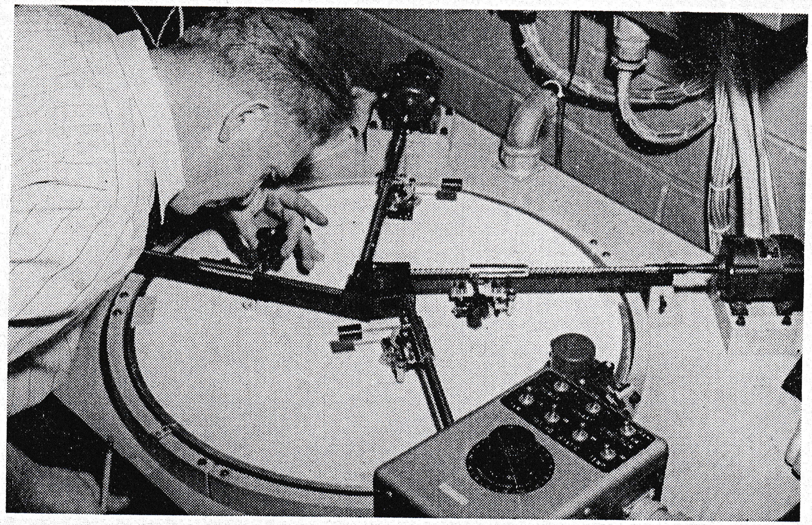


JET SECRETS PROBED AT NOBEL TEST PLANT

SPECIALIZING in the study of the inner workings of gas turbine engines, the Nobel Test Establishment of Avro Canada is a vital but little-known phase of jet engine design and development in Canada. Corresponding, in its functions, to $30 million plants in the U. S. and U. K., the Nobel establishment is a salvaged war plant with about $1 million of special equipment for the postwar task. The Nobel facility, near Parry Sound, 180 miles north of Toronto, formerly operated by Dominion Industries Ltd., is now on loan to Avro from the Federal Government.

Three principal testing devices at Nobel are: the cascade wind tunnel; the diffuser test rig; and the combustion rig.

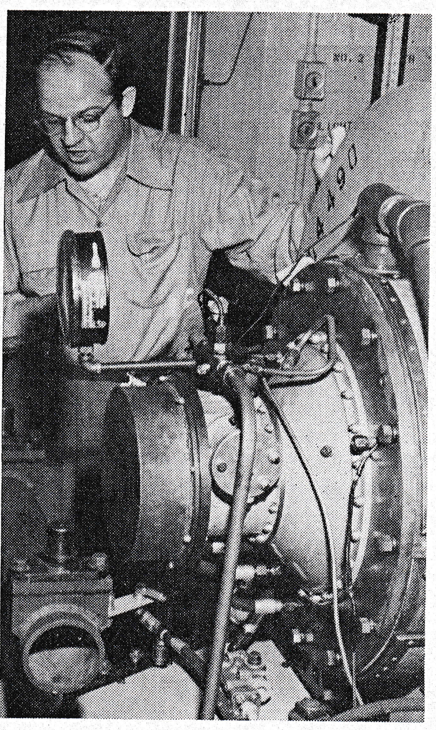
The variable-incidence cascade wind tunnel is intended to provide the basic information for the design of turbines and compressors. By varying the angles of special blades it is possible to determine the aerodynamic effects of the variations in direction of air flow on them.

The function of the diffuser test rig is to test on full scale models the efficiency of the conversion of the high-speed low-pressure air from the compressor outlet to the low-speed high-pressure condition before entering the combustion chamber.

Nobel's high-pressure combustion rig is designed to permit testing of combustion chambers under conditions closely approximating those on the actual engine. The turbine test rig is used to determine turbine characteristics without being coupled to the compressor.

The altitude and atmospheric combustion test rig provides means for testing combustion chambers under

ABOVE: Electronic computations on this recording traverser are of major importance in the calculations related to basic jet engine research in Avro Canada's gas turbine test plant.



Douglas Knowles, Avro's chief gas turbine development engineer, demonstrates the rig for testing Orenda compressors. A Chinook engine turbine driven by steam is used in the test rig.

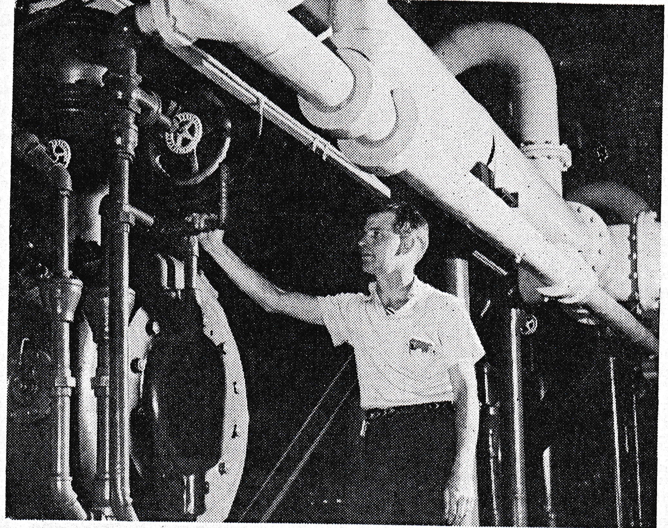
low pressure conditions. Development tests at atmospheric pressure have a great advantage over pressure tests in that it is possible to look up the exhaust and observe hot spots and flame conditions. Altitude tests are necessary to predict the chamber performance at altitude — particularly blow-out and light-up characteristics.

In November of 1946 the plant was formally turned over to Avro Canada and work commenced immediately on the installation of test equipment and the modification of plant facilities. The first test run was made in March of 1947 on the diffuser test rig, followed very closely by tests on the fixed incidence cascade rig and atmospheric combustion rig.

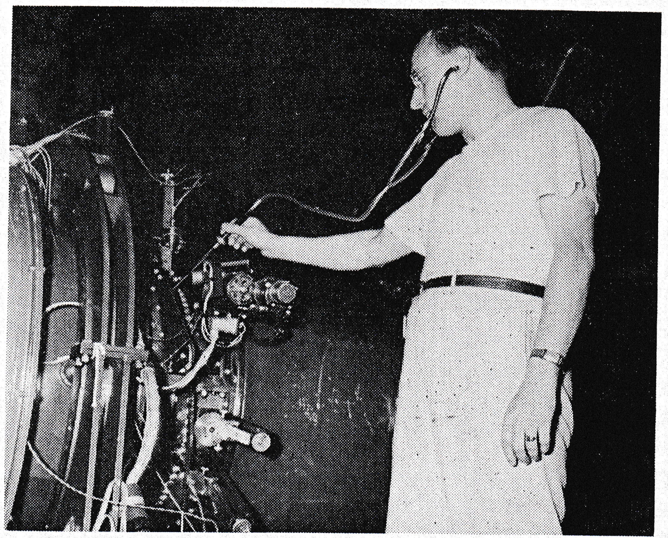
The work of the Nobel plant is described in the following terms by W. H. Gibson, the engineer in charge:

The establishment is engaged in testing, with a view to improving, the aerodynamic and thermodynamic characteristics of the main components of the Orenda jet engine. The Malton Test Department concentrates on mechanical improvement of components, and fuel system development, and the proving of combined aerodynamic, thermodynamic and mechanical improvements as bench tests, and later flight tests, of the complete engine. Long-term programs, of course, are also pursued at Nobel to provide design information for future designs of jet engines.

The main engine components which are tested are the axial-flow-type



W. S. Jones of Avro Canada's gas turbine plant at Nobel, checks one of the many air compressors needed to test the Orenda compressor.



Leslie Fielding, senior fitter tester of Avro Canada's gas turbine plant at Nobel, tests the Orenda compressor with a stethoscope.

compressor and turbine and the combustion chamber.

To test the complete axial-flow type compressor the electrical generator was removed from its bedplate. The steam turbine of 6,000 hp with the addition of speed-increasing gears now drives the compressor on test at speeds up to 11,000 rpm if necessary.

The complete axial-flow compressor consists of several rows of alternately rotating and stationary blading. To supplement the information obtained from the test of a complete compressor, tests are carried out on individual stages, comprising one row of rotating blading preceded and followed by a row of stationary blading. Tests also are made on individual stationary rows of blades. These tests are called "single-stage" tests and "cascade" tests respectively.

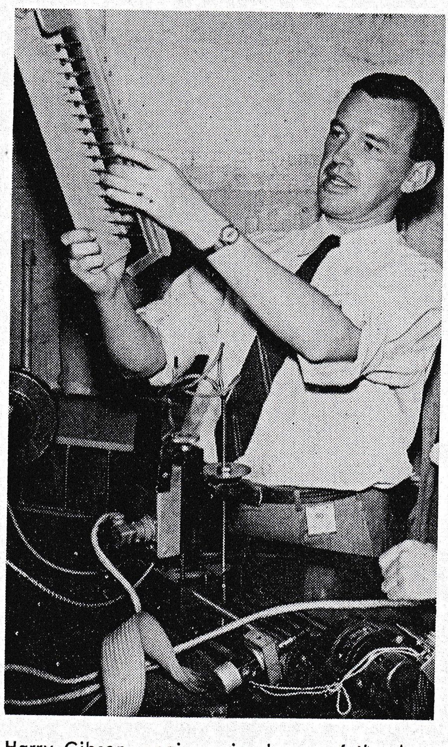
While single-stage tests can be conducted on the same test rig as a complete compressor, to speed up the program a special rig has been built for these tests. The cascade tests are carried out on a special cascade test rig.

The cascade test rig is simply a wind tunnel into which a row of blading is inserted. The efficiency of the blade row at its particular configuration is derived from pressure measurements before and after the blade row. Its air supply is derived from three 500-hp reciprocating compressors. Needless to say, because of its simple mechanical construction and the ease of producing test specimens, the cascade rig was one of the first rigs to come into operation and has yielded much valuable information in the past several years.

The testing facilities for turbine development are similar to those for compressors and since a complete turbine consists of one or two stages, only one rig is required to carry out rotating turbine tests. The turbine under test is driven by low-pressure steam and the power produced by the test is absorbed by a directly driven eddy-current-type dynamometer.

The supplementary turbine cascade tests use the same rig as the compressor cascade tests.

At the present stage of jet engine development, both the axial-flow compressor and turbine programs in their many phases require the services of many specialists and special machines. Fortunately, to a large extent, the many program phases can be divided between the Nobel and Malton plants. All design, drafting and manufacture of the rigs and experimental blading is carried out at Malton while Nobel concerns itself only with the testing of the experimental blade forms supplied.



Harry Gibson, engineer in charge of the Avro gas turbine test plant, demonstrates the variable-incidence wind tunnel used in research on Orenda engines.

However, in the case of combustion chamber development, because of the empirical or "cut and try" nature of the work, it is impossible to separate the initial program phases. The Nobel Test Establishment is therefore fully equipped to handle the design, drafting manufacture and testing of combustion chambers.

The initial development and testing of a combustion chamber normally is carried out with the chamber exhausting at atmospheric pressure since this allows the program to start in the shortest possible time, the test rig being quite simply constructed and an ecomony of fuel and air supply being achieved. A low-pressure turbine-driven centrifugal blower is the source of air supply. Sea-level atmospheric pressure in the combustion chamber corresponds to conditions occurring when the engine is operating at between 30,000 and 40,000-ft. altitude.

While the general aerodynamic and thermodynamic pattern within the chamber does not change too much with the engine operating at sea level it is desirable to check the chamber performance and life at full pressure and heat release conditions corresponding to the engine running at sea-level altitude before the chamber is produced in quantity for engine

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course I know that the full term usually is used at the beginning of the article, then the abbreviation is used. However, I note more and more instances where no enlightenment is given . . .

Albert E. Cummings
Arborford, Sask.

Note—USAF—United States Air Force; DME—Distance Measuring Equipment; VHF—Very High Frequency (radio); QCA—Queen Charlotte Airlines; SAS—Scandinavian Airlines System; BOAC—British Overseas Airways Corporation; TCA—Trans-Canada Air Lines; TWA—Trans-World Airways—The Editor.

AIR POWER WILL BE DECISIVE IN WAR

(Continued from page 28)

terrible menace was reduced to a serious nuisance. By the end of 1943, after nearly a year of intensive bombardment, Germany was defeated in the air and desperately short of all military equipment and clothing. By the spring of 1944 the combined effect of our air offensive and attrition on the Eastern front had brought about the collapse of German military power and she was ripe for invasion.

Later, Germany's loss of the Romanian oilfields and the improved accuracy of the Allied radar bombing technique made it practicable, for the first time, to bring about a fuel shortage by destroying the German synthetic oil plants. Thus, toward the end of the war, the German forces were largely immobilized for lack of fuel.

To sum up, the air offensive against Germany was successful, and alone made the final assault possible. In the Pacific, once the heavy bombers were brought within range of Japan, they ended the war. Incidentally, no one who has seen the Japanese industrial cities would believe that the British had a monopoly of the practice of "area bombing."

If the Allied air offensive could so cripple Germany that we could invade Europe by sea, and so devastate Japanese industry as to bring about her surrender without invasion, what will airpower—equipped with high-speed, long-range bombers, improved radar, and atom bombs—be able to do in the future? Can anyone doubt that airpower, so armed, will be decisive?

JET SECRETS PROBED AT NOBEL PLANT

(Continued from page 27)

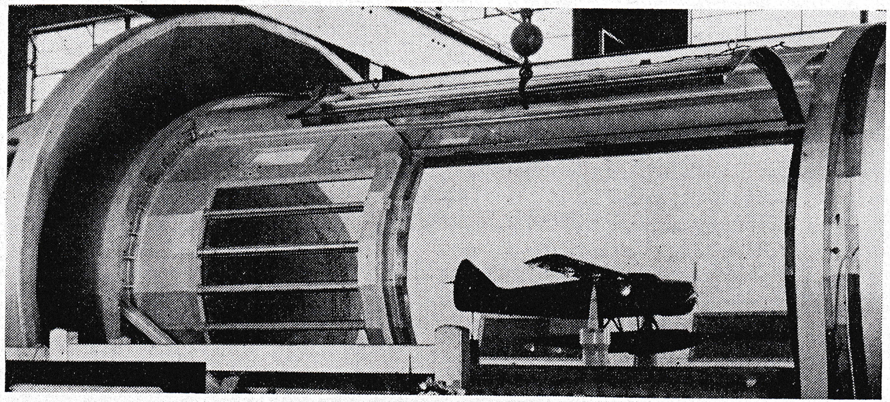
bench tests. For these tests the full output of five 500-hp reciprocating compressors is required. Of course, for some extremely large types of combustion chamber the cost of installing plant for high-pressure testing would be prohibitive so that this development phase would have to be carried out on the engine.

The final development phase of a combustion chamber, as a separate component, is "altitude" testing. Today aircraft may be required to operate at altitudes as high as 70,000 ft. where the chamber pressure is less than sea-level atmospheric pressure of 14.7 lb. psi.

However, this condition can also occur whenever it is necessary to start the engine in flight and the decrease in the pressure of the atmosphere with altitude is greater than the ram pressure of forward speed.

As is well known it becomes increasingly difficult to initiate and maintain efficient combustion with decreasing air density in the chamber. The "altitude" or sub-sea-level atmospheric pressure test rig is there-

BELOW—Design of the King Beaver has been assisted by wind tunnel experiments conducted by the National Research Council at Ottawa. This photo shows the scale model of the new aircraft in the NRC wind tunnel.



fore used to develop ignition systems and study the combustion process which will occur in engines operating at extreme altitude.

The subsea-level amospheric pressures are achieved by the use of a powerful steam ejector.

In view of the large number of programs being followed simultaneously at Nobel and because of electric power restrictions at certain hours it is necessary to operate on a 24-hour basis. The cascade rig and high-pressure combustion rig require up to 2,400 kw for operation of the synchronous motor-driven compressors.

In the 10 years since the first British aircraft jet engine flew, we have seen extremely rapid development take place and at this stage tremendous effort and ingenuity are required to effect further improvements.

One result of this "law of diminishing returns" gradually taking effect has been the introduction of semi-automatic recording and computing devices which allow, within a reasonable time, far more detailed investigation of the aerodynamic and thermodynamic characteristics of compressors, turbines and combustion chambers, with a correspondingly greater volume of useful data, than was possible using hand traversing, visual reading of manometers and slide-rule computation of results.

Thus today with the test specimen at hand, it is possible to make a complete two-dimensional investigation of the air flow through a cascade in a matter of hours and a three-dimensional investigation of the flow through the single stage of a compressor or turbine in weeks. Without such devices the cascade investigation would take weeks while the time and running costs for a single-stage investigation would place it outside the bounds of practical realism.

Ultimately, of course, the human factor must enter the picture when it comes to the problem of the analysis of results as a finite time is required to decide upon the next line of attack but so far, in view of all the other processes involved, such as design and manufacture of specimens, this limitation to the rate of progress of a program has not yet materialized, to any extent.

At present we have established programs stretching into the next two years which will yield continuous and useful results over the whole of that time. As to when the "law of diminishing returns" will come into effect, in view of the military importance of the aircraft jet engine the answer is "probably never."

FLOAT FLYING SCHOOL IN BRITISH COLUMBIA

(Continued from page 41)

insurance executive told Canadian Aviation:

"The establishment of this school is the biggest development in the field of light floatplanes flying, since such flying first started in British Columbia."

This is particularly significant because it is in British Columbia that float flying meets its hardest tests and probably has its most brilliant future. A significant feature of this type of aviation is that it proves of most service both now and in the foreseeable future in territory where the making of airstrips is either very difficult and expensive or quite impossible. Yet in such rugged, mountainous terrain chains of lakes abound and in B. C. there are, as well, the great arms of the sea, the long, winding canals which everywhere indent the coast for as much as 100 miles inland.

Fullest advantage of this spectacular terrain is taken by the Sproat Lake Float School. In fact, one division of the course deals with mountain flying.

Mastering Mountain Flying

Here for instance the student is asked to set his craft down on some mountain lake cupped by ridges 2,000 feet high with a 30 mph wind blowing over them. In half an hour of such instruction he gets vivid introduction to the mastery of up and down currents, and the vital importance of making the right turn on taking off. He might not meet such a condition more than once a year in his work as a pilot but once might be enough if he lacks the necessary experience.

Vancouver Island, close to the school's home base, offers perhaps the greatest variety of float-flying hazards. The Alberni Canal which almost bisects the Island from the west would be hard to beat for rough air conditions. Nearby Tofino on the coast provides a frequent landing assignment for the student. Here he is confronted by a combination of a dock crowded with fishing boats, high pilings, usually a cross wind, and changing currents. Add frequent sea fog to this combination and you have an ideal study problem for the float school.

Nor does the nearby mainland lack problems. Near the mouth of Jervis