Chinook Seen First Step To New Canadian Industry

Ultimate aim is independence of aircraft engine design and manufacturing industry in Dominion—New developments for jet anti-icing reported from Avro Canada factory.

Some 50 representatives of suppliers on gas turbine components and parts were guests of A. V. Roe Canada Limited at a special running of the Chinook engine late last month.

Greeted by W. N. Deisher, vice-president and general manager, members of the party made a tour of inspection of the plant in which Canada's first jet engine was built, climaxed by a visit to the engine test house where the Chinook was put through its paces.

"It is our plan to develop a Canadian Aircraft Engine design and manufacturing industry that will not be dependent on foreign sources of supply in an emergency," Mr. Deisher told the visitors. "In this first engine we have gone a long way on the road to independence, and we will reach our goal as time goes on."

He emphasized that the Chinook was conceived, designed and, with the exception of a few accessories and standard parts, built in the Avro plant at Malton.

Brief Description

Basically the Chinook is a gas turbine jet propulsion engine, consisting of a nine stage axial flow compressor, six combustion chambers, a single stage turbine and an exhaust tail cone.

In operation, air is first drawn into the engine by the compressor, which, in the Chinook, is made up of nine stages. Each stage, or row, of whirling blades compresses the air a little more until at the end of the ninth stage it has been compressed to about four and half atmospheres, or 50 lbs. psi. This compression also heats the air to about 400° F.

The air at this point is forced into the combustion chambers placed around the engine. Kerosene fuel is pumped into this compressed air in the form of a spray, and burned continuously somewhat in the manner of an oil furnace. A spark plug is used to ignite the mixture when starting.

Only a small proportion of this air is used for combustion, but the tremendous heat generated expands the main volume of air passing through the combustion chambers.

Since the combustion chambers have an open end, the pressure does not build up, but the heated air and burned gases, because of their rapid expansion, force their way at high speed between the blades of the turbine disc causing the turbine wheel to rotate at about 10,000 rpm at full speed.

This energy is transmitted by the turbine shaft to the compressor, which in turn compresses more air into the combustion chamber, and the action then becomes continuous so long as fuel is fed into the combustion chambers.

There is one row of blades, or one stage in the turbine wheel, which is all that is required to drive the nine-stage compressor and the engine auxilliary equipment.

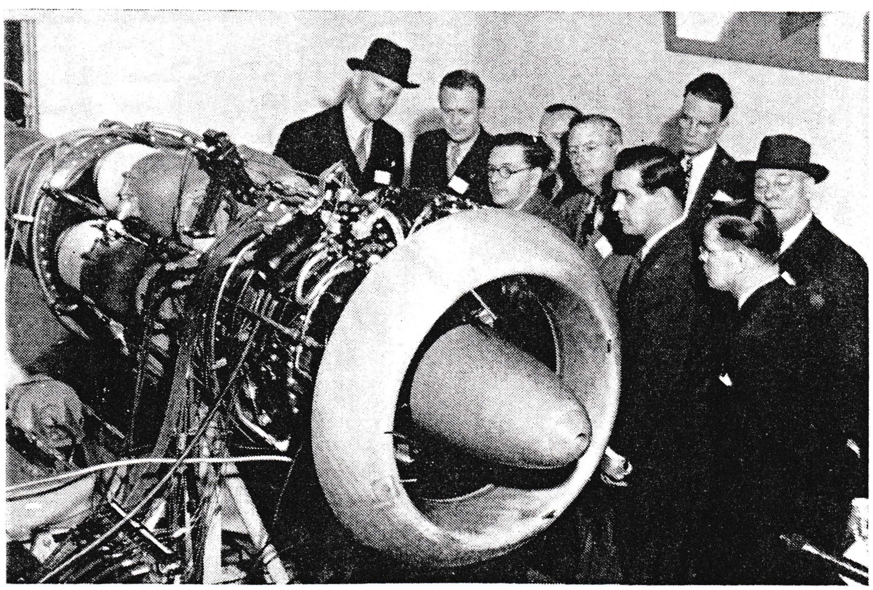
The air, or hot gases, passing from the turbine are still expanding, and leave the rear end of the engine at about 1200 mph. The reaction of the engine from the acceleration of these gases produces a thrust which propels the aircraft in flight.

For starting the Chinook, an electric motor, located at the front, is connected to the compressor and runs it up to about 1/8 engine speed until sufficient air is being pushed through for combustion purposes, at which time the fuel is introduced.

Six "Cylinder" Engine

There are six combustion chambers in the Chinook, and each one (about the size of a wasterpaper basket) is capable of heating 70 seven-roomed houses when the outside temperature is 10° below zero.

Weight of air handled by the compressor in this engine is over 75 tons per hour, or about two million cubic feet per hour. The thrust power developed by the Chinook is equivalent



A group of suppliers' representatives looks over the Chinook prior to the special test run. Left to right, they are G. H. Wheeler, Dunlop Tire and Rubber; J. R. Beale, Aluminum Company of Canada; H. Keast and W. J. C. Brown, Avro Canada; G. E. Foster, Shell Oil; J. Parkinson, Vokes Company; J. B. Barron, Alloy Metal Sales, S. B. Jones, Shell Oil and A. Grant, United Steel.

to about 25 large automobile engines each delivering 100 hp, yet it weighs only 1250 pounds.

Technical Data

The nine-stage axial flow compressor is preceded by precision cast aluminum alloy inlet guide vanes, and discharges its air directly into the combustion chambers through six diffusers. The first two stages of rotor blades are stainless steel; the remainder aluminum alloy.

The rotor is supported in a self-aligning anti-friction bearing at the front end, and a duplex-type ball bearing in a self-aligning mounting at the rear.

The combustion system consists of six interconnected straight-through combustion chambers discharging into a fabricated nozzle box, each chamber consisting of an outer air casing and an inner flame tube. It is because of this construction that the observers may touch the outer housing while the engine is running.

The turbine rotor comprises an alloy steel disc with an integrally forged stub shaft, and chrome nickel alloy rotor blades fastened to the rim with fir tree roots. Cast chrome cobalt nozzle guide vanes are used. The front end of the turbine shaft connects directly to the rear of the compressor rotor through a flexible coupling designed to compensate for angular misalignment.

The tail cone is fabricated from stainless steel sheet with cast flanges at front and rear, and is insulated by glass wool blankets encased in silver foil shields under a sheet aluminum outer covering.

The fuel system comprises two Lucas variable delivery positive displacement pumps, one flow control unit, a pressure regulating valve, six burners, a combined solenoid and torch igniter reducing valve and two torch igniters.

A dry sump lubrication system is used which incorporates a multiple type pump consisting of one pressure and two scavenge elements. The two scavenge pumps draw oil from the front and rear main bearings, with the centre bearing drained by gravity both fore and aft. An oil tank, oil filter and pressure regulator complete the system.

A direct drive electric motor is used for starting the engine from a 24 volt DC supply.

Anti-Icing Developments at Avro

Thermal system for intake components and electrical insert for compressor blades

Coincident with the design and building of the Avro Chinook, Canada's first jet engine, at the Malton plant of A. V. Roe Canada Limited, there have been several developments suggested and worked out by the men engaged in this project. These have been made available to the plant development and engineering staff for possible refinement or incorporation into the engine.

Two of these developments are concerned with gas turbine anti-icing, and are expected to prove specially valuable in jet engine operations in Canada.

Thermal anti-icing of intake components is the theme of one of these developments suggested by Winnett Boyd, chief designer of the gas turbine division, while the second development concerns itself with electric anti-icing of jet engine compressor blades and is the joint effort of Mr. Boyd and G. F. Kelk of the design office.

Under certain atmospheric conditions, ice will form on the various parts of the intake end of an aircraft gas turbine engine, and it is this condition which is being fought by attempting to supply enough heat to the surfaces involved to keep them above the freezing point of water and prevent ice formation.

Mr. Boyd suggests a method of anti-icing the intake components of a turbo jet engine by making them double walled structures and passing hot air through them in order to raise the surface temperature of the parts.

The intake components of a turbo jet engine of the axial flow type consist of the intake fairing (13), the intake struts (section A-A) and the nose bullet (14). The anti-icing method developed by Mr. Boyd calls for the introduction of hot air into a closed intake fairing (13), passing it through the double wall (2) of the fairing and discharging it out an