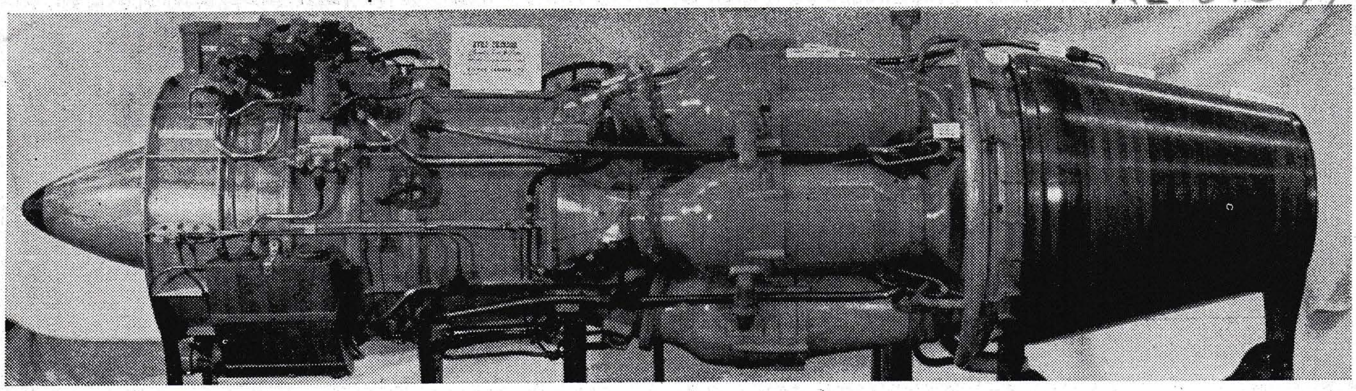

"Chinook" Engine Spearheads Canadian Turbine Program

RUNNING OF the Chinook, first Canadian jet engine, at the A. V. Roe Canada plant near Toronto within the next few weeks will be the climax of a story that began in 1942. From the moment when the first hints of gas turbine development were received from England, Canada took a lively interest in this new and promising form of propulsion.

This article will describe the present organization for jet aircraft engine development in Canada, then will sketch in the historical background of the current activity.

The gas turbine organization as it now exists at Malton comprises two major divisions: (1) the **manufacturing division** comprising all shop, tool design, planning personnel and manufacturing equipment, and (2) the **engineering division** embracing all design, experimental laboratory, inspection, and test personnel. There are presently some 250 employed in the manufacturing division, and about 200 engineers, draftsmen, and laboratory technicians in the engineering division.

The physical facilities for development and manufacture of jet engines fall into three main groups. Firstly, there is the **experimental shop** comprising a major portion of the former machine airframe shop to which has been added a considerable quantity of specialized machine **tools.**

Secondly, there are the Malton **laboratory facilities** which have been designed, built and equipped since May, 1946. These include (a) a mechanical test laboratory for testing engine components such as bearings, seals, gear boxes, engine blading, etc.; (b) a fuel system component testing laboratory for testing and developing fuel system components such as fuel pumps, burner jets, flow control units and so forth; (c) an aerodynamic laboratory equipped with a small wind tunnel and an electrolytic analogy tank for experimental aerodynamic work aimed at improving the design of turbines and compressors, and reducing losses in gas passages for obtaining higher efficiencies; (d) an instrument laboratory for the development of special instruments and equipment necessary in the testing of engines and their components; (e) an engine test laboratory for performing complete running tests on entire jet engines.

The third major group facilities is at the **Nobel plant.** This plant, formerly used for the manufacture of explosives, was selected and taken over because of its basic power plant equipment consisting of a 6,000 hp steam turbine for compressor testing,

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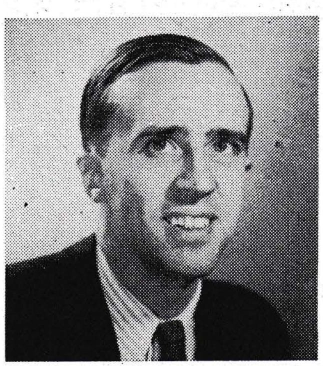
Leaders in Gas Turbine Project



PAUL B. DILWORTH

WINNETT BOYD

PAUL B. DILWORTH is Manager and Chief Engineer of the Gas Turbine Division, A. V. Roe Canada Ltd. A mechanical engineering graduate, U. of T., he worked for the National Research Council until January, 1943, when he went to England to investigate jet development. Subsequently he was senior project engineer at the Cold Weather Jet Test Station at Winnipeg before joining Turbo Research. Received present appointment in May, 1946.

WINNETT BOYD is Chief Designer, Gas Turbine Division, A. V. Roe Canada Ltd. U. of T., M.I.T., Aluminum Company of Canada, and the Royal Canadian Navy were part of Mr. Boyd's experience prior to his assignment to jet development in England. After nine months there, he continued in Canada with the National Research Council, Turbo Research Ltd. and Avro Canada.

ABOVE: Full scale wooden mock-up of the Chinook jet engine soon to have its initial test run at the A. V. Roe Canada plant, Malton. It will have a take-off thrust of 2,590 lb., weight 1,250 lb. It has a nine-stage axial-flow compressor, six combustion chambers and a single-stage axial-flow turbine.

Chinook Heads Canadian Jets

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and five large reciprocating air compressors capable of providing a substantial supply of high-pressure air for combustion and aerodynamic tests.

This is probably equal to that available to most engine firms in the United Kingdom and the USA today. The facilities have been modified and are used in the testing and development of compressors, turbines, and combustion chambers, and also for carrying out miscellaneous aerodynamic tests on airfoil cascades, diffuser passages, etc., in connection with compressor and turbine design.

The first jet engine called "Chinook," the design of which was started at Turbo Research Ltd., and completed at Avro Canada is now being assembled at Malton. It is a development engine which will provide the practical answers for larger and more powerful engines already on the design boards and in the initial stages of manufacture.

Historical Background

As early as 1942, the Canadian Government received word of developments in the United Kingdom on a new type of aircraft engine of great promise, and the stories received aroused interest and speculation as to its possibilities in Canada. The Government sent a technical mission to the United Kingdom early in 1943 to study the new power units. The survey and report required five months of intensive work. The findings and recommendations were finally submitted to Ottawa in June, 1943.

Cold Weather Testing — One of the problems facing the British was the testing of jet engines under low temperature conditions such as would be encountered in high altitudes or even at sea level under Arctic conditions. Due to the vast quantities of air consumed by even the smallest jet engines (about 30,000 cu. ft. per minute) it was impossible to provide equipment for artificially refrigerating sufficient quantities of air to be of use on wartime development. Since Canada had an abundance of cold air, supplied by nature in winter, this appeared to provide a logical and quick solution to the problem of cold testing.

With the support of the British Government, and various British engine firms, it was decided to set up a Cold Weather Test Station in Canada for the testing of British jets.

A survey was made for a suitable site, and ground was broken for the establishment of a Cold Weather Test Station at Stevenson Field in Winnipeg, September, 1943. In less than four months the buildings were constructed and occupied, and the first engine was on test. While the buildings were being erected and test and shop equipment being procured, a group of engineers and fitters was recruited from various places in Canada and sent to the United Kingdom for training on the testing and overhauling of jet engines. These men were brought back to Winnipeg during December, 1943, and formed the backbone of the staff which operated this station during that and subsequent winters.

The training of personnel, the construction of the Cold Test Station, and the test operations through the first winter were carried out under the supervision of the National Research Council.

The second phase of Canadian development began in August, 1944, when the Government set up a Crown company known as **Turbo Research Limited** with headquarters located just outside of Toronto. This company took over National Research Council activities and continued the operation of the Cold Weather Test Station, while at the same time recruiting, organizing and training staff to engage in the larger activities of engine design and development.

Though considered a long-term project, and not intended as part of the war effort, except for the operation of the Cold Test Station, nevertheless, it was found possible gradually to recruit personnel. Engineers and draftsmen were hired and a number were sent for training in the United Kingdom. The RCAF also sent a number of officers and NCO's to take courses of instruction in the U. K. and many of these later took up employment with Turbo Research upon their release from the service.

At the end of the war, the Canadian Government, consistent with its policy of disposing of Crown companies, decided to discontinue the operation of Turbo Research. At this point, A. V. Roe Canada Limited, engaged as it was on the design and manufacture of jet-powered aircraft, realized the importance of the jet engine in its own program, and desirous of carrying on the work in Canada, took over Turbo Research facilities in 1946, and transferred these, together with the staff to Malton.

The acquisition of this staff brought to Malton the majority of those men who had been working in the new field in Canada. At the same time, National Research Council undertook to carry on the necessary allied fundamental research work.

While the life of Turbo Research Ltd. was a short one, nevertheless it provided a vital working basis for the gas turbine organization at Avro Canada.

Icing in Jets

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perature is directly induced by the increase of fuel flow which results from the governor trying to maintain the set engine speed in spite of decreasing compressor performance.

The runs were usually continued until such time as the exhaust gas temperature exceeded the maximum permissible value of 700 deg. C or the ice formation was considered dangerous. The drop in thrust which is important for aircraft operation was not the limiting factor in the bench tests.

It should be noted that most of the icing runs were made with the exhaust bullet locked in the retracted or starting position. In this position, the exhaust gas temperatures are lower than with the bullet in operation. This permitted a larger ice accumulation to be built up without exceeding the allowable tail pipe temperature than would otherwise have been possible.

When an ice formation of the coronet type was building up, the exhaust gas temperature rose slowly at the beginning, then at a rapidly increasing rate. When the coronet attained a diameter of about 15 inches, the increase was about 50 deg.C. per minute and an immediate shut-down was necessary. The drop in thrust was about 350 lb. in this run.

The rose and its advanced stage, the tulip type of ice formation obtained with straightening entry to the compressor, blocked the compressor entry to a lesser extent than did the coronet type. Hence the drop in performance was not so pronounced. In the longest run, when 16.7 lb. of ice built up on the starter fairing in one hour, the exhaust gas temperature rose only about 90 deg. C and the thrust dropped only 150 lb.

One run with straightening entry was performed at a higher engine speed, 8,420 rpm, which is the maxi-

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