadrons with the CF-105; or alternatively for construction and equipment of ten Bomarc sites.

It will be seen that the Bomarc is the more costly proposition, as must be obvious to anyone with a knowledge of aviation and missilery. For the Bomarc, like all present-day anti-aircraft missiles, is limited in coverage, is costly, and is a one-shot expendable article.

Comparative costs to Canadian defense of the interceptor or missile programs

Avro CF-105—sufficient quantity for squadron service.

Already invested	\$403 million
Production of Arrow with U. S. missile and fire control	\$900 million
Sage system (necessary for both aircraft or missiles)	\$100 million

Total \$ 1,403 million

Boeing Bomarc — construction and equipment of ten installations.

Already spent on CF-105 (Must be included as part of over-all defense investment)	\$403 million
Ten Bomarc installations .	\$820 million
One thousand missiles (100 per squadron) estimated at	\$400 million
Sage system (necessary for both aircraft or missiles)	\$100 million

Total \$ 1,723 million

These costs would probably be projected over about the next five years. This represents a future outlay of about \$200 million per year for the Arrow, and about \$244 million per year for the Bomarc missile. For an additional \$300 million on top of the estimated Bomarc costs, the full Arrow-Astra-Sparrow system could be supplied to all RCAF Squadrons.

aviation intelligence

Defense Policy Shift

Cabinet level decisions on Canada's defense program announced late last month have placed the Royal Canadian Air Force on a course out of the manned-aircraft field and into the all missile defense era. Highlights of Prime Minister Diefenbaker's outline of defense policy:

No immediate production of the Avro CF-105 Arrow but continuation of the present development program on airframe and engine until next March at which time a further decision will be made in the light of existing circumstances.

Cancellation of the Astra navigation, flight and fire-control system and also of the Sparrow 2 air-to-air missile designed specifically for the Arrow weapons system.

Purchase of Boeing Bomarc ground-to-air missiles to be put into service by the Royal Canadian Air Force, initially at two bases—one in Northern Ontario, the other in Quebec.

Improvement and extension of the Pinetree radar line to include increase of range and coverage and installation of SAGE system for plotting and guidance of weapons.

Determined effort to integrate U. S. and Canadian defense production programs under the joint North American Air Defense system concept to ensure Canadian industry participation in the Bomarc and future programs.

If the Arrow goes into production it will be with an existing fire-control and missile system of U. S. design.

Free WHEELing

A Wheeler Airlines DC-4 dead-heading overseas for an immigrant charter flight may have come up with something resembling a range record for the aircraft. Originating at Frobisher, Baffin Island, after a regular DEW Line resupply flight from Montreal, the aircraft was scheduled to touch down in Scotland for refueling before going on to Vienna to pick up passengers. Fuel state over Scotland was such that the captain was able to avoid a landing in marginal weather and press on to Vienna direct. Total flight mileage was about 3,700 miles, airborne around 17 and one half hours.

DECCA in Canada

Future operation and development of the Bendix-Decca air and sea navigation system in Canada was understood to be under consideration by top level Department of Transport officials at press time. Indications are that DOT will place prime emphasis on marine navigation coverage in any immediate extension of the present three-chain network which covers a 1,000,000 square mile area from Newfoundland to Eastern Quebec. However, the most logical addition to the system, a link providing marine coverage of the treacherous but vital Strait of Belle Isle and Anticosti Island region would be located so as to provide Decca air coverage for Goose Bay. This would provide full Decca coverage of the Canadian air ap-

proaches off the main North Atlantic air routes now served by the long range Decca navigation system. Discussions scheduled for sessions of the International Civil Aviation Organization early next year as seen as crucial to over-all acceptance of the Decca system by the world's air operators.

CL-41 Roll-Out

Canadair's CL-41 pure jet basic trainer is scheduled to roll out of the company's Montreal plant about the middle of next month (Nov. 14 is the specific date on Canadair's production program). The company is building an initial two aircraft as a private venture. They are to be powered by a Fairchild J-83-R-1 lightweight turbojet engine, a power plant which has seen service in target drones but is getting its first aircraft installation in the Canadair ab-initio trainer.

Canadian Bomarc Link

A long range communications system which is to provide a vital link in the United States Bomarc "B" ground-to-air guided missile installations has been developed by Canadian Westinghouse Co. Ltd. of Hamilton. Consisting of super high frequency scatter equipment that sends signals beyond the horizon, the system will be used initially in the establishment and testing of ground control in the missile defense organization. The order received by the Canadian company is for a multi-channel voice and radar link to be installed as part of the control system. It is a part of a \$10,000,000 contract awarded Westinghouse Electric Corp. in the U. S. by Boeing Airplane Co. of Seattle, prime contractor on the Bomarc project. The Canadian firm's work on the communications system is expected to eventually amount to about \$1,000,000. Interest in the lightweight scatter system engineered and built by Canadian Westinghouse has been indicated by Sweden and South American countries.

Twin Pioneer Demonstration

Scottish Aviation Ltd. of Prestwick is making plans for demonstration of a Pratt & Whitney engine powered Twin Pioneer in Canada next spring. No definite date has yet been set for the demonstration, but the company is understood to be contemplating a determined selling effort on the versatile STOL aircraft in North America. The conversion from Alvis Leonides engine is understood to be under way.

F-27s to Quebecair

Quebecair Inc. has taken delivery of its two F-27 Friendship turbo-prop airliners from Fairchild Engine and Airplane Corp. The Quebec carrier, with headquarters at Rimouski, has announced plans to have the Rolls-Royce Dart powered aircraft in service on its routes later this month.

OCT 1958

Members See Arrow

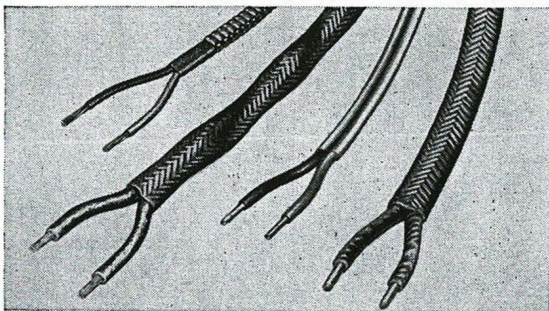
Members of the House of Commons who visited the Avro Aircraft plant at Malton recently saw the third of five CF-105 Arrows that have now left the production line. The machine is scheduled to fly early this month. The MPs were members of the Estimates Committee which was in special session at the Avro factory. The chairman Arthur Smith, a former air force officer and test pilot, said they were favorably impressed with the plant and the CF-105. The meeting was addressed by J. L. Plant, President and General Manager of Avro Aircraft. Speaking of apparent high cost of the Arrow and its components, Plant gave some revealing figures on the CF-100. He said cost of the 600 of so aircraft produced, including development costs, was \$50 to \$60 million less than it would have cost Canada to buy comparable aircraft from the U. S. It was the third meeting the Estimates Committee had held at Canadian plants. Previous meetings were at Canadair Ltd., Montreal, and Canadian Vickers Ltd.

Multi-Purpose Missile

United States sources indicate approval for a program to develop a ballistic missile of advanced type on which operational range can be varied between 500 and 5,000 miles. To be fired from underground installations located far enough apart to ensure all could not be knocked out in an attack, the Minute Man project would provide a versatile, many-purpose weapon.

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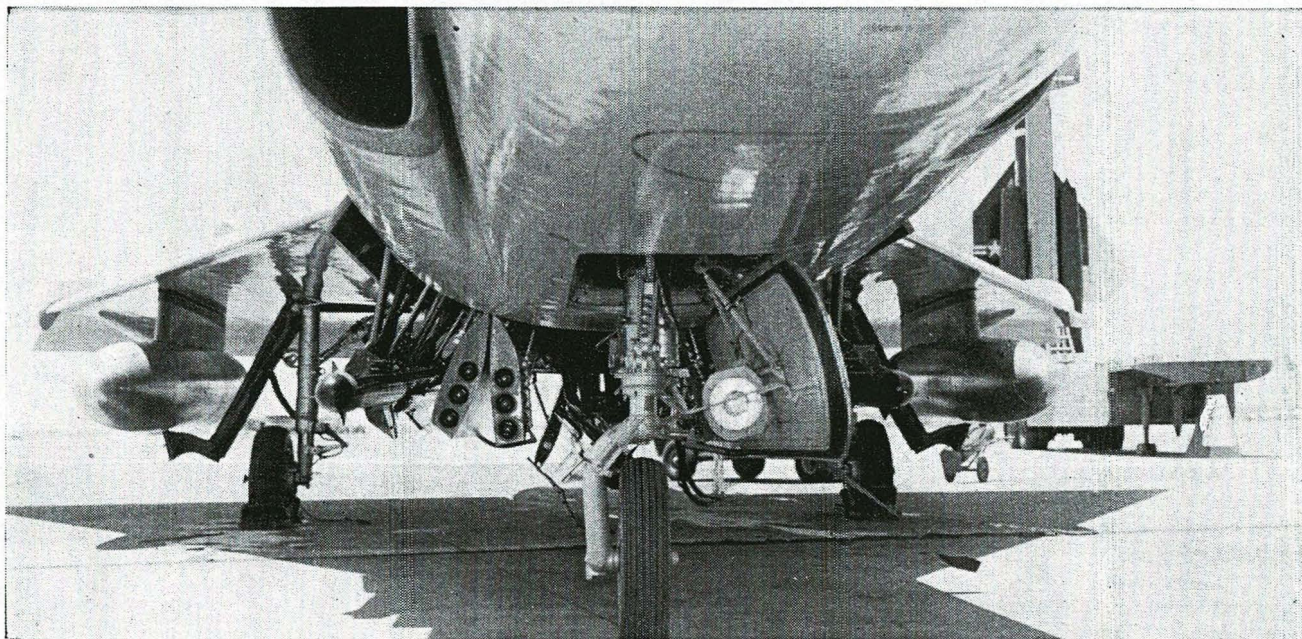
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ENGLAND.

Missileanery



NORAD DEFENDER. Weapon complement of this USAF Convair F-102A includes six Hughes Falcon air-to-air missiles (two of them are seen just inboard of the main landing gear) and 24 folding-fin rockets. Six of these are seen in the drop-down fuselage containers to the left of the nose wheel. F-102A also carries the glass-nosed, infra-red Falcon.

International Astronautics

Representing the Guided Missile Division of the de Havilland Aircraft Co. of Canada Ltd. at the forthcoming International Astronautical Federation Conference in Amsterdam, will be A. E. Maine, firm's Senior Electronics Development Engineer. The August conference is expected to be one of the most high-powered scientific events of the year. Papers will be presented by experts from many nations, including Soviet Russia. Mr. Maine is secretary of the Canadian Astronautical Society.

Call For Versatility

Single-purpose missiles are not practical or economical, members of the American Rocket Society were told at a recent meeting by Ronald R. Smelt, director of research and development for Lockheed Missile Systems division. Smelt called on U. S. missile makers to build versatility into their products so that they could maintain an efficient and ready missile arsenal that would not rapidly become obsolete. He cited the Lockheed Polaris as an adaptable missile. Its solid fuel engines permit ease of handling and storage plus readiness for rapid firing.

First Bomarc Base

Boeing Airplane Co. has awarded a \$3½-million contract for the installation of mechanical and electronic support equipment at the first U. S. Bomarc missile base at McGuire AFB, near Trenton, N.J. Work will begin in November.

Missile Procurement

U. S. missile procurement has increased from 10 percent of air force spending in 1954, to 35 percent in 1958. Progressively bigger proportion increases are expected, with 50 percent missile procurement estimated for 1959.

Propellant Research

Thiokol Chemical Corp., Utah Division, has placed a contract with the Budd Co., Philadelphia, Pa., for study of missile propellants. Contract covers research and evaluation of methods for the non-destructive testing of solid-fuel propellants. Thiokol recently completed a basic development contract on a packaged liquid rocket powerplant for the U. S. Navy Department two and a half months ahead of schedule. Unit includes propellant tanks and thrust chambers. It is shipped complete with factory-loaded propellants and can be maintained in a ready state for extended periods.

Reducing Missile Weight

As part of a research project being conducted with the Convair Division of General Dynamics Corp., by Bettinger Corp., of Waltham, Mass., a new alloy is being given a ceramic coating to achieve weight savings. Magnesium-thorium, said to be lighter and stronger than aluminum or magnesium, is being given a ceramic coating of .001 to .002 in. thickness for missile applications. This helps protect the comparatively soft metal against loss of strength at high temperatures, and provides resistance against oxidation and erosion.

Mine Safety Methods

Mine Safety Appliances Co. of Canada Ltd., Toronto, reveals that specially designed infrared gas and liquid analyzers, developed by the U. S. branch of the firm, played a safety role in the launching of Explorer III. These devices serve as continuous monitors of the hydrocarbon content in the liquid air, nitrogen and helium streams with which missiles are fueled and pressurized. Should the hydrocarbon content of any of the streams approach a critical explosive point, the whole operation is automatically shut down. Three such instruments were used during the launching of the Jupiter C which sent Explorer III into orbit.

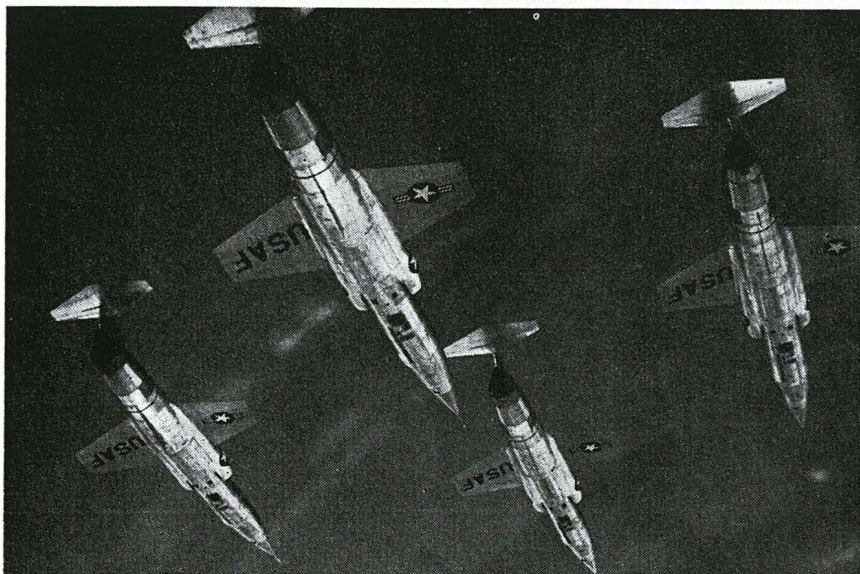
Bloodhound Abroad

Bristol/Ferranti Bloodhound, the RAF's first surface to air guided weapon, was seen at the NATO Air Displays in Belgium and Holland last month. Bloodhound was airlifted with its transporting and loading trolley by Blackburn Beverley.

Astronautics Library

Library of the Canadian Astronautical Society now contains about 30 books on rockets and allied subjects. There are also some 60 magazines and reports of proceedings of other astronautical societies, most of them having been donated by the British Interplanetary Society. The Canadian Society has made application for membership of the International Astronautical Federation.

Missileanery



MISSILE-MOUNTS! Lockheed F-104A Starfighters pose for the first time in formation. They will carry air-to-air Sidewinder missiles on their wing-tips

British Nuclear IRBM Under Development

Named prime contractor for the intermediate-range ballistic missile being developed in Britain is de Havilland Propellers Ltd., Hatfield, Herts. The company is also the co-ordinating authority for construction of the missile, with Rolls-Royce Ltd., the de Havilland Aircraft Co., and the Sperry Gyroscope Co. Ltd., as associated main contractors. Claimed that the ground-launched missile will carry a thermo-nuclear warhead "with extreme accuracy" over a range of several thousand miles to a surface target. Test facilities are being established at several centres in the U. K. for the initial testing of the missile's components. Large steel towers have been erected at the headquarters of de Havilland Propellers at Hatfield, and Rolls-Royce are building a facility for testing the rocket motors in Cumberland. Firing trials will be at Woomera, Australia.

Business Breakdown

Small firms have received more than 20 percent of the ballistic missile dollars spent by the U. S. Air Force. Of the Thor IRBM contract held by Douglas Aircraft Co., some 23 percent, or more than \$18 million, has been distributed among 8,473 different small companies.

Metal For Missiles

New nickel-chromium based alloy developed by the Allegheny Ludlum Steel Corp., Pittsburgh, is designed for applications in aircraft and missile engines requiring high strength at up to 1,600 degrees Fahrenheit.

Bullpup In Production

The Bullpup air-to-surface guided missile, produced by the Martin Co., has gone into production at Orlando, Fla. Development was begun three and a half years ago. In recent test a U. S. Navy pilot destroyed a 4-in.-square smoke pot in the North Atlantic from two miles range with a Bullpup.

Missile Freighter

A Bristol Bloodhound ground-to-air missile was transported by air during a recent exercise in Britain. Aircraft used was a Blackburn Beverly freighter of 53 RAF Squadron. Bloodhounds have been carried aboard Bristol Freighter aircraft in Australia.

Launcher For Drones

The Lockheed C-130 transport has been designated as a universal drone launcher by the USAF. Plane will also be used as the control "office" to direct drone launching manoeuvres, as well as the support aircraft for transporting personnel, the drone operating unit, and other equipment. Two airplanes are to be adapted for test purposes.

Tartar For U. S. Navy

Convair Division of General Dynamics Corp. has been awarded an \$8-million contract for pilot line production of Tartar surface-to-air missiles. A junior version of the Terrier, Tartar will be used on U. S. Navy destroyers.

Missile and Aircraft Attack Simulator

Electronic system designed to test North American defenses against aircraft and missiles has been demonstrated to the USAF by the Sperry Gyroscope Co., Division of Sperry Rand Corp., Great Neck, N.Y. It comprises a micro-wave command system designed for use with supersonic drones. System is being developed under contract to the Air Research and Development Command. It is said to enable a control team on the ground or in the air to track a drone, command its engine and flight controls, and receive flight data. These functions are carried out on a single radar frequency band.

New Missile Division

Establishment of a new unit to be known as the missile equipment division is announced by Minneapolis-Honeywell Regulator Co. This will consolidate Honeywell interests and activities in ground missile facilities in one unit of the military products group. Carl A. Anderson, vice-president of Honeywell's Aeronautical Division in Canada, said the establishment of the new unit increased the scope of the experience and ability upon which the Canadian division can draw. New division is located initially in a 150,000-sq.-ft. plant at Pottstown, Pa.

Re-entry Breakthrough

Re-entry of the ballistic missile cone was first achieved in the U. S. using the Lockheed X-17 test vehicle more than a year ago. Since that time more than 20 nose cones have survived the extreme heat generated by re-entry into the earth's atmosphere. Two of the missile's three stages are used to accelerate the downward plunge into the earth's atmosphere. A telemetering system aboard the missile transmits data on speed, temperature, pressure and other information almost to the point of impact with the earth. The nose cones impacted off the coast of Cape Canaveral.

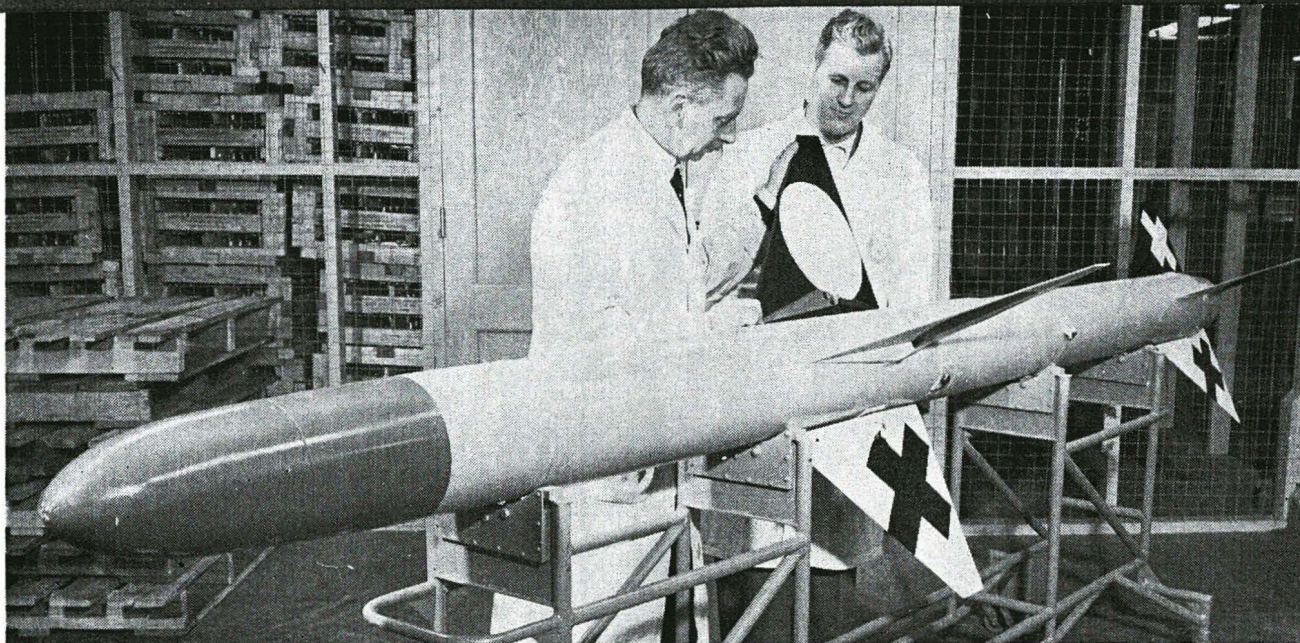
Bomarc Firings

Boeing Airplane Co. revealed that a total of 39 Bomarc interceptor missiles have been fired during the current test program. In the majority of tests the missile has been fired without warhead so that the space could be utilized for instrumentation. Tests will begin soon on an advanced version of the Bomarc for the USAF. This will have a 400-mile range, twice that of the earlier version. The new test program, to comprise a further 35-40 firings will be spread over a period of several years.

Poor Quality
Too Costly
In Missiles
— Page 44

Canadian **MISSILES** and **ROCKETS**

Serving the Astronautics Industry



FIRST PICTURE released by Canadair of Sparrow II in the Montreal plant. Firm has order for immediate production.

Sparrow II Missile Among World's Most Modern

Canadair Ltd., Montreal, has formally announced its selection as co-ordinating contractor for the production of the Sparrow II missile in Canada. Canadair has been jointly commissioned by the Department of Defence Production and the Royal Canadian Air Force to go into immediate production.

The Sparrow II is described as one of the world's most modern, high performance, air-to-air guided missiles. It will be the first Canadian-built operational missile, and will be supplied to Air Defense Command of the RCAF.

Under the terms of the contract Canadair has the over-all responsibility for the manufacture, assembly and flight testing of the missiles. The firm has been engaged in programs in Canada for the development of air-to-air guided missiles for the past seven years. The number of units to be produced is not revealed.

Details of the missile are still on the secret list. But it is known to be rocket-powered and able to fly several times the speed of sound. With its small but powerful rocket motor, and built-in radar seeking system, the Sparrow has a combination of speed, manoeuvrability and accuracy that makes it a match for any present manned operational airplane.

Canadian Westinghouse Co. Ltd., Hamilton, Ont., has been appointed an associate contractor to produce the radar seeking system. Subcontractors on the program will include Aviation Electric Ltd., de Havilland Aircraft Co. of Canada Ltd., and Sperry Gyroscope Co.

The missile is produced under a license agreement between the Canadian Government and the Douglas Aircraft Co. Inc. in California, and with the concurrence of the United States Navy.

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Rocket Engined Airliners

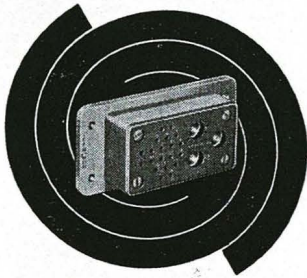
Engineer addressing a recent American Rocket Society conference predicted the use of rocket engines for commercial airliners "in the not too distant future." J. M. Cumming, of Rocketdyne, a division of North American Aviation Inc., said these airplanes would enable businessmen to span the continent for a day's negotiations. He said military applications—combined use of liquid propellant rockets with turbojets — would precede the commercial adaptation. Rocket-powered airliner would connect Los Angeles and New York in 28 minutes, he said.

Guiding The Bomarc

Control Data Corp., Minneapolis, Minn., has been selected to produce computer components for the guidance system of the Boeing Bomarc ground to air missile. Order was received from Lear Inc., Grand Rapids, Mich.

CANNON PLUGS

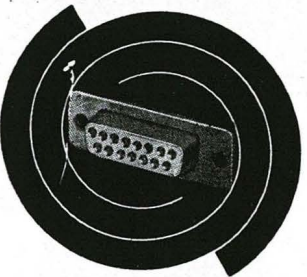
Rack/Panel/Chassis & Miniature



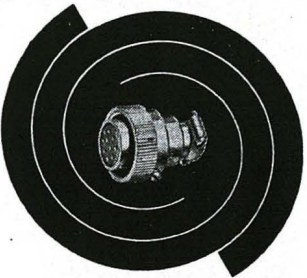
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All above, excepting DPA are fully described in HMC Bulletin; DPD in DP9. Copies from Cannon Electric representatives or factory.



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Brown's M.R.G.

(Continued from page 49)

collaboration with the Institute of Aviation Medicine, the Royal Aircraft Establishment and the Ministry of Supply.

As designed for use with the K-H Flight Data System, the MRG takes just 20 seconds from time of switching on to make the attitude indicator fully operative. From there on the MRG feeds continuous information through 360 degrees of pitch and roll to the system's attitude indicator and also provides gyro-compass headings for the heading indicator. In the K-H developed system, the heading indicator can be changed to accept information for display of an Instrument Landing System, TACAN range and bearing, and TACAN homing by use of a roller-blind.

Advantages of the Master Reference Gyro have been fully explored through the extensive testing which has accompanied development of the K-H Flight Data System. Experienced pilots report no difficulty in running through their complete repertoire of aerobatics with reference only to the flight system's attitude indicator. One claims he finds it easier to "stunt by the system," than to battle around following outside visual references.

Production Lead

The Master Reference Gyro as developed by the S. G. Brown company has now reached what is termed its A5 version. It is said to be the only MRG in production at the present time.

Systems using the Brown MRG have already been installed in British military aircraft. A spokesman for the firm indicated the unit has attracted considerable interest from abroad.

For Farnborough the A5 model MRG was set up on a specially designed test rig which permitted demonstration of the system through the full 360 degrees of pitch and roll with the display showing up on an instrument panel attitude indicator just as it would in the modern fighter cockpit.

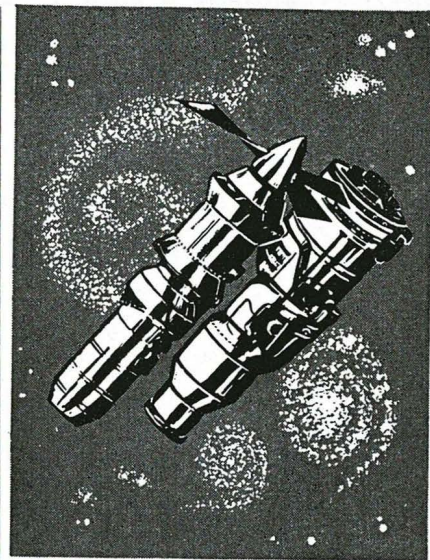
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Bomarc Atomic Study

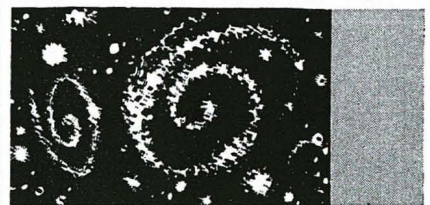
A study to determine the effects of atomic explosions on transistors used in the Bomarc missile is being conducted by the Boeing Airplane Co.

J75 Parts Contract

The USAF has awarded a \$1,300,000 contract to Solar Aircraft Co. for production of J75 jet engine components. These are for the Ford Motor Co. aircraft engine division, which is manufacturing J75's on license from Pratt and Whitney.



LOOKING TO THE FUTURE!



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Supersonic power plant

Ramjet thrust increases with speed

By A. L. Cole

Release of further details of the Bomarc missile is accompanied by news of a production contract of some \$7 million. This is in addition to development costs of more than \$1,000 million. The return of the Bomarc to news prominence has focused interest on the "ramjet" engine, used to provide its power.

Bomarc (BOeing-Michigan Aeronautical Research Centre) of the Boeing Airplane Company, Seattle, Wash., employs two Marquardt 28 in. diam. ramjets. Each of these 500 lb. weight engines produces the equivalent of 50,000 bhp when flying at more than 1,500 mph.

The ramjet engine is essentially a "supersonic" engine. It is unsuitable for use at lower speeds. At the same time it is an engine capable of developing immense power from very low structural weight. Except at very high Mach numbers, it is a short duration engine. Fuel consumption is high and over an extended period engine weight plus fuel weight approaches, and then exceeds, that of conventional high performance engines.

It appears to be a simple engine—little more than a blazing stovepipe. But all the phases of operation of an internal combustion engine are present: compression, ignition, expansion and exhaust.

Compression comes from the slowing of inlet air; conversion of kinetic energy of the relative airstream to the potential energy contained in the pressure rise.

Limitations

It is this essential slowing of the air which presents the inherent limitation to ramjet operation. The vehicle must have a high speed relative to the ambient air before it can function. Therefore it must first be accelerated by another means, such as the liquid rocket motor of Bomarc, solid rockets, or ordinary jet engines. The ramjet engine can not be used on its own.

Power comes from the fuel burnt after injection into the compressed air. As compression and succeeding phases take place continually, unlike the pulse jet or reciprocating engine, burning is at an essentially constant pressure. This accounts for the high potential efficiency of the ramjet engine, together with its low internal

drag, and lack of mechanical losses.

Expansion and exhaust phases take place in the exhaust nozzle.

Usual construction of the engine is simply a casing of circular section which separates dynamic air at different pressures; the ambient pressure of the free air stream, and the compressed air used for fuel burning.

The intake and exhaust are designed to select and eject the correct mass flow of air.

Centrally situated are the fuel injectors. These have devices to assist flame stabilization and to provide proper mixing of the fuel air mixtures. Allied to these is the fuel supply system, initial ignition equipment, and instrumentation devices.

The over-all efficiency of a ramjet engine rises from only 3 to 5 per cent at high subsonic speeds to a peak of more than 50 per cent at about Mach 4. This makes it by far the most suitable engine for vehicles flying at such high supersonic speeds.

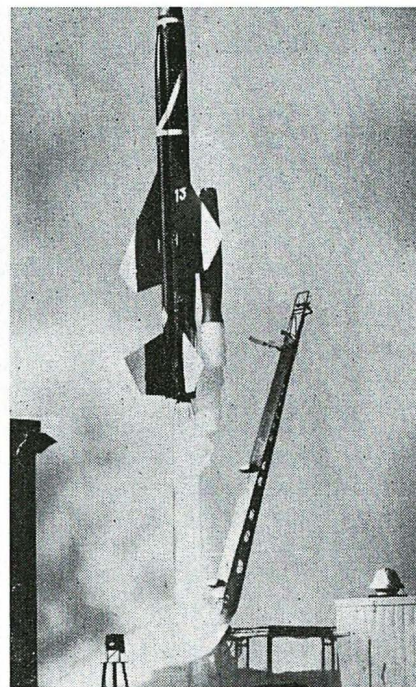
Speed Problems

Other limitations are imposed on this engine. It cannot be operated at too high an altitude, since the low pressure resulting from the low speed (Mach number) causes flame stability problems. At too high a speed at low altitudes, the structure is very heavily loaded by air pressure, aggravated by skin temperature rise. And a maximum speed limit exists. It comes at the commencement of dissociation of the products of combustion which will reduce the temperature ratio through the engine.

Used for aircraft, the ramjet is acutely aware of its installation positioning. Slight blanking of the intakes during manoeuvres can upset the critical intake design. This causes rough running or flame-out. The Bomarc pod mounted installation, requiring two engines, shows the need for considerable compromise.

In the design of a ramjet engine it is possible to accentuate one of two parameters: the thrust-to-weight ratio, or minimum fuel consumption. Thus the engine is differently designed for short or long time operation. Variation of nozzle area has the effect of increasing net thrust (by reducing drag) as the nozzle throat is increased in diameter. But this is achieved at the expense of fuel consumption.

Consumption is lowest when the nozzle area is reduced for maximum



BOMARC leaving vertical launcher at Patrick U. S. Air Force Base, Fla. It was claimed recently to have a longer range than any other missile presently being used in air defense.

expansion of the exhausting jet to nearly ambient pressure at the nozzle exit. Under this condition the fuel/air ratio will be at its best.

The air inlet of the engine is also critical in design. The aim is to achieve a high total pressure recovery. The minimum operating speed will dictate the external shape of the inlet, while the maximum operating Mach number will indicate the supersonic compression achieved by the number of oblique shock waves induced forward of the normal shock wave. Pressure recovery takes place across each shock wave.

Sophisticated engines can incorporate a variable inlet and exhaust configuration. Such a variable inlet is used on General Dynamic's Convair B58 supersonic bomber for its jet engine intakes. The reason is the same, that of optimizing the total pressure recovery.

Ramjet engines are only just coming into their own. It is early therefore to be thinking of the restrictions that will hold back ultimate progress. But the main factor, common to all very high-speed devices, will be temperature increases exceeding the operating ranges of available structural materials.

About the size of a small supersonic fighter, Bomarc has a flight time of about eight minutes. With two-stage guidance it can either destroy the target directly, or release other missiles and return.

Bomarc is therefore a true link between the aircraft of the past and the missiles of the future.

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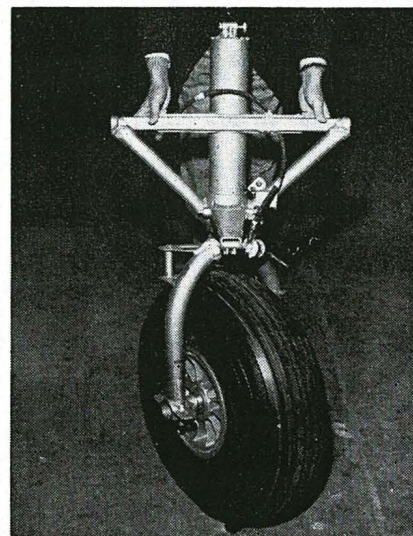
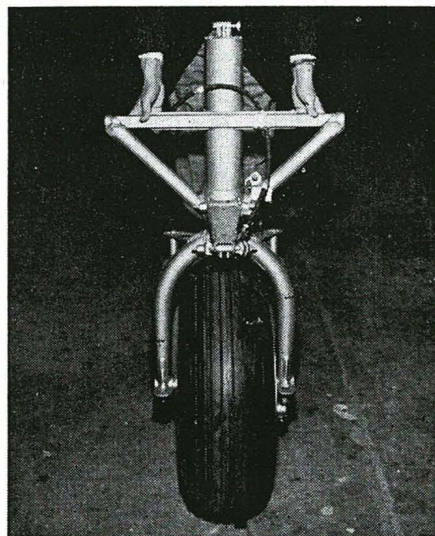
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news digest



SAFETY GEAR. Optional on the new Beechcraft Super 18 is the Geisse Safety Landing Gear pictured above. On the left the gear is shown in normal alignment. Right, it is shown castered outward as in a crosswind landing. The downwind wheel casters on contact with the runway and automatically compensates for crab introduced to correct for drift. With the wheel castered, the plane then swings to a heading parallel with the flight path and the wheel returns to normal alignment.



STING IN THE NOSE. Modified for the U.S.A.F. by Temco Aircraft Corp. this Martin B-57 Canberra will be used as a flying test bed for Bomarc missile guidance systems.

Firebee Record

Newest version of Ryan's Firebee jet drone target missile has set up what is claimed to be an endurance and altitude record. Missile flew to 53,000 ft. and remained aloft for 1 hr. 44½ mins. Three new U.S. contracts, from the navy and air force, have added \$5,250,000 to order backlog of the Firebee.

B-58's Future

Despite doubt as to the future role of the Convair B-58 the USAF will obtain some as SAC B-47 operational replacements. B-58 may also be used as a chemical bomber test bed and for the attachment of a short-range missile.

CPAL Freight

Canadian Pacific Air Lines has broken into the air cargo field on its Europe-Orient runs. Permission through an IATA resolution to offer cargo rates on its polar route via Vancouver to Tokyo comparable to the via India rates of other carriers has CPAL reporting a "steady pick-up" on freight out of Europe. Loads were "practically non-existent" prior to the IATA ruling. The airline is also looking for a heavy cargo volume from Southern Europe to Canada, Mexico and Peru when it becomes the only one-carrier through service linking these points from Lisbon as of June 1.

LINATEX

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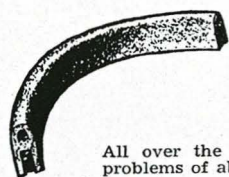
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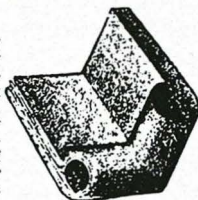
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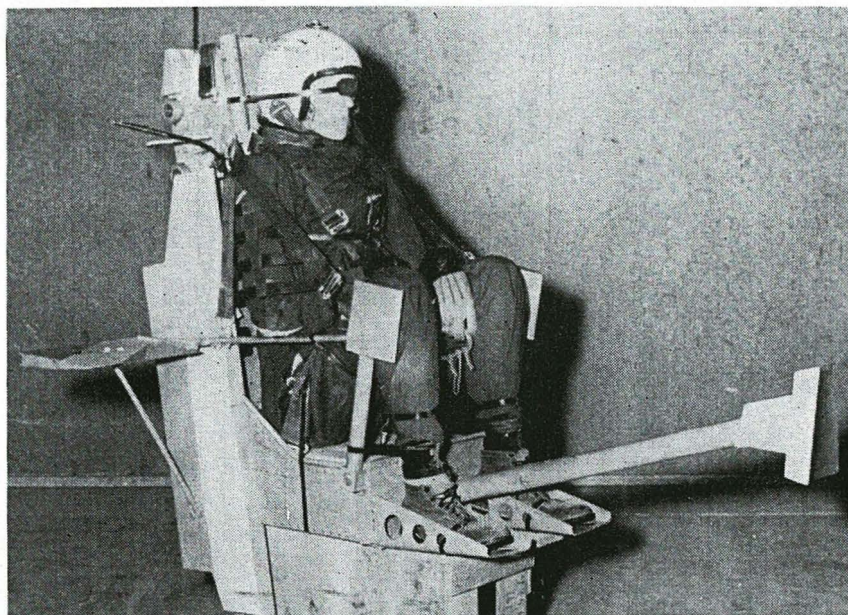
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news digest



FLYING SEAT. Safe ejection from high-speed aircraft is the aim of this parachute seat developed by Lockheed in co-operation with the U. S. Air Force. The protruding deflector guards against windblast, while stability is provided by the stub wings and vertical fins at the rear.

New System

A revolutionary radio navigation system said to possess range and accuracy necessary for common use by helicopters, transcontinental and transoceanic planes and ships has been developed by Sperry Gyroscope Co.

Designated the CYTAC system, it is described as up to 10 times more accurate than other present navigation systems at equal range. Further, it requires only 15 ground transmitters to provide a complete 24-hour-a-day, all-weather air and sea navigation umbrella over the entire United States and adjacent sea lanes.

CYTAC signals, it is said, may be transmitted more than 1,500 miles over land routes and more than 2,200 miles over sea routes. The system has just completed a year-long testing program, results of which are said to have substantiated Sperry's claims for the system. Its features are described as characteristic of the ultimate hyperbolic system predicted by long-range planners as the future common solution of high-density traffic control.

Engine Finishing

Stainless steel jet engine component production is being speeded at the Solar Aircraft Company's Iowa plant by means of tumbling machines. These machines, which look like rotary laundry washers, smooth the edges of large precision assemblies in a quarter of the previous time.

C-130A Contract

A \$20,000,000 contract for the production of C-130A and C-130A-3 turboprop transports has been awarded to Lockheed Aircraft Corp. of Marietta, Ga.

IGY International Meet

The International Union of Geodesy and Geophysics has scheduled its eleventh assembly for Toronto Sept. 3-14. Some 1,500 delegates from 50 countries are expected to attend the conference which will have for its main theme the various world wide projects being undertaken in connection with the International Geophysical Year.

Bomarc Program

Production facilities at the Boeing plant in Seattle are to be utilized for the manufacture of the Bomarc pilotless interceptor. Limited support had been given the broad network of subcontractors by Boeing's Wichita division, but the Wichita facility is now heavily occupied with B-52 production.

Convair Orders

New order for J75-powered F-106A's received by Convair from the USAF amounts to \$70,200,000. Previous USAF contracts for the F-106A supersonic delta-wing fighter, amount to \$146 million. Convair has also announced \$74-million follow-on contract for continued production of J57-powered F-102A's.

Honeywell Autopilot

The first electronic autopilot system developed for supersonic aircraft, Honeywell's MB-3 Automatic Flight Control System, is described in a new company brochure detailing the components as used in the North American Aviation F-100 Super Sabre. Weight of the system is 98 lb. compared to Honeywell's World War II C-1 which weighed 160 lb.