Arrow System Leads the Way

Weatherhead explored new avenues to cope with the CF-105's unique 4,000-lb. hydraulic system

By Peter Brannan

"We can make it here!"

This might well be the "battle cry" of the Weatherhead Company of Canada Ltd.

It is difficult to name a major Canadian aircraft project in recent years with which Weatherhead of Canada has not been associated. Avro Aircraft's CF-100 and CF-105 programs, Canadair's F-86, T-33 and CP-107 Argus projects, and de Havilland of Canada's Beaver, Otter, Chipmunk and Caribou; in all of them, Weatherhead's team played a vital role.

In fact H. Ross Harris, the firm's technical representative and quality control supervisor, told Canadian Aviation that the fluid connections produced by the company for the Arrow are leading the way in the field of high pressure, high temperature hydraulic systems.

No standard fittings were available for the 4,000 lb psi hydraulic system chosen for the Arrow. This meant that Weatherhead had to produce some entirely new fittings, and adapt others, working and testing to Avro's specifications. In addition to being necessary to cope with the increased stresses in an aircraft of the CF-105's potentiality, the high-pressure system also contributes to the compactness of the package.

200 Items For CF-105

Something over 200 items are produced by Weatherhead's for the Arrow, and a fair number of modifications are being dealt with during the current test development stage.

This Canadian subsidiary of an American company began producing hydraulic system and other components for the aircraft industry as part of the war effort in 1941. The volume of business diminished considerably in the immediate postwar years. With a view to boosting the firm's aircraft accessories business, an aviation division was established in 1954.

Today about 15 per cent of the production of the St. Thomas, Ontario, plant goes to the Canadian aviation industry. With its parent company, the firm has become one of the world's foremost manufacturers of precision aircraft products.

Weatherhead holds RCAF and Department of Transport manufacturing and distributor approval. The laboratory at St. Thomas is approved by the RCAF for the certification of dynamic and static pressure testing of hose assemblies and other equipment.

"Flareless" Pioneers

The parent company pioneered the "flareless" fitting in North America. The device, which originated in France, had its first American military application in tanks of the U. S. Army in World War II. Developed by Weatherhead for aviation applications, the flareless tube fitting became a U. S. military standard under Mil-F-18280.

Flareless fittings possess great strength and are suitable for quantity production. They are used extensively on both the Arrow and the Canadair Argus. The fittings are ideal for the high-pressure lines of aircraft and missiles, where the assembly may be subjected to severe vibration. They are also economical, installation and maintenance being accomplished easily with standard tools.

An advantage of the flareless fitting is that the metal tubing used is produced in continuous lengths of identical section, and no distortion of the end of the tubing is necessary for the purpose of making a connection. Instead of the end of the tubing being flared, a specially designed sleeve fits

ON TEST. Mask and gloves are worn to protect against hot oil as fittings are placed in environmental chamber (top). Ross Harris examines hose after burst testing (centre); and R. Miners inspects assembly after cold soak at minus 65 degrees Fahrenheit in deep freeze (below).

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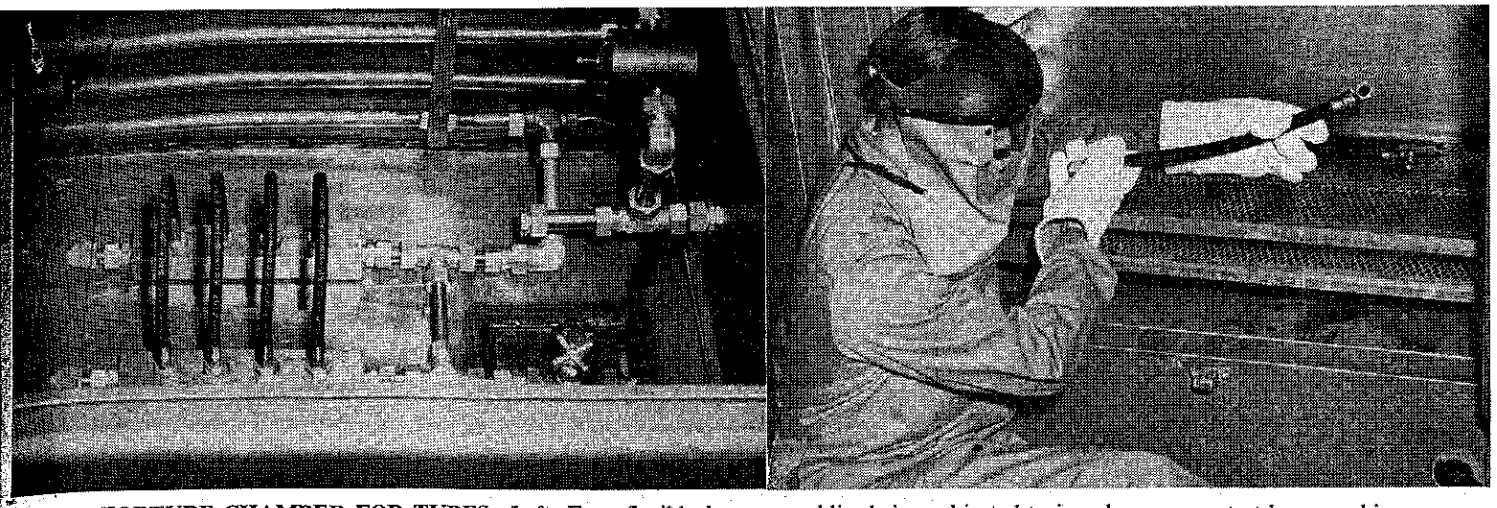

TORTURE CHAMBER FOR TUBES. Left: Four flexible hose assemblies being subjected to impulse pressure test by a machine designed and built by the Weatherhead company. Right: Sample lengths of hose being removed from the hot air age oven test.

over the tube. The nut is tightened over the sleeve, forcing it into the body taper. The cutting edge of the sleeve sheers a groove in the outer surface of the tubing, making a tight joint between the fitting and the tube.

This method provides an almost unbreakable grip upon the tube. In fact the tubing itself will burst in a test to destruction, before the flareless fitting fails. A length of 1¼ in. x .125 wall industrial C1010 tube placed on test in the plant's research and testing laboratory took on an ominous bulge, while the connections each end held.

After the first assembly the sleeve is permanently attached to the tube. Disassembly and reassembly of the fitting can be made without loss of strength or sealing qualities.

Flexible hose assemblies are another Weatherhead specialty. The hose is supplied by an outside firm, but it is tested by Weatherhead, and the firm is also responsible for the serviceability of the final assembly. Low,- medium- and high-pressure hose assemblies are covered in the firm's range.

Test Demonstration

One piece of hose was test demonstrated for Canadian Aviation, and reached about 15,000 lb. psi before failure. In the case of flexible hose assemblies, the ends may be permanent or detachable. In each case the hose is gripped between a threaded body and a threaded insert.

Hose end fittings and tube fittings are manufactured at the Canadian plant. Flexible control assemblies of the push-pull type, used for a number of aircraft applications, are also produced at St. Thomas.

These items are manufactured integrally with the plant's general production for the automotive and other industries. But the inspection and test program for the aviation parts is entirely separate, and is maintained at a much higher standard.

A piece of test equipment recently introduced into the firm's laboratory is an environmental test chamber, designed by Weatherhead engineers. This is capable of checking hose assemblies, tube fittings, or any fluid component under pressure at temperatures from —65 to 1,000 degrees Fahrenheit. The top temperature is in excess of anything required at the present time but, as Ross Harris explained, they are planning for the future.

The chamber, which has six-in.-thick insulating walls, was made up by an outside contractor to the firm's specifications. It was built to meet an urgent test requirement within a week of the order being placed. A block and tackle is used to raise the heavy lid, which has two inspection windows.

The chamber may be used in conjunction with one of two pressure impulse machines in the laboratory. One of them, designed by the National Research Council, is described as a sine wave machine. This has a test pressure rang of 0-10,000 lb. psi and a rate of cycling of 575 per minute. That is to say the pressure can be applied and relaxed 575 times every minute. The pressure is monitored on an oscilloscope and a pressure gauge, while an electronic device enables readings to 11 lb. psi accuracy at 10,000 lb. psi.

The temperature range of the test machine is limited only by the safe temperature range of hydraulic fluids in use. In fact fluids with a flash point of 200 degrees Fahrenheit have been tested at 275 degrees. The chamber has to be saturated with nitrogen gas for this to be done, and elaborate fire precautions are taken.

At the same time as the parts on test are being subjected to fluctuations of temperature and pressure in the environmental chamber, they may also be placed on mechanical fatigue cycle (or vibration) testing.

Dry ice is used to achieve the low test temperatures, and electric heaters provide the high temperature ranges. Two automotive type fans ensure circulation and proper diffusion of the air in the chamber. This can either be circulated internally, or exchanged with air outside of the chamber.

The second impulse machine is of the square wave type, and was designed by the parent company. This has a pressure range of 75 to 3,000 lb. psi operating, and a peak pressure of 4,500 lb. psi. It has a cycling rate of 36 per minute, and a temperature range of ambient to 150 degrees. Again the pressure is monitored on an oscilloscope and pressure gauge, and if desired, photographs of the scope readings can be taken as a permanent record.

Testing To 30,000 lb psi

The static proof pressure test machine in the laboratory, employing water, is capable of testing up to 30,000 lb. psi. This is sufficient to test almost any piece of equipment in the plant to destruction. Every part produced for the aviation industry is placed on test before being shipped. Generally, proof pressure is twice working pressure and minimum burst pressure is four times working pressure. Selected items from every batch are tested to destruction.

Other pieces of equipment in the test lab include a hot air age oven, cold air age box, and hot oil age tank. Selected items from the production are subjected to various ageing tests before being placed on impulse pressure test. Here they are left for many hours, the flexible hoses flexing and contracting with the pressure cycle, until they have served for their maximum simulated life.

Having survived this exacting ordeal, the parts are carefully examined for any sign of stress or failure. This is

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Saab Draken

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front of the centre wing, accommodates the single-seat cockpit, landing gear, integral fuel tanks, air ducts and miscellaneous equipment.

The rear section, which is integral with the rear of centre wing, houses the engine with afterburner, fuel tanks, armament, landing gear and miscellaneous equipment.

The centre wing of the Draken is integral with the fuselage. The outer wing, which is attached to the centre wing with a bolt joint, is made of relatively thick skin sheet on a framework of spars and ribs. Sweepback on centre wing leading edge is 80 degrees, on outer wing leading edge 57 degrees. Aspect ratio is 1.77.

Four air brakes are located on the upper and lower side of the fuselage rear section. All control surfaces are servo operated by two hydraulic tandem jacks, which are fed by two separate hydraulic power systems. No part of the load on the control surfaces is transmitted to the stick and pedals. The stick forces are instead generated by a unit which is sensitive to Mach number and to dynamic pressure. A three-axis automatic flight control system is fitted.

The landing gear is of the hydraulically retractable tricycle type. The main units retract outward, the legs shortening during retraction to reduce the space required when in retracted position. The nose wheel is retracted forward. Landing gear retraction is effected in four seconds. The main wheels are provided with double-disk brakes and anti-skid brake regulators. Wheel track is 2.7 m.

RSAF pilots on immediate call will sit in the pressurized and air-conditioned Draken cockpit 24 hours a day at the end of runways or in their hangars, carved out of solid rock. They will be ready to be towed out by jeep and get into the air in little more than a minute after an alert.

The aircraft carries complete radar equipment with nose scanner and pilot's scope as well as fire control equipment. The Draken is designed to carry mainly external armament in the form of air-to-air missiles as well as fighter rocket projectiles. The external armament is intended to be used in combination with built-in large-bore cannon. Latter can be replaced by internal extra fuel tanks.

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Weatherhead Ltd.

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where other items of equipment come into play—like the comparator, which has 50 X magnification, and the metallurgical microscopes and precision measuring equipment.

Weatherhead of Canada's general sales manager, William F. Braun, is proud of these test facilities. He doubts whether they can be duplicated at any one facility in Canada. Mr. Braun directs the aviation sales division, all aspects of which are closely co-ordinated with the parent company.

In addition to its manufacturing activities, the Canadian company is distributor for a number of other aviation products. These include: bullet sealing flexible hose assemblies, Teflon and other specialized hose assemblies and hose and fittings, drain valves, swivel and cluster fittings, and quick disconnecting self-sealing couplings.

The company is essentially Canadian. The only American on the key personnel list is vice-president and general manager, Harry L. Adams. Mr. Adams, though resident in the United States, keeps the plant under keen and active supervision. He has reason to be proud of the thriving Canadian subsidiary.