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The Orenda Iroquois

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Development of an engine for the Arrow: The Orenda Iroquois

In 1953 the subsidiary of A.V. Roe Canada, later known as the Orenda Company, decided to design an engine based on an RCAF specification for an interceptor aircraft with a performance of Mach 1.5 at 50,000 feet altitude. It required the aircraft to be airborn within 60 seconds from standing at "readiness" (pilot in cockpit but engines not running). This posed a considerable challenge in mechanical design and manufacturing technology.

The Iroquois was a high performance turbojet engine. The airflow through the engine was straight through (axial flow), and it incorporated a two-spool compressor with an integral afterburner. It was designed for operation under supersonic flight conditions. As for all turbojets, it derives its thrust from the reaction of an increase in momentum of the air mass passing through it. This increase in momentum is produced by burning fuel in the air mass to increase its temperature and volume, and by accelerating the exhaust gases to a high velocity by means of a final nozzle at the rear of the engine.

The Orenda company designed and built the Chinook in 1949, the first turbojet engine designed in Canada, and the Orenda 9 which powered the Canadair Sabre and Avro CF-100. The Iroquois' development costs was financed from its own funds. The progress of this project was encouraging, and the Canadian government then funded its production. This was the engine that was to be used in the production Arrow (Mk. 2). One was installed in a Mk.2 Arrow in preparation for flight testing, when the Arrow program was cancelled in 1959. The Arrow only flew with the test program's interim engine, so the aircraft's performance with the Iroquois installed can only be estimated.

The Iroquois design was based on simplicity and lightness. With this

... mind, Orenda pioneered work in the use of titanium, and 20% by weight of the Iroquois (mainly the compressor rotor blades) consisted of this metal. It has light weight, high strength, and good temperature and corrosion resistance. It was estimated that the engine would be 850 lbs. lighter than if steel had been used for the parts made of titanium. During the early 1950's this material was in short supply, and the lack of knowledge of its physical properties and fabrication techniques created problems which had to be overcome. It was also very expensive relative to the more common materials such as steel and aluminum.

It was recognized that if the engine part could be designed with titanium, then the supporting structure could also be lightened, with an overall saving in weight. Other parts, such as gearbox casings were made with a magneseum alloy. Inconel was another light metal used to make the blades in the low pressure turbine assembly and the metal insulation blanket found at the rear of the engine. This heat resistant nickel-chrome alloy retains its strength at high temperatures and resists oxidation and corrosion. The primary reason for using these light metals was to save weight, and have an engine with a 5:1 thrust to weight ratio that could produce a sea level dry thrust * of 19,250 lb. (26,000 lb. with afterburner).

The design, development and manufacture of such an advanced jet engine was accomplished in an increadibly short time by the Orenda Iroquois engine team. The detailed design was completed in May 1954, and the first run was acheived in December 1954.

The earlier Orenda 9 had more parts but produced less power. For example, the earlier engine weighed 2,560 lb. (1160 kg) and produced 6,355 lb. (2 883 kg) static thrust. The Iroquois weighed 5,900 lb. (2 675 kg) but was reported to have produced 30,000 lb. (13 608 kg) static thrust with afterburner for take off. (The earlier engine did not have an afterburner.) The thrust was enormous for an engine of that time, and the highest dry thrusts produced in North America were recorded.

Wind- tunnel tests revealed the engine's successful operation under sustained high inlet temperatures, and the ability to make normal relights up to 60,000 ft. (18 290 m), the limit of the wind-tunnel in which the tests were conducted.

By 1958 the Iroquois had completed more than 5000 hours of ground running, and many thousands of hours had been spent testing the engines' principal components at the Orenda test establishment at Nobel, near Parry Sound, Ontario.

The Iroquois took to the air for the first time in 1957 using a Boeing B-47 on loan from the United States Air Force as a flying test bed. The 30 foot long and 6 foot diameter engine pod was mounted on the right side of the aircraft below the tailplane. There were not many aircraft available that could handle an extra engine of the Iroquois' size and power. The modifications to the aircraft were done by Canadair in Montreal, and approximately 20 tons of instrumentation and ballast were added. The ballast was necessary

to compensate for the engine's weight, as the B-47 was very sensitive to a shift in its centre of gravity.

The Canadian flight crew which flew the B-47 received flight training at Strategic Air Command in the United States and were qualified as a regular SAC B-47 crew. This was a major concession by the United States Air Force on this highly classified aircraft.

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