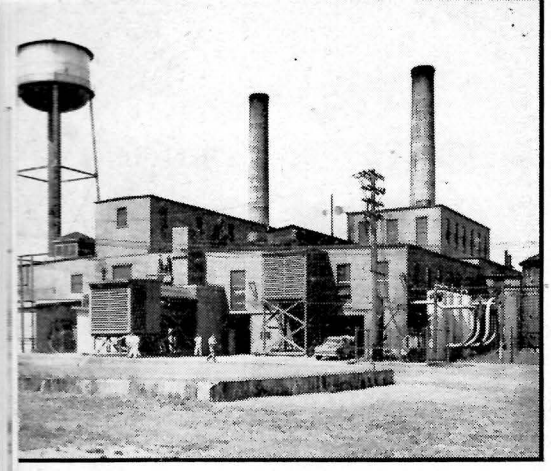
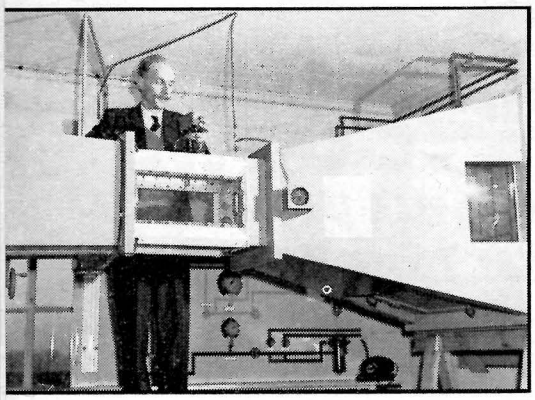
RESEARCH AND DEVELOPMENT

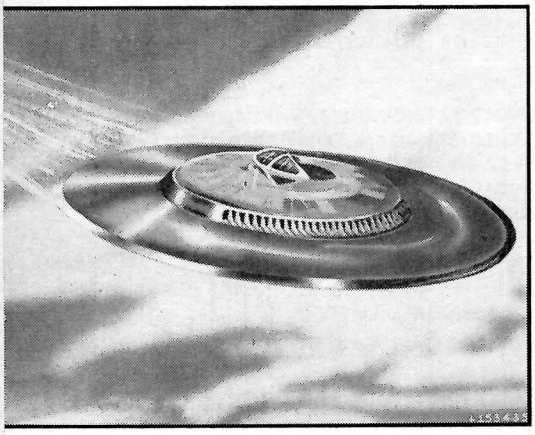
in Canada's Aircraft Industry



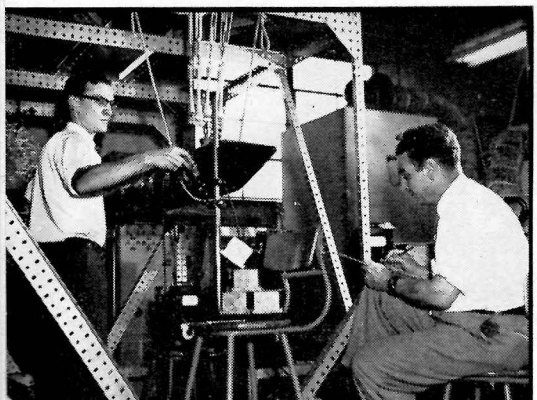
In photo above is gas turbine test & development establishment operated at Nobel by Orenda Engines. Below, Applied Research icing wind tunnel.



Below, USAF artist's impression of VTO disc-shaped aircraft configuration on which Avro Aircraft Ltd. is carrying out research for the USAF.



Below, the torsion rig in Canadian Westinghouse's environmental lab. This rig is used to simulate the stresses encountered during flight.



HOW ACTIVE in the research and development field is Canada's Aircraft Industry, and those members of the Electronics Industry which have an allied interest in the aviation field?

Defence Research Board officials sum up the situation this way: the Canadian Aircraft Industry is weak in research capacity, but strong in development; the Electronics Industry is reasonably strong in both phases.

In the electronics field, all the large companies have in the past few years set up research laboratories. Some of these labs have already paid for themselves by designing and developing products that have resulted in financial returns many times greater than the initial cost of setting up the lab.

Defence Stimulation: Of the research and development work that is going on at electronic and aircraft companies, a large proportion has been stimulated by the defence program. The DRB is of the opinion that it's equally important for industrial firms to inaugurate their own programs. While it is not considered too good to have industry depending entirely on defence programs for sustenance, Government scientific officials are anxious to continue fostering research because it is desirable to have a civilian scientific capability in universities and industry that can be converted to defence industry if necessary.

Though the aircraft industrial research and development capability in Canada has not yet reached very large proportions, the situation is improving, with individual companies slowly building up their facilities. The major deterrent is expense. Although most of the companies are well aware of the importance of research programs, the staggering costs involved are enough to discourage all but the wealthiest of industrial concerns. Still, considering that research and development facilities in the Canadian Aircraft Industry were practically non-existent prior to 1951, there is some evidence that progress is being made to alleviate this situation.

On the other hand, it is significant that the amount spent on research and development in Canada in the past few years is equal to only about 1% of the amount that has been expended on aircraft production. It is generally conceded that to support an aircraft production program properly requires a minimum expenditure equal to about 10% of the amount allotted for production.

Because so much of the research and development work being carried out in industry falls into the class of defence work, little can be said about it without breaching security. However, brief outlines are presented here of the facilities which some Canadian companies are operating. with mention being made of some of the activities going on therein.

Canadair Ltd.: Canadair's Engineering Test & Development Laboratory was officially inaugurated in December 1955. It was formed to obtain the research data necessary for advancement, and the answers on performance capabilities and structural limitations of equipment already in use.

Ben Kaganov, chief structures engineer, is responsible for the Structures and Dynamics Test Sections which include an array of complex machines. Says Kaganov: "Most of this equipment is specially designed to fill a specific need. It is built elsewhere and then brought in. Sometimes though, the situation gets so bad that we have to build our own."

Such a situation arose during the development work on the CL-28 wing. It was discovered that the natural frequency of the wing was down

two cycles per second. Since there was nothing on the market to record such a low frequency, Canadair was forced to develop its own special recording and measuring equipment.

Another department concerned directly with the research and development program is the Engineering Experimental Section headed by Lou Chow. Experimental work carried out in this section involves aircraft, systems, and components. This work extends even to testing component parts manufactured elsewhere under sub-contract.

Canadair's Development department comes under the direction of Chief Development Engineer R. D. Richmond and is broken down into four main sections:

Preliminary Design—where the department is given an initial order for a project. This could be a requirement from the RCAF, or it could be a component part. Depending on its complexity, the project could take from two weeks to two years to complete.

Aerodynamics — under which all wind tunnel testing is carried out. This testing takes place at either the National Research Council's wind tunnel facility at Ottawa, or at the Convair plant in California. Although Canadair recognizes the need for facilities of their own, the ultra-high costs involved in setting up an adequate tunnel are considered to be not justified at present.

Experimental—which performs laboratory tests of all systems in an aircraft prior to flight. This includes hydraulic mock-ups, electrical systems, fuel systems and power plant. In the case of the CL-28, one of the engines was mounted on a specially built test stand. Some 500 hours operating time were logged on this test stand before the engine was installed in the aircraft.

Special Weapons—better known as the Guided Missile Development Facility. Since the government abandoned the Velvet Glove project, the missile engineering set-up at Canadair has been operating at half-steam. Still shrouded in security, the special weapons laboratories seem to be existing for the time when the government decides to get back in the guided missile business. Meanwhile, it is here that Canadair engineers and scientists work out problems in electronic reduction of complicated data on missile performance, the determination of its weight-rolling moment of inertia, and simulation of the missile's operation in flight.

Orenda Engines: A different company with a different set of engineering problems, is Orenda Engines Ltd., at Toronto. Engaged in the mass production of gas turbine engines, Orenda employs more than 5,000 men. Two-fifths of its technical staff, that is: scientists, engineers and technicians, are engaged in research engineering and development work.

The constant need for research in turbine development has resulted in the Orenda company sinking another $7.7 millions into test facilities this year. Included in the multi-million expansion is the construction of afterburner, blade cooling, aerodynamic, combustion and engine altitude test facilities and six additional engine development test cells.

At Nobel, Ont., is Orenda's full-scale engine test establishment. Situated 170 miles north of Malton, the Nobel plant communicates via teletype. Here Orenda engineers seek solutions to basic problems associated with compressors, combustion systems, control systems, turbines and exhaust systems. It is at Nobel where aerodynamic and thermodynamic tests are conducted to prove the theoretical basis of design and to determine the practical limitations of both engines and components. This is accomplished by automatic instrumentation in test equipment. These studies determine the characteristics of blade sections, compressors, turbines and combustion chambers.

At Malton, in the Sir Thomas Sopwith laboratory which came into use

Most impressive development tool in Canada is this B-47, which will be used for airborne development trials of Orenda Engine's Iroquois. The aircraft is on loan from the USAF and is presently at Canadair where modifications necessary for the Iroquois installation are underway.

in early 1955, are five major laboratories. Between these five bodies is divided the research and development work of the company.

Mechanical Laboratory—where complete engines or the major structural components are put under simulated flight load conditions to determine stresses.

Aerodynamics Laboratory — where work centres around the wind tunnel used for aerodynamic investigations of small models.

Materials Laboratory — which contains equipment for chemical analysis, fatigue testing, creep testing, tensile and hardness testing, thermal shock testing and welding investigations.

Instrumentation Laboratory—which has, in addition to other things, facilities for testing specialized electronics devices.

Fuel Systems Laboratory — which features test rigs for all fuel and oil system components and complete systems. It includes also, a temperature controlled, dust-free room for tear-down and assembly of finally machined components.

Avro Aircraft: "Across the road", as the saying goes at Malton, is Avro Aircraft Ltd. Employing as it does, some 8,000 people, it is the largest aircraft production company in Canada. At the present time, the Engineering Division's Research & Development Department is busy with security-ridden labors concerning the company's much-heralded "Arrow." Generally, Avro's R & D department is responsible for a variety of testing activity which can be divided into four sections.

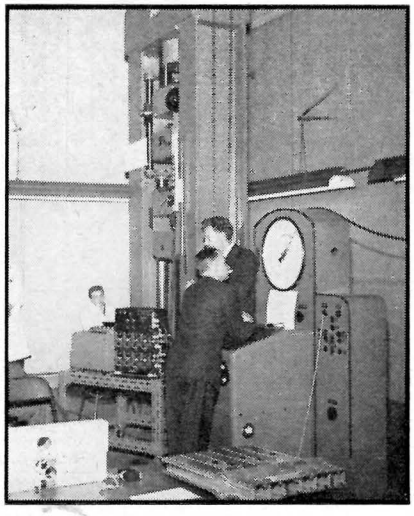
Through their research, Avro metallurgists have produced a corrosion-resisting protective treatment for magnesium alloy. This treatment can be applied in half the time required by previous methods, and makes an acceptable paint base. Before, aircraft structural steel components of 200,000 psi were considered to be of maximum tensile strength. Metallurgy has produced heat treat methods and alloys making steel 30% stronger with no increase in weight.

The second section of the department is the testing of structures, systems and mechanical testing. Starting with the smallest items such as valves and hydraulic jacks, each part of each system is subjected to in flight conditions of load and temperature. To test for such things as metal fatigue, the aircraft must be instrumented and set up for ground engine running with recorders and other paraphernalia hooked on.

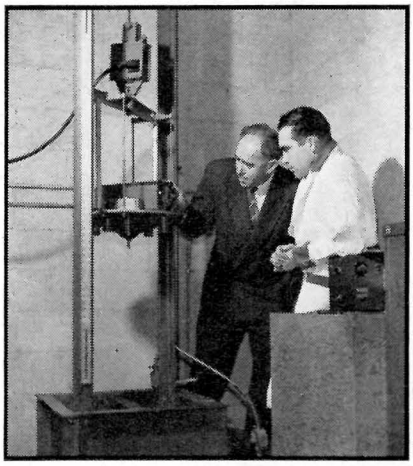
In the flight testing phase, the R & D department strives to check every mechanical function of the aircraft in flight. By the use of the Telemetry Trailer, a large mobile receiving station, signals are collected from airborne test aircraft which are converted into the recorded data needed by the test engineers. Facts such as airspeed, accelerations, vibrations, stick forces are all checked in flight with telemetry.

The final section under the R & D department is that concerned with armament and electronics test. They study such problems as the effect of projectile pods on flight characteristics and methods of jettisoning external stores. The ultimate objective of the tests is to subject the armament and radar installations to a series of simulated combat conditions.

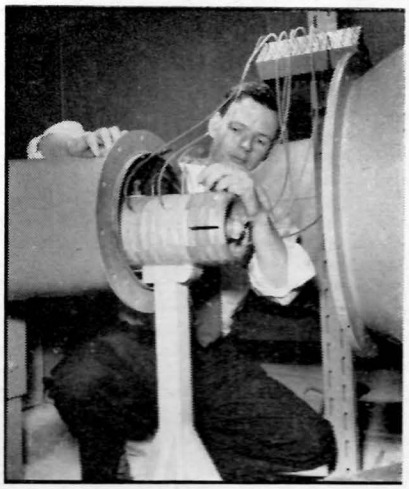
De Havilland Canada: The aircraft development work of The de Havilland Aircraft of Canada Ltd., is well known, with the company being credited with the design and development of four major types of aircraft since the end of World War II. The Chipmunk was followed by the Beaver,



Above left is Canadian Marconi engineering lab. Above is 200 ton tension/compression test machine in Canadair's test and development laboratory.



Above, a drop test machine in the environmental laboratory at PSC Applied Research. In photo, machine is used for shock testing R Theta Computer.



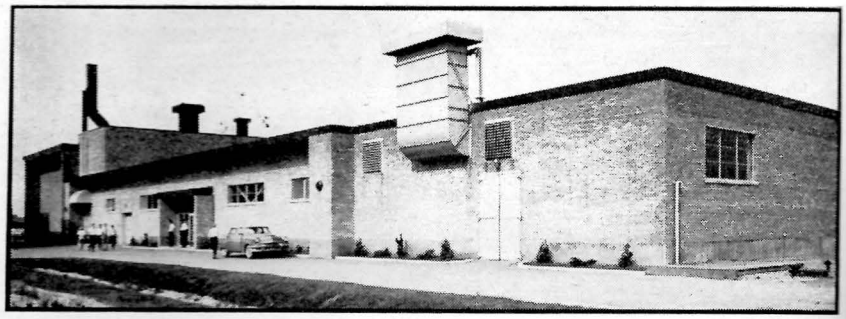
Above, tests being made on airflow characteristics of model turbojet intake, in Orenda Engine's Sir Thomas Sopwith Gas Turbine Exper. Lab.

which in turn was followed by the Otter. At the present, the DHC-4 Caribou is being developed.

This firm does little that could be described as research work, though it was active in the now-dormant Velvet Glove program. Wind tunnel testing of its designs is carried out at the NRC's Montreal Road Laboratories.

Aviation Electric: Although this company does not regard itself as a design and research company, its main activities of sales, overhaul and manufacture of a wide range of aircraft instruments and aircraft accessories necessarily involves it in a certain amount of design, development and research work. In this direction, recent efforts have been highlighted by the development of the Borden Tube (Canadian manufacture), research, design and manufacture of the AEL Ball Resolver (for use in an automatic navigational computer) and research, design, development and manufacture of (Torpedo) course controls.

The company's research and development activities are classed as part and parcel of its engineering facilities, which include an Engineering Department, Engineering Model Shop, Chemical Laboratory, Metallurgical Laboratory and a wide range of environmental test equipment, all of which are available for use in a research and development capacity.



This is Orenda Engines' Sir Thomas Sopwith Turbine Research Laboratory.

Computing Devices of Canada: Essentially a research and development organization, this company employs about 500, a large proportion of which are degree-level technical personnel. Main activities in the modern Ottawa plant of CDC include engineering and development in the fields of simulation, automation, computers, instrumentation, semiconductors, guided weapons, and electronics. Among the current projects, other than those of a classified nature, are the development of a navigation computer for the CF-105 Arrow; the Antac navigation system for the CP-107 Argus; a radar spectrum analyzer; a velocity measurement system for projectiles; a radar test set.

CDC's Data Processing Centre has the latest analog and digital computer and data reduction facilities.

Canadian Aviation Electronics: This company's main research and development efforts are in the areas of computers, simulation, stability and control, and fire control. Specific projects include: CF-100 flight and weapons system simulation; precision servos; airborne instruments; airborne armament systems; airborne communications and remote control systems; transistorized power supplies; transistorized products for aircraft use. Personnel engaged in this work number about 30.

Dowty Equipment of Canada: Dowty has a long development record in the aircraft undercarriage and hydraulic field. For instance, it developed the main and nose undercarriage for the CF-100 and is performing a similar function in connection with the main undercarriage of the Avro CF-105 Arrow. This development activity also embraces a very wide variety of aircraft hydraulic components. The Ajax, Ont., plant is equipped with many types of hydraulic test equipment to assist in this development work. In connection with its undercarriage development projects, Dowty of Canada has installed and put into operation a large undercarriage drop test rig, complete with cathode ray oscillograph equipment, capable of testing undercarriages for aircraft up to 175,000 lb. gross weight.

Lucas-Rotax Ltd.: This company is well-established as a Canadian development facility for aircraft fuel system, electrical, hydraulic, and combustion equipment. Projects embrace fuel pumps and controls, reheat controls, starting equipment for aircraft gas tur-

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···THE CF-105 WEAPON SYSTEM···

Appointment of three Canadian companies as subcontractors for engineering services relating to the Avro CF-105 electronic weapon system which is under development by the Radio Corp. of America and Minneapolis-Honeywell Regulator Co., has been announced by the two U.S. firms.

The appointments reflect a primary objective of the CF-105 electronic system development program to make maximum use of Canadian facilities and to develop Canadian industry potential in the field of systems engineering and production.

The Canadian subcontracts have been assigned to RCA Victor Co. Ltd., Montreal; Honeywell Controls Ltd., Toronto; and Computing Devices of Canada Ltd.., Ottawa.

It will be recalled that a research and development contract for the CF-105 electronic weapon system was awarded to RCA last fall by the USAF, acting on behalf of the Canadian Department of Defence Production. At that time, it was announced that as much as possible of the subcontract work in connection with the project would be farmed out to Canadian companies.

The USAF contract assigns to RCA full responsibility for the development of a complete electronic system of fire control, navigation and communication, and an integrated automatic flight control system. Minneapolis-Honeywell's Aeronautical Div. is working with RCA on an associate basis, with responsibility for the development of the automatic flight and other system controls.

Certain portions of the sub-contracted engineering services will be performed in Canada. Other portions will require assignment of Canadian engineers to RCA and M-H facilities in Camden, N.J., and Minneapolis, Minn., respectively.

RCA Victor Co. Ltd. will perform various engineering studies and provide engineering services in connection with electronic portions of the CF-105 integrated weapon system.

CDC has been awarded a sub-contract in connectio nwith the development of an automatic dead reckoning navigation system, which will be integrated with the electronic weapon system. The navigation system will automatically advise pilots of their distance from target or base and of required courses to reach specific destinations.

The subcontract award to Honeywell Controls Ltd., made by the parent M-H company, involves engineering services in connection with the development of automatic flight controls.

VELVET GLOVE

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adian design convinced the Government leaders that development should be terminated in favor of license production."

Since that time, much of the laboriously built up missile development organization has gradually dwindled away. Though most of the industrial concerns involved have guided missile departments, they are dormant. Many of the personnel have been transferred to other work or, tiring of twiddling their thumbs, have drifted away into other fields in order to keep their talents at work. Several who came from the U.K. have returned to await a time when Canada needs them again.

Conversion to still non-existent production was at the expense of destroying much that had been built up.

Missile authorities in the U.S. and U.K. held Canadian achievements in the field in high regard. They were particularly impressed at the enthusiasm and hard work of the Canadians and the way so much was accomplished in such a short time, starting from scratch. DRB officials claim that the Velvet Glove development had reached the stage where some of the tests being carried out were in advance of those for similar projects in other countries and that the Velvet Glove development program was a better base on which to build for the future than the Sparrow production program. When the development program ceased, some components of the Velvet Glove were rated as being ahead of comparable components in the U.S. and 18 months later some of them still are.

Expenditures: Approximately $24,000,000 was expended altogether on the Velvet Glove program, and of this amount about 90% was spent in Canada. Because the development organization is being allowed to crumble, it appears that some of this money must be written off. However, not quite all is waste. About a third of the expenditures were on facilities which will be of use in other fields for years to come and the DRB personnel are fully employed in examination of missiles for Navy and Army requirements, and in the examination of weapons for the CF-105 and for defence against the ICBM. The industrial teams have been hardest hit.

It is the opinion of some Canadian scientists that nearly two years have been lost in addition to a great loss of morale. It does seems that a longer term plan for development and production of guided missiles is in order.

INDUSTRY R & D

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bines; AC generating system and ancillary equipment including actuators, booster pumps, hydraulic devices, navigation light flasher units to operate at altitudes in excess of 60,000 feet, for use in the Avro CF-105 Arrow.

Sperry of Canada: Though Sperry has mainly been concentrating on the production of items for aircraft instrumentation which have previously been developed by the parent Sperry company in the U.S., or Kollsman, it has recently received a U.S. development engineering contract to redesign and repackage an existing airborne radar indicator. The contract calls for Sperry to improve and modify existing circuitry, repackage the entire equipment using sub-miniature techniques, and to provide improved performance under certain flying conditions.

Jarry Hydraulics: Considerable development work in the field of aircraft hydraulics and undercarriage systems is performed by this Montreal organization. For example, it is responsible for the development of the CF-105 nose undercarriage, complete with steering system. Development work in connection with this aircraft also includes control actuators of size and power hitherto unknown, in this country at least. To enable it to carry out development work on undercarriages, Jarry has recently installed a large drop test rig capable of accommodating landing gear for aircraft with all-up weights up to 200,000 lb.

Canadian Marconi: The Aviation Dept. of the Canadian Marconi Co. operates its own group of development engineers solely occupied with aviation products. It has specialized in designing and producing equipment to the various Canadian and U.S. specifications dealing with form factors, engineering practice, environmental testing, performance characteristics and airworthiness certification. It is the first company in Canada to develop and produce a piece of civil airborne radio equipment as a private venture.

The three major products developed by the department to date have been the CMA-301 ADF, the CMA-402 Loudnailer, and the CMA-101/201 HF Transmitter/Receiver. Nearing the final stages of development is an interesting line of transistorized equipment, notably power supplies for dynamotor replacement, and a complete system of aircraft audio control panels, cockpit and cabin loudspeakers, isolation amplifiers and passenger-address power amplifiers, all being fully transistorized with the accompanying great saving in weight, size, and power requirement.

Canadian Westinghouse: Developmental activities embrace complete aircraft power generation, regulation and protective systems for AC and DC requirements; AC and DC electrical aircraft motors of all sizes and types; rectifier units; electrical instruments, temperature control relays; electrical apparatus for ground service; airport and aviation lighting and distribution equipment; pneumatic valves and anti-skid equipment; ground and airborne electronics equipment of all types; communication equipment; radar. This company was active in the Velvet Glove program.

Canadian Westinghouse maintains a comprehensively equipped environmental laboratory facilities at Hamilton, where they are set up in quarters separate from the main plant.

Cossor Canada Ltd.: This Halifax firm specializes in the development and production of such advanced electronic items as airborne radar defence equipment; aircraft inter-communication systems, underwater equipment, test gear including industrial oscilloscopes, logarithmic amplifiers, signal generators, advanced display systems (radar and computers).

Phoenix Engineered Products: Phoenix has devoted most of its research energy towards the development of electronic and electromechanical devices, which it regards as the "brain" content of automatic controls and instrumentation associated with high speed aircraft and guided missiles. The firm is, however, interested in any sort of development or work where precision is paramount.

An outstanding line of telemetering equipment has been developed which

Phoenix claims is second to none in the field and moreover, this accuracy is maintained over exceptionally wide temperature and acceleration ranges. Inductive type, variable reluctance type and differential transformer type transducers have been designed, developed and prototyped by Phoenix and these in turn have been stepping stones to the manufacture of precision apparatus such as angle of pitch and yaw transducers, relative wind sensors, pressure transducers of all kinds including differential types, accelerometers including airborne recording types, remote position indicators (servo types for stress testing).

PSC Applied Research: As this company's name implies, its activities are aimed mainly at research and development, though it has now become active in the production side as well, as a result of the success of some of its products. An outstanding example of this is the R Theta Computer navigation aid which is now in production for the RCAF.

Originally set up as the research division of Photographic Survey Corp., ARL was later incorporated as a separate entity specializing in design engineering and production of aircraft instrumentation and controls; photogrammetric and optical instruments; airborne geophysical survey equipment; photographic equipment. Products developed, besides the R Theta Computer include instrumentation cameras, rocket fire control intervalometers, dual-probe ice detectors, and specialized armament control equipment.

Canadian General Electric: The development activities of this company which are of particular interest to the aviation field are handled mainly by the Electronic Equipment & Tube Department. Suitable facilities and personnel are maintained to provide consulting, engineering and manufacturing services for the development and production of military electronic equipment and systems.

FLIGHT RESEARCH

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ing parachute, which by automatically opening and closing (the canopy is collapsed by twisting the shroud lines, which then unwind, allowing the canopy to open again) makes possible more accurate dropping of supplies and equipment.

Of more recent interest are the Section's investigations into the effects of vortex generators and, more to the point, the causes of these effects. Vortex generators are well-known and have been widely used to improve the characteristics of subsonic wind tunnel diffusers and to suppress shock-induced separation on aircraft wings. In general, vortex generators are small wings mounted at right angles to a surface; the tip vortices of these wings is used to alleviate separation of the boundary layer from the surface. A typical configuration and application is shown in photos accompanying this article.

This program started in 1954 and is still continuing. Both a T-33 and a CF-100 have been used in connection with the allied flight testing. Tests have also been carried out in a low speed wind tunnel.

AEROPHYSICS

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situation would be to be able to prevent this noise from penetrating inside the fuselage, without having to resort to