

A CANADIAN CONTRIBUTION TO INDUSTRIAL TECHNOLOGY

4691









Through all the associated engineering functions of designing and producing modern turbojet engines an extensive contribution is being made to Canadian technology.

Progressive, imaginative, highly skilled engineering and manufacturing personnel, supported by the finest equipment and facilities, provide this company with the capability of designing and producing a wide range of products both in the aeronautical and the industrial fields.

Backed by the resources and broad experience of A. V. Roe (Canada) Limited and the Hawker Siddeley Group, Orenda Engines Limited has contributed much to the air defence of the free world.

A brief outline of the Orenda facilities is presented in this brochure.

## **DIRECTORS AND OFFICERS**

F. T. SMYE  
*Director and Chairman of the Board*

W. R. McLACHLAN  
*Director and President*

E. K. BROWNRIDGE  
*Director, Executive Vice-President  
and General Manager*

C. A. GRINYER  
*Director and Vice-President Engineering*

K. R. CHURCH  
*Director, Vice-President Finance and Treasurer*

P. Y. DAVOUD  
*Director and Vice-President Sales and Service*

A. A. BAILIE  
*Director*

J. H. READY  
*Secretary*

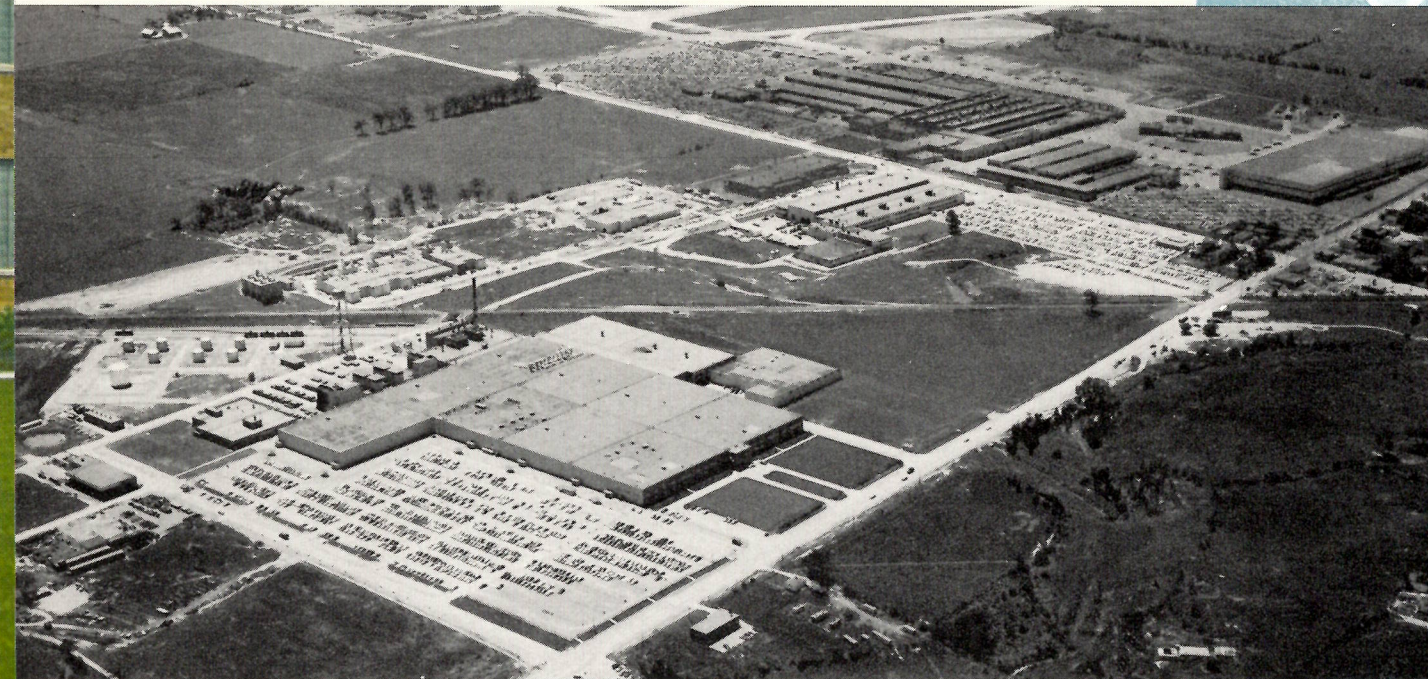
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# Orenda facilities

The main plant is located at Malton, a few miles northwest of Toronto, Ontario, Canada. Close to road, rail and air transport, and the St. Lawrence Seaway shipping, this facility is ideally positioned for efficient operation, with adequate room for expansion.

A test establishment is situated at Nobel, Ontario, close to the shores of Georgian Bay. Chosen because it satisfied the requirement for large quantities of available power and water, this site also features remoteness for the release of high energy sound.



*Orenda Main Plant at Malton*



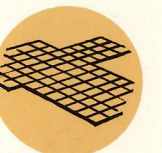
*Section of Nobel Test Establishment*



Personnel—  
about 5,000.



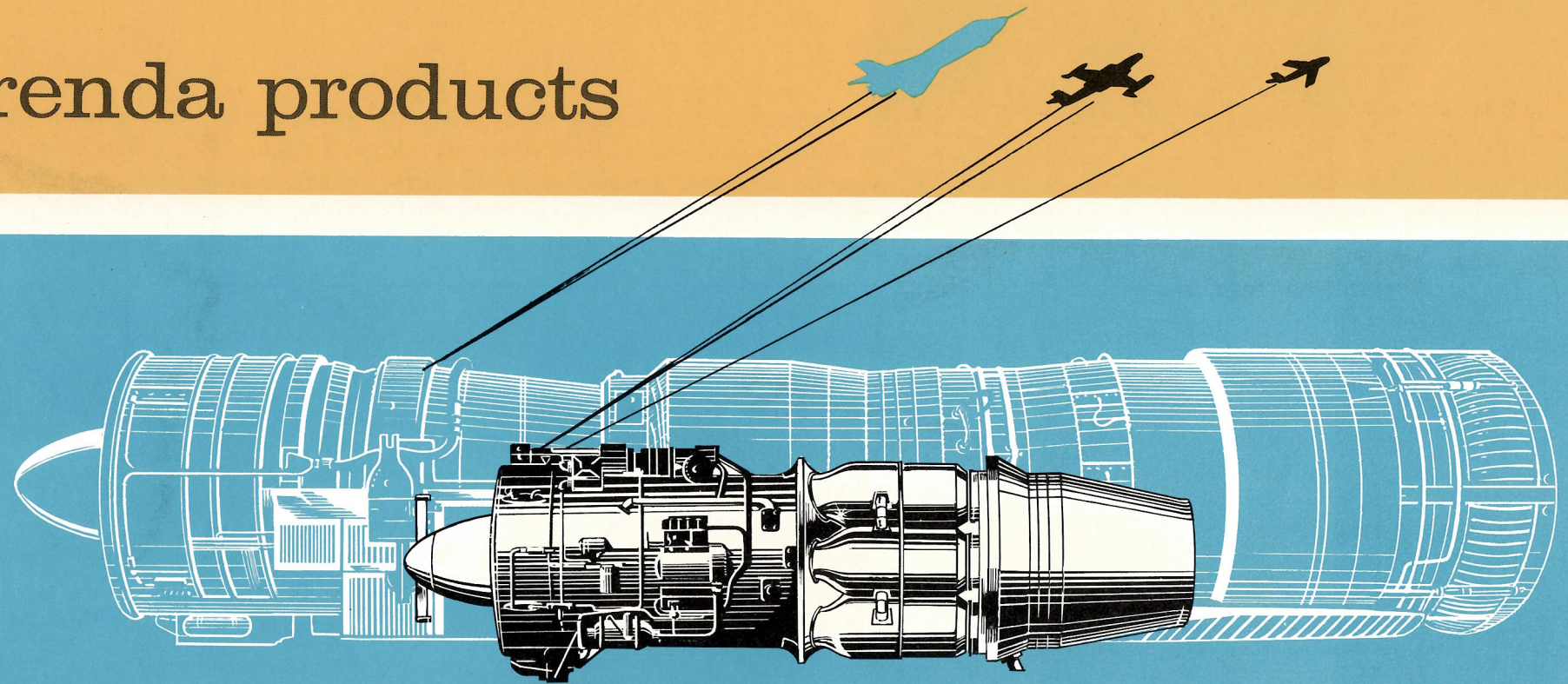
Orenda's  
replacement  
assets—  
\$46,550,600.



Company  
floor area—  
1¼ million  
sq. ft.



# Orenda products



## ORENDA ENGINE

The Orenda, the Company's first production engine, is a single-spool axial flow turbojet. Since its conception, it has undergone constant development through to Model 14, resulting in appreciable reductions in specific weight and specific fuel consumption. This achievement has permitted the Orenda to become one of the most competitive aero engines in its class today.

The Orenda engine powers the Avro CF-100 all-weather interceptor and the Canadair F-86 Sabre 6 day fighter.

These formidable weapons which comprise the front line aircraft for the Royal Canadian Air Force, have been also purchased by the Air Forces of South Africa, Colombia, Belgium and West Germany.

## IROQUOIS ENGINE

The Iroquois engine is a high thrust twin-spool axial flow turbojet engine with an integral close-coupled afterburner. It is a lightweight powerplant embodying the most advanced engineering design concepts and is specially suited for supersonic high performance aircraft. Careful consideration during the design of the engine makes it capable of satisfying a wide range of aircraft powerplant requirements over all possible operating conditions.

During development, the engine was subjected to thousands of hours of bench testing, was flight tested in a converted B-47 flight test vehicle, and run successfully under simulated flight conditions in excess of the initial design requirements.

In Canada, the Iroquois engine powers the supersonic delta wing Avro Arrow, a twin-engined all-weather interceptor. This extremely versatile weapons carrier is capable of over twice the speed of sound.



$$W_{NET} = C_{P_t} \eta_t T_3 \left[ 1 - \left( \frac{P_4}{P_3} \right)^{\frac{\gamma}{\gamma-1}} \right] - \frac{C_{P_c}}{\eta_c} \left[ \left( \frac{P_1}{P_2} \right)^{\frac{\gamma}{\gamma-1}} - 1 \right]$$

# Engineering

$$S_2 - S_1 = \int_{(1)}^{(2)} C_v d \log T - \frac{R}{T} \log \frac{P_2}{P_1}$$

The Orenda engineering team consists of aerodynamists, thermodynamists, metallurgists, and design and development engineers, supported by a wide range of scientific personnel specializing in chemistry, physics, mathematics, electronics, instrumentation and controls. This team has the proven capability of carrying out the preliminary design, through development to production, of products of the highest standard required either for an aeronautical or industrial application.

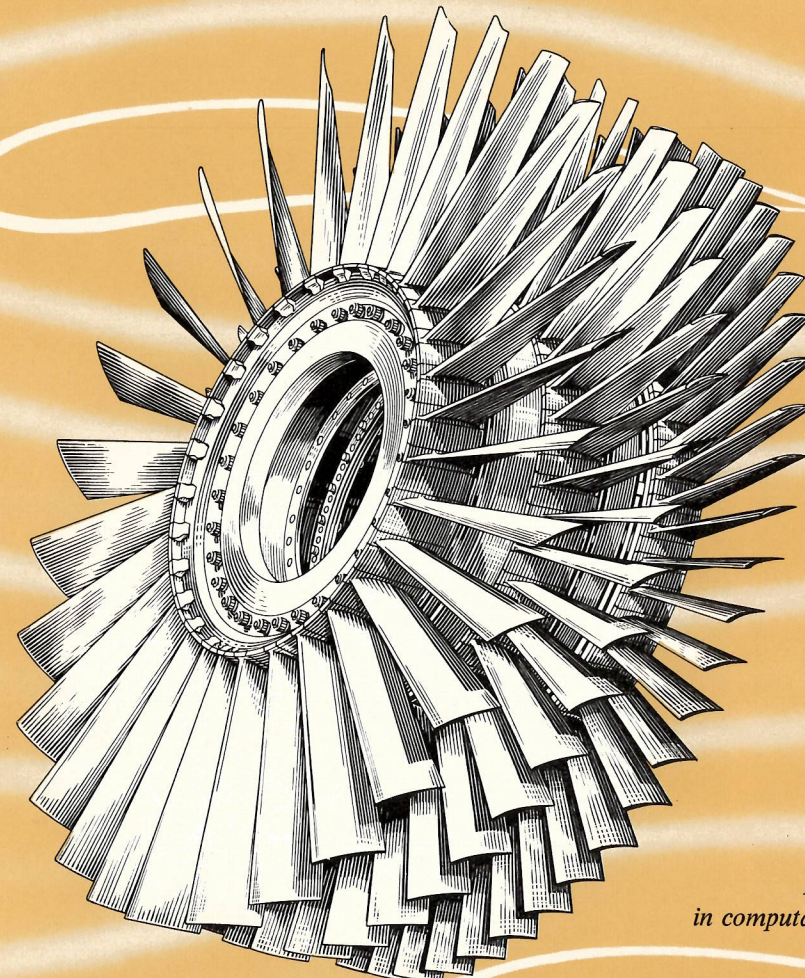
Characterized by the close coordination between design, development and technical departments, Orenda's engineering organization ensures that any project cleared for production will be of a well balanced design, incorporating the latest technology in the field of precision engineering.

Orenda engineers and technicians are in constant touch with the latest development, testing, and manufacturing processes through other members of the Hawker Siddeley Group, research organizations, and engineering societies.



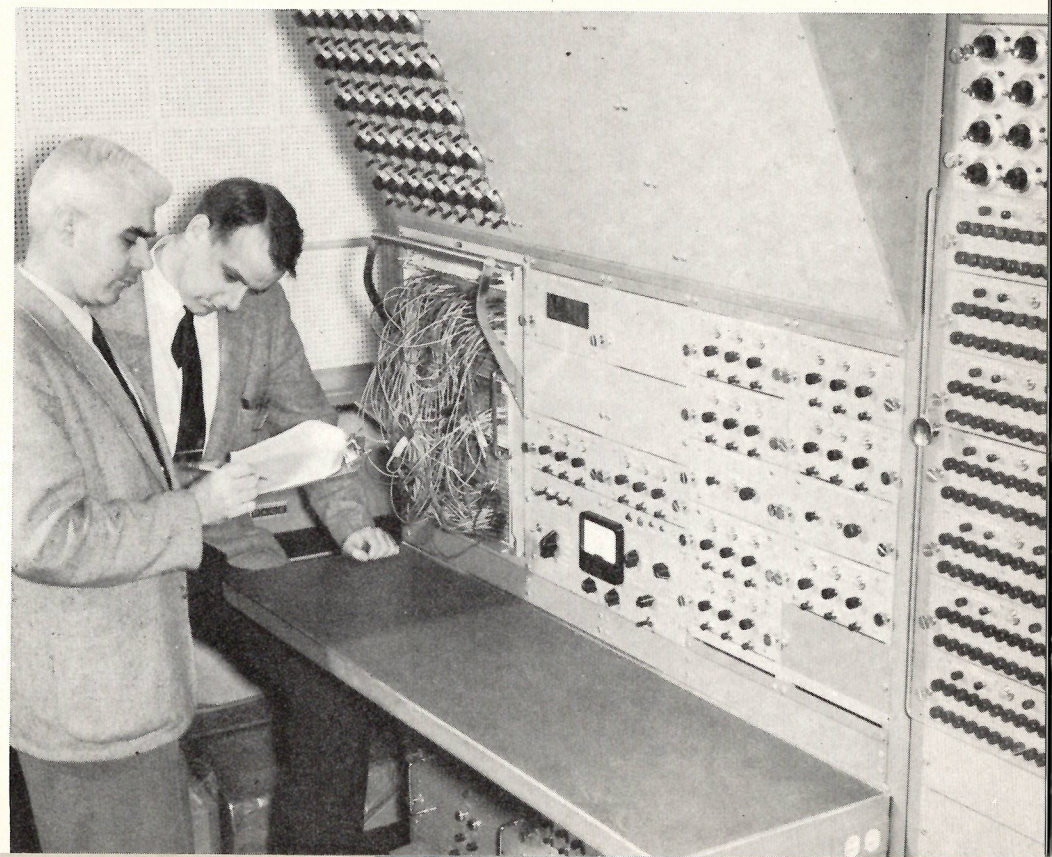
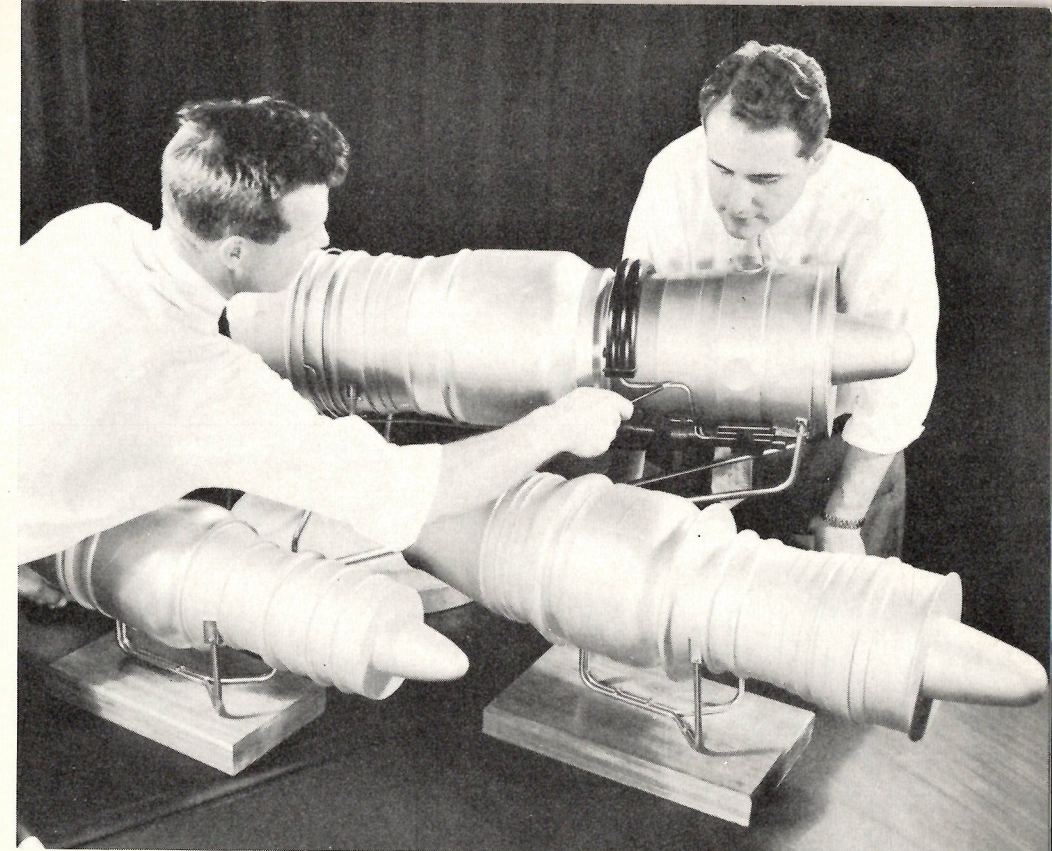


*Engine models  
used by engineers*



*Analog computer  
in computations laboratory*

In support of the Orenda engineering effort, is a computations laboratory where intricate engine cycle, stressing and design problems, are rapidly solved by data processing machines. Control, stability, and engine transient problems are simulated on analog computers.

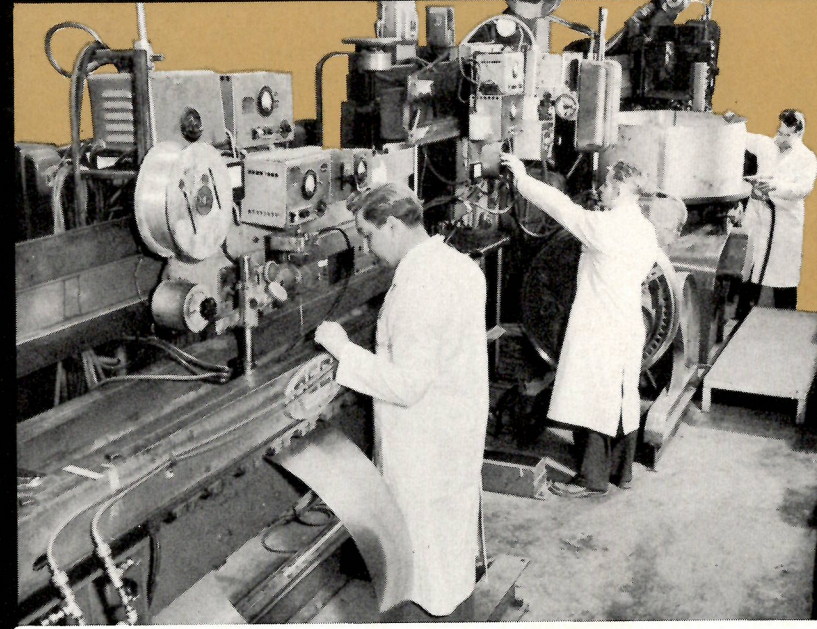




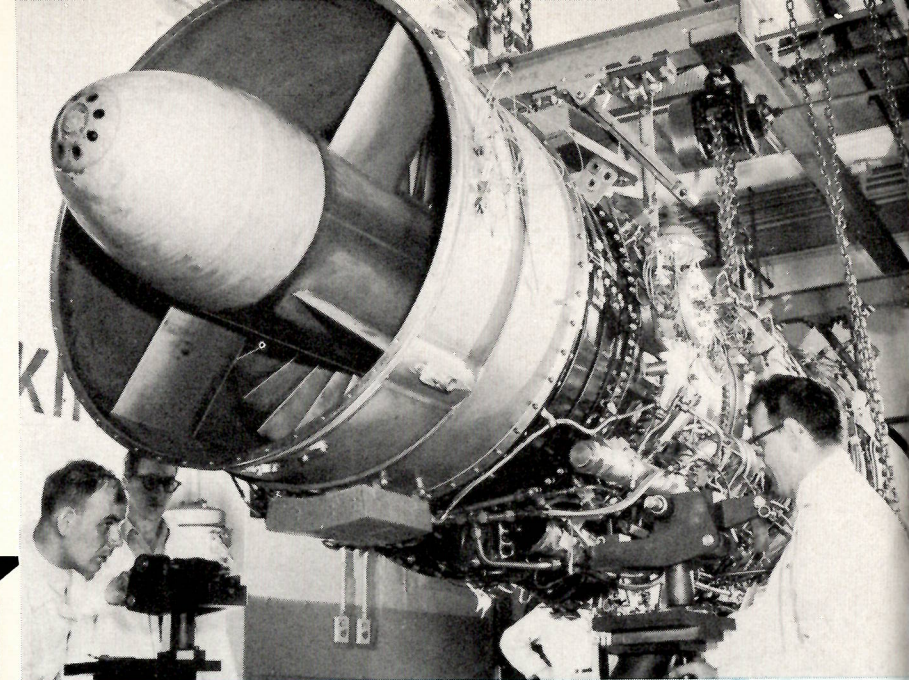
# Experimental manufacturing



*Detail inspection of experimental parts*



*Automatic welding machines*

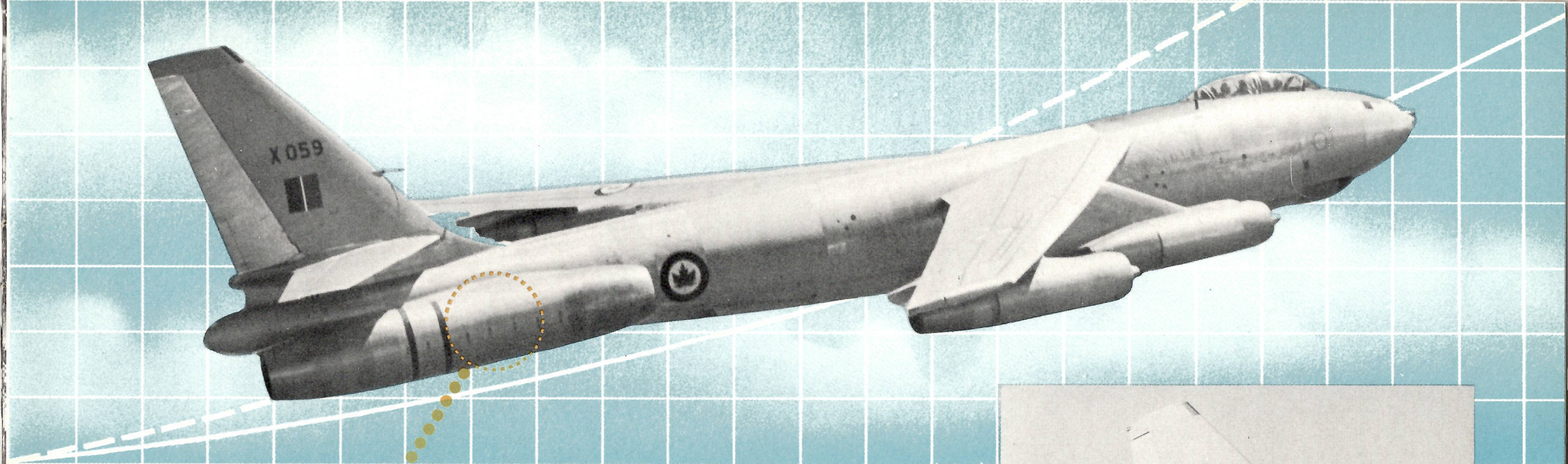


*Preparing a prototype engine for test*

The experimental manufacturing shop is designed for the flexibility of operation essential in the fabrication of prototype engines and special test components. It is an integral part of the engineering organization thus facilitating the rapid incorporation of engineering design changes and permitting close scrutiny of the engine configuration at all times by the design and development engineers.

The shop itself includes facilities for the assembly and stripping of engines and test components, manufacture of special test-rig equipment and the fabrication of mock-ups. In addition to the normal manufacturing functions, a considerable effort is applied to the development of new machining and fabrication techniques required by the use of modern high temperature, high strength and lightweight materials.

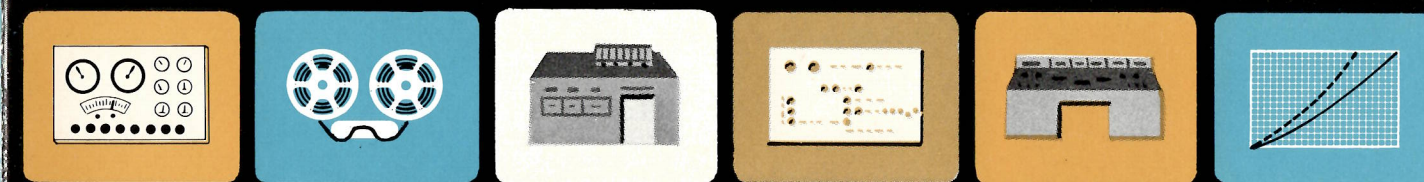
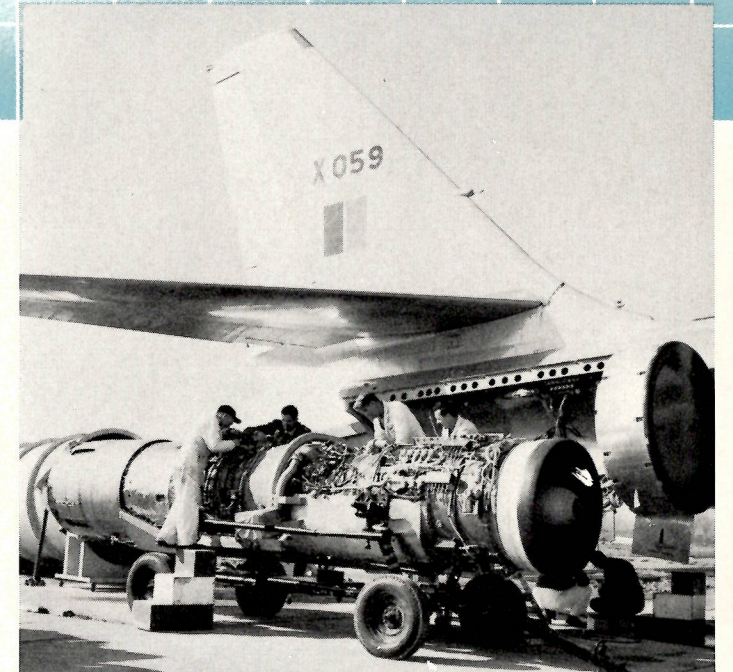




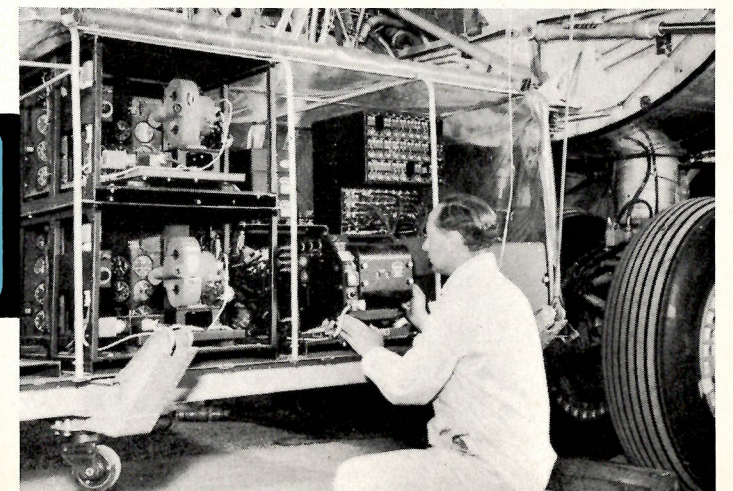
## Flight test

A valuable tool in the development of a turbojet engine is a special flight test vehicle—better known as a “flying test-bed”—equipped with comprehensive instrumentation in order to evaluate the operation and performance of the engine under actual flight conditions. The Iroquois, for example, was installed in a rear fuselage pod on a specially modified B-47 aircraft. The extensive test data, either recorded automatically or telemetered to a ground receiving station, was analyzed rapidly and integrated into the overall technical program.

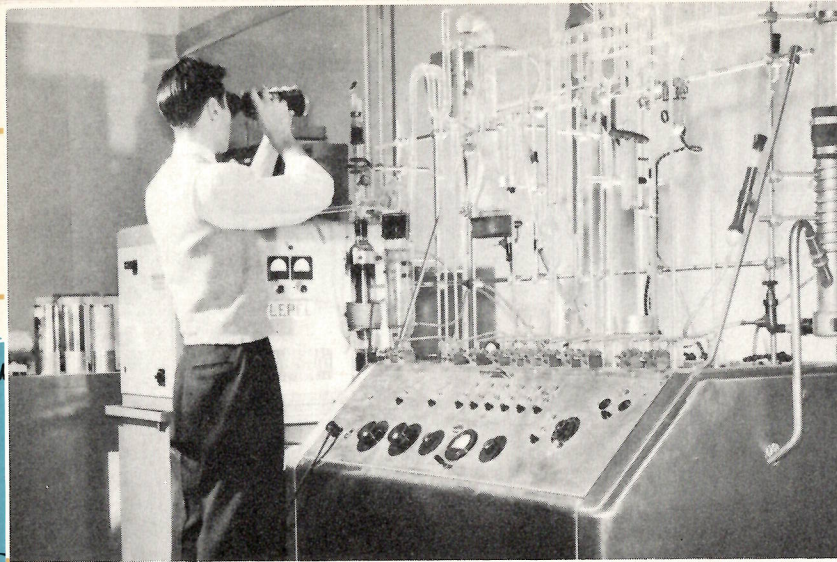
*Installing an Iroquois engine  
for flight testing*



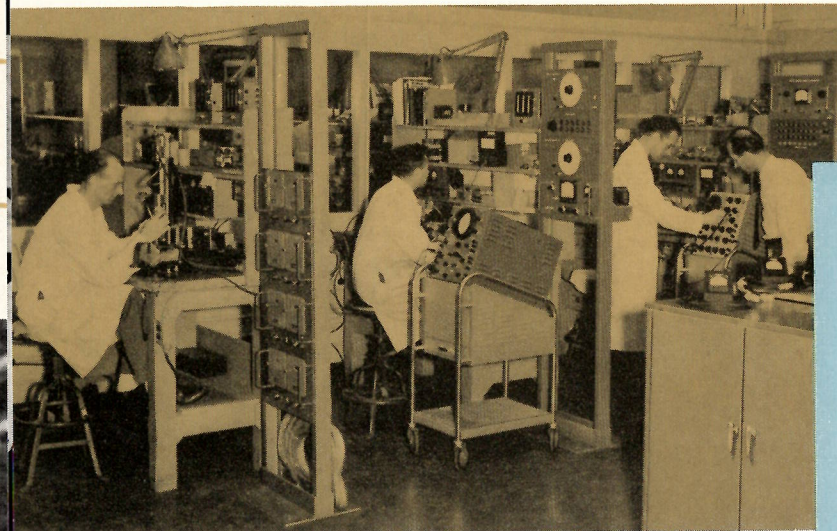
*Instrumentation pack  
installed in B.47*



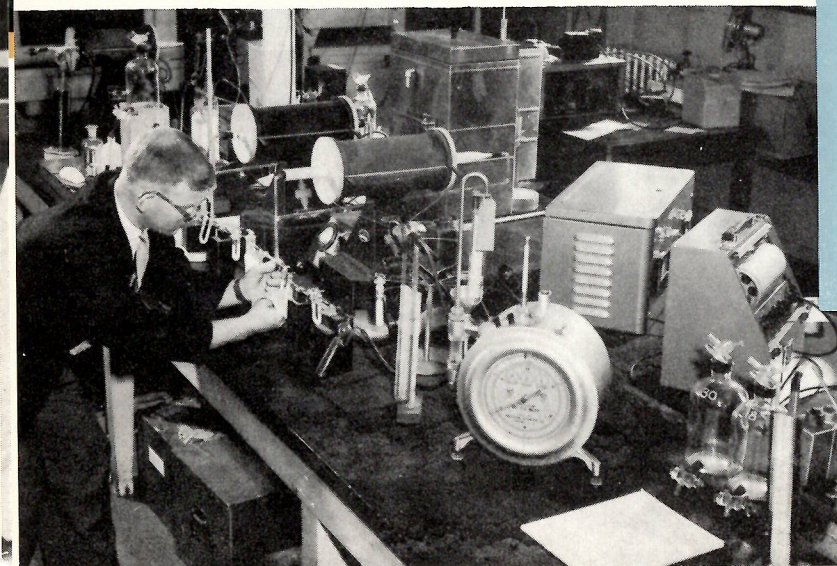




*Vacuum fusion analysis of gases in metals*



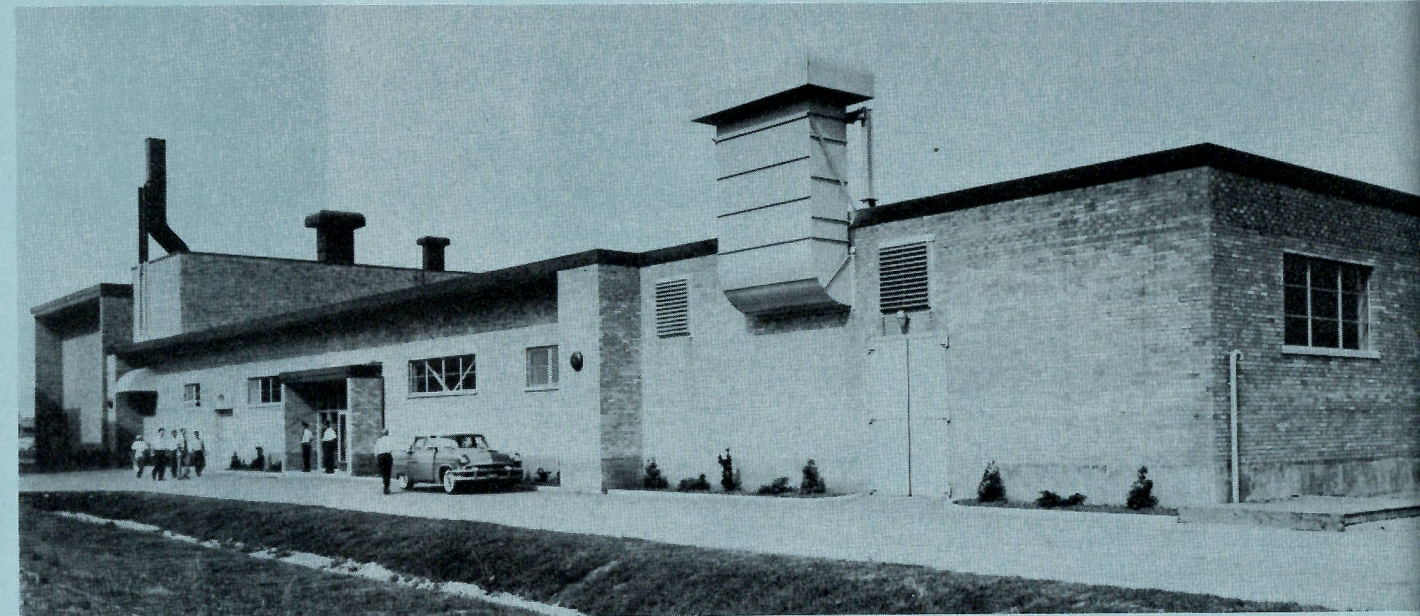
*Section of Electronics Laboratory*



*Analyzing the products of combustion*

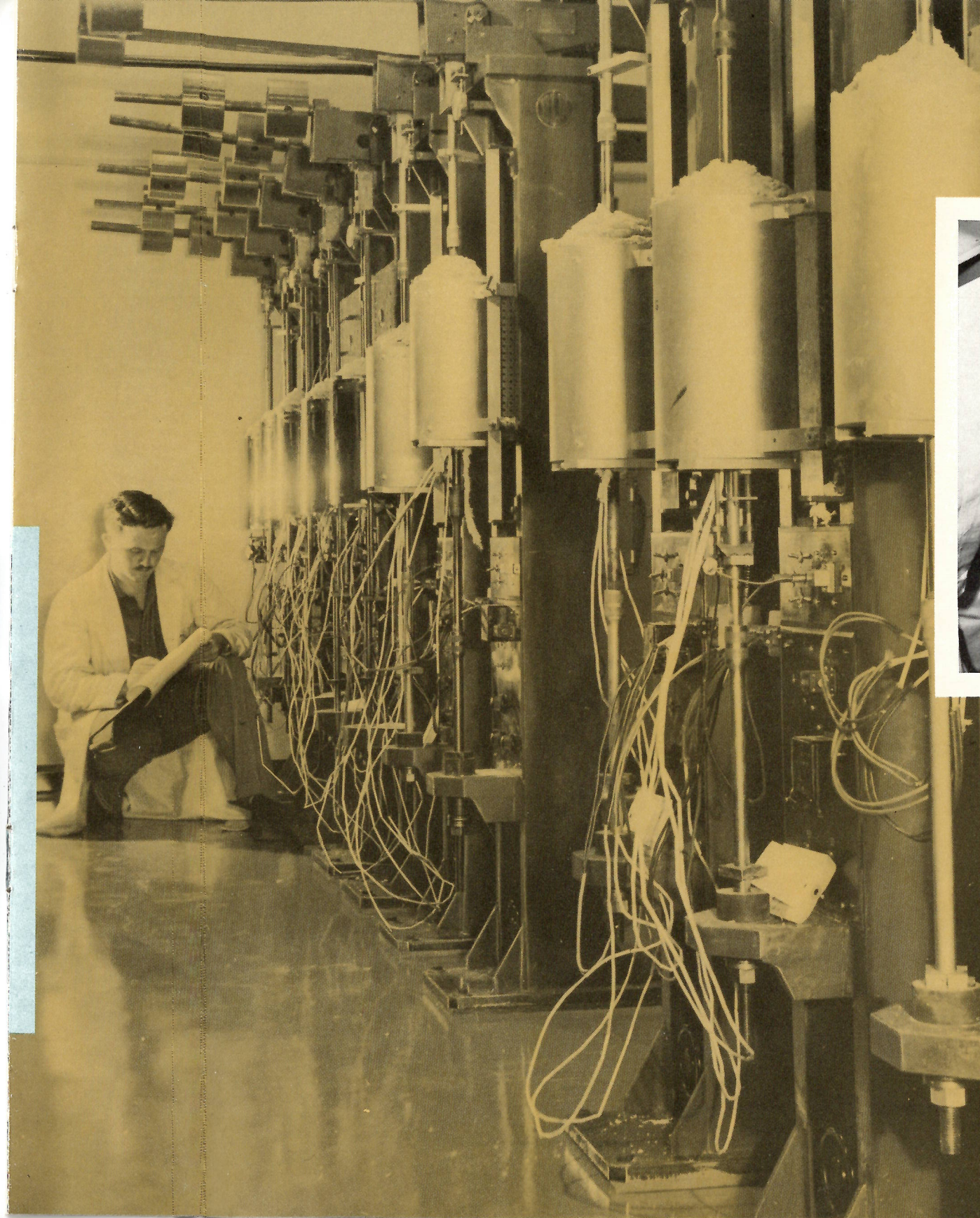
# Research

Basic investigations play a most important role in the success of future projects and are, in effect, a necessary and sound investment. Such research in the fields of metallurgy, aerodynamics, mechanics, instrumentation and controls is constantly being pursued to make possible more refined and efficient designs. At the disposal of the many Orenda technicians and scientists in the quest for this knowledge are the specially equipped laboratories such as those in the Sopwith Building.



*Orenda Sopwith Research Laboratories Building, Malton*





*Creep testing machines*



*Variable incidence cascade automatic plotter*

Outstanding among our research activities are, the investigation and development of new materials and their fabricating techniques, the design and manufacture of intricate engine instrumentation for the measurement and recording of the temperature and pressure of gases, the determination of the characteristics of hundreds of aerofoil combinations in cascade, the mechanical investigations of new components, and air flow and combustion studies.



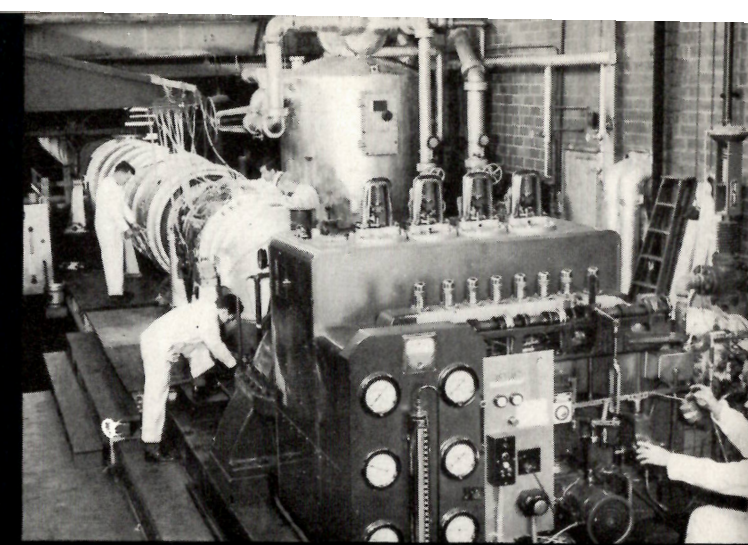
# Development

Final proving of the design of a complete engine is based on its meeting or exceeding the specification to which it is designed.

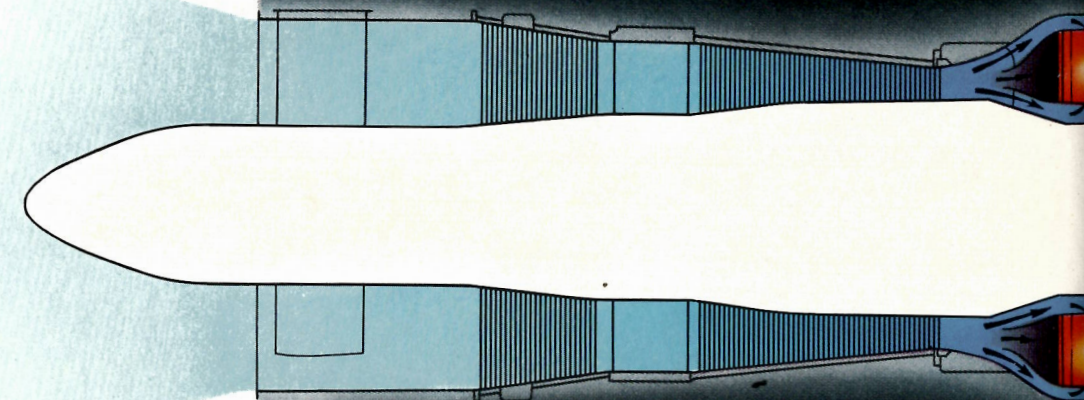
To ensure this, many hours of testing are carried out on engines in the development test cells.

Achievement of the high efficiencies required of the modern powerful turbojet engine also demands that development be carried out on individual components.

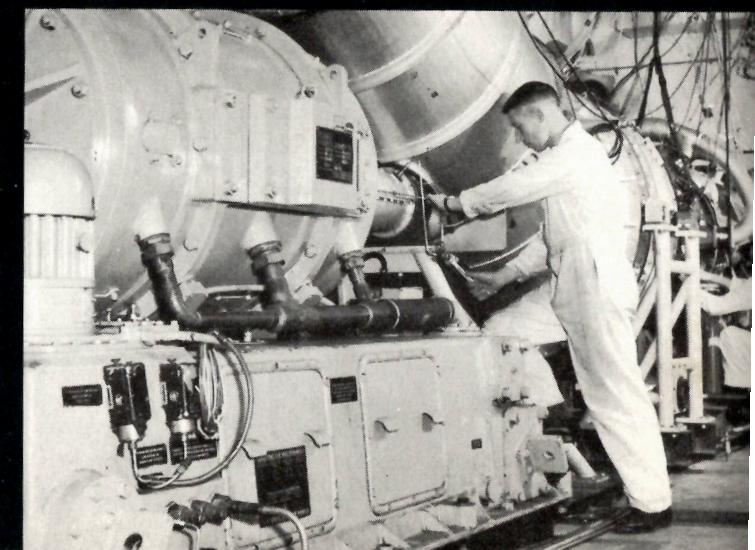
Testing of compressors, turbines, combustion chambers and mechanical components is carried out on various test rigs that are fully instrumented and able to simulate actual engine operating conditions. By this means the limits of existing technical knowledge are being extended continuously and improvements can be incorporated quickly and effectively prior to the production stage.



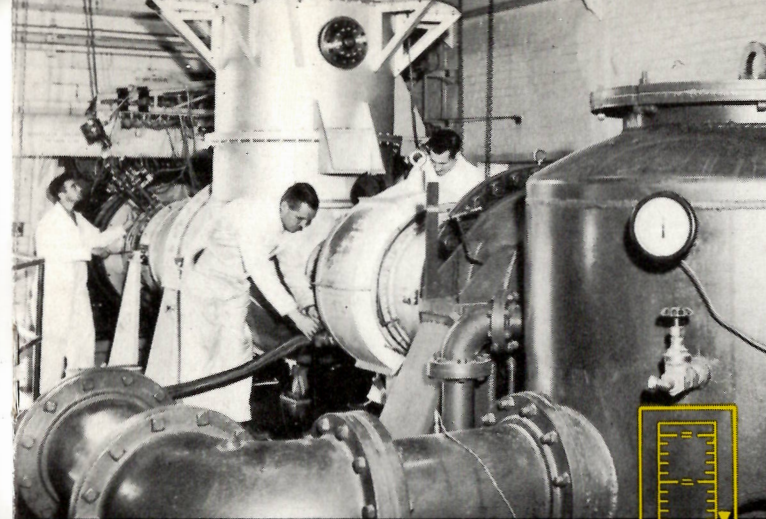
Installing a Compressor for Testing



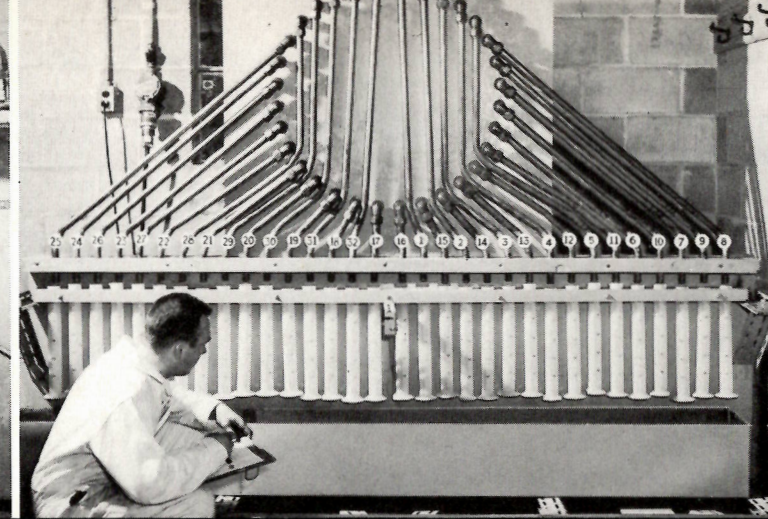
Turbine Test Rig



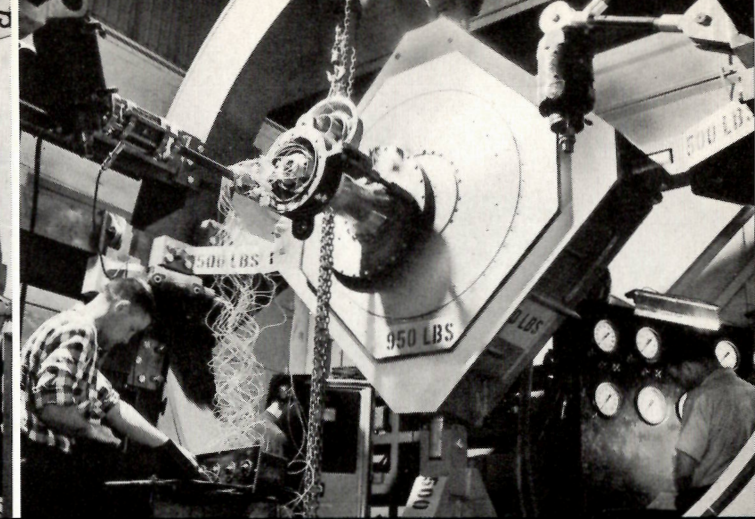




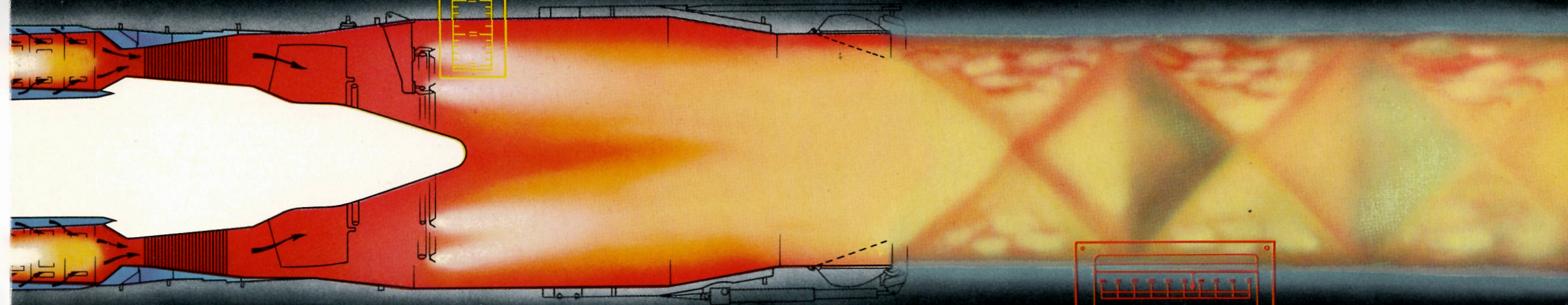
No. 2 Compressor Test Rig



Fuel System Checking Equipment

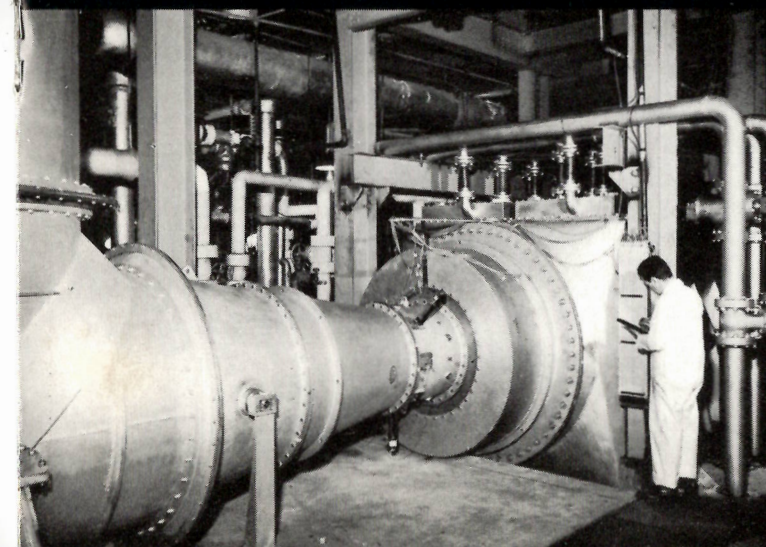


Structural Test Rig

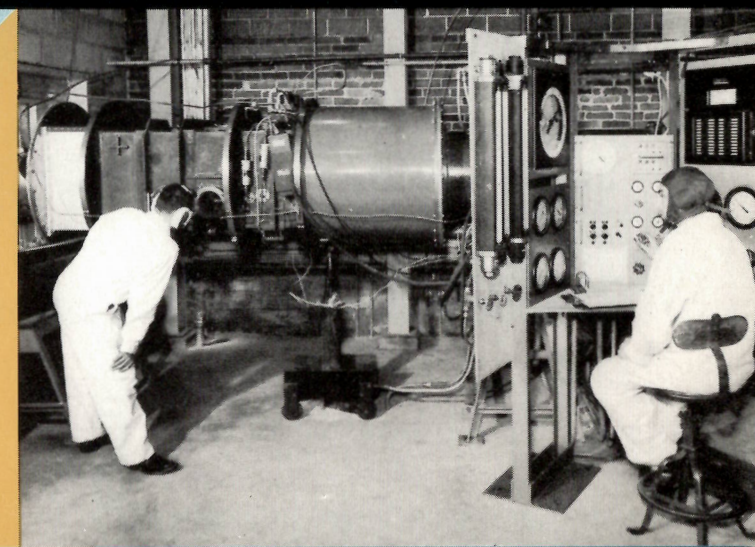


Aerodynamic Test Equipment

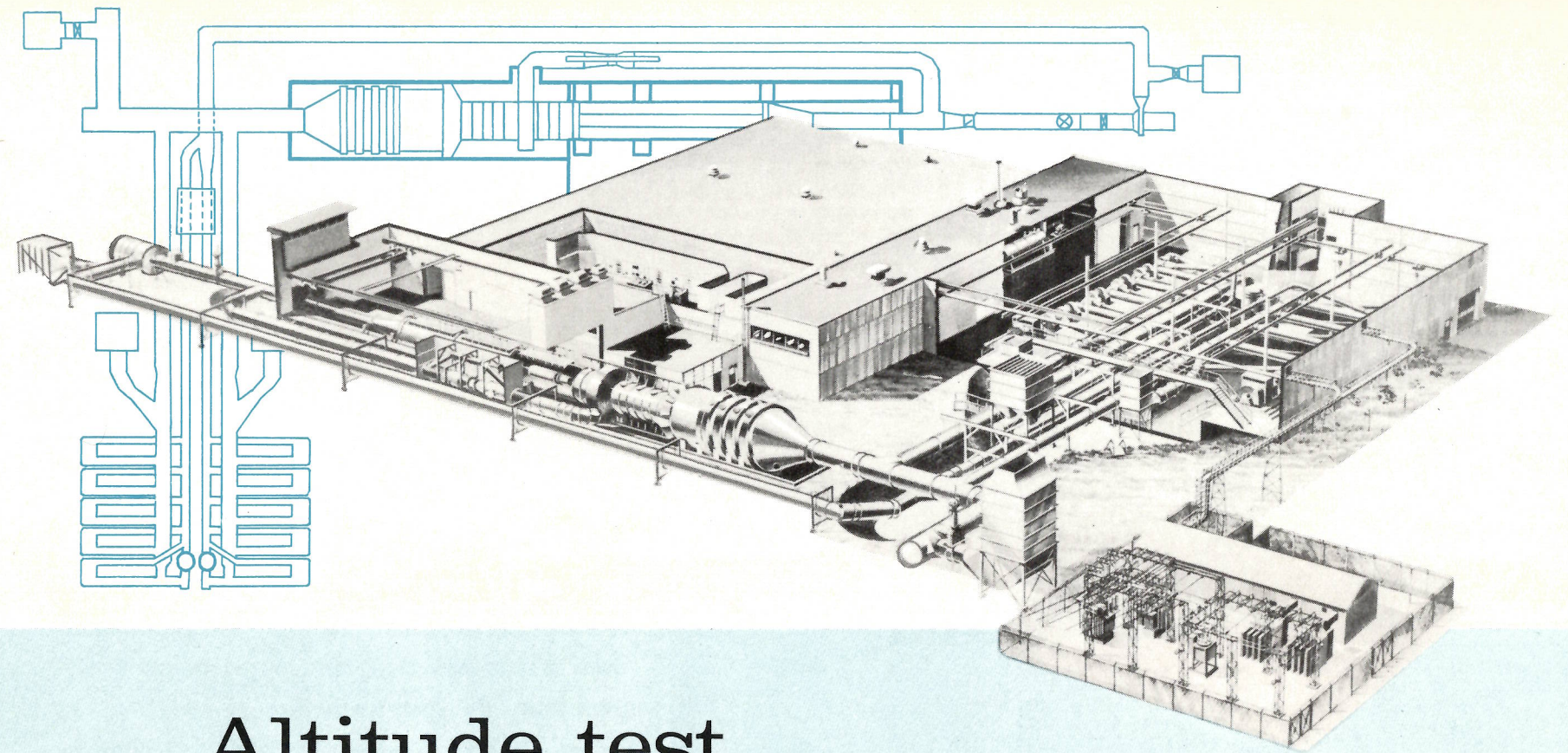
Altitude Combustion Test Rig



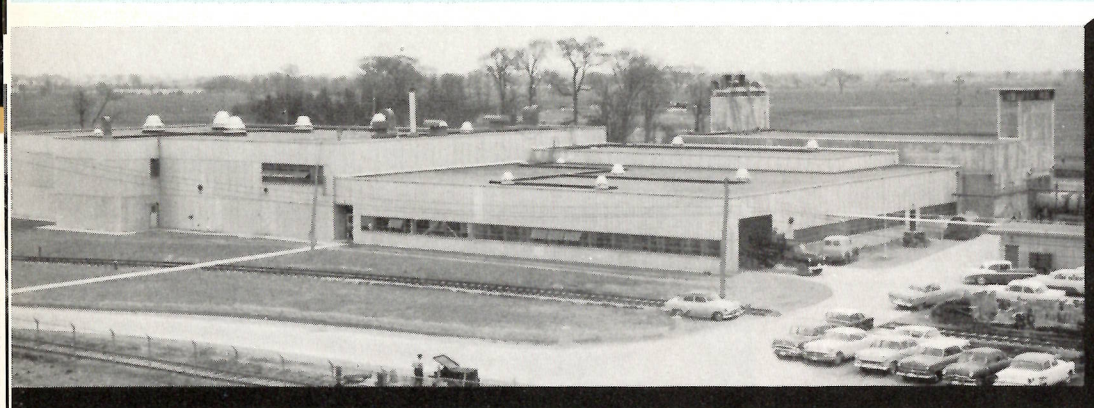
A large percentage of the aerodynamic and combustion development testing is carried out at the Nobel experimental establishment, which is laid out as a research facility having general purpose test rigs and machinery. The Nobel facility is ideal for the testing of all sizes of powerplant components.







## Altitude test facility

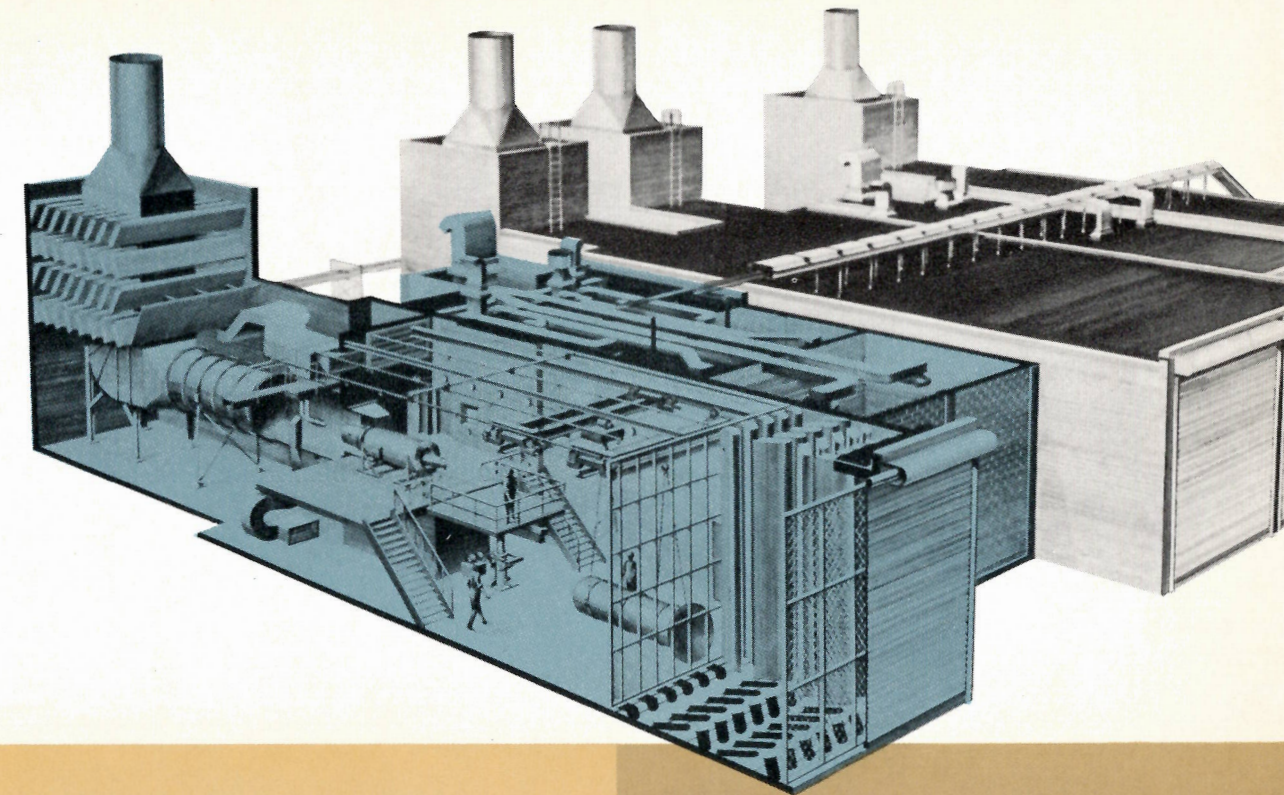
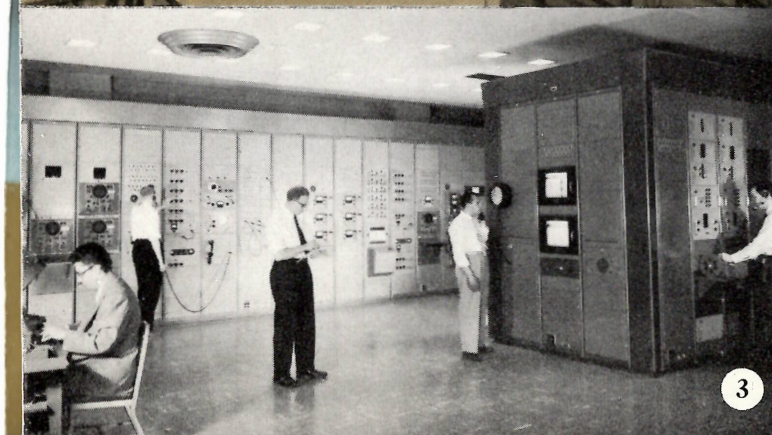
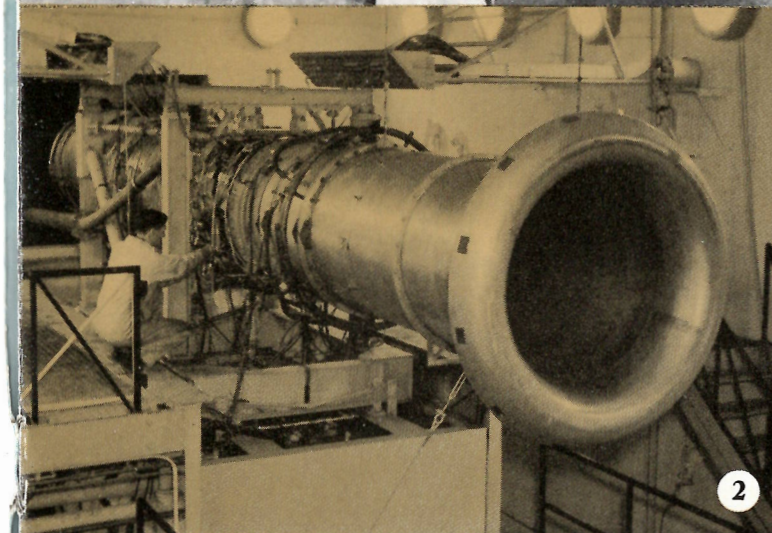
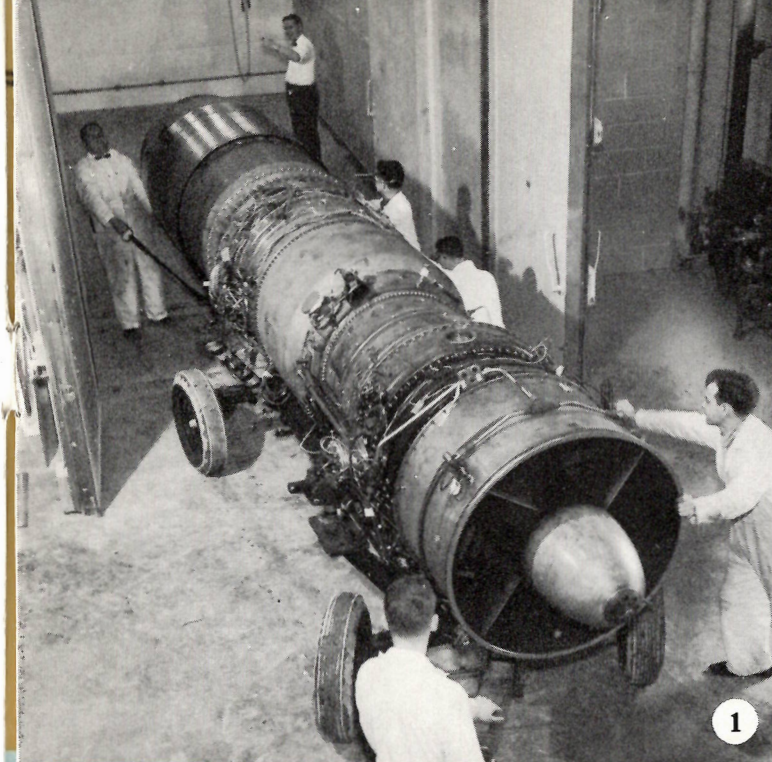


The final analysis of the operating characteristics of the modern turbojet can only be made in the aircraft for which it was intended. At an early stage however, it is necessary to assess as accurately as possible the engine's anticipated performance. This is done by flight testing in a special flight test aircraft and in addition by testing the engine in a special ground test facility, the latter providing greater flexibility and control of the actual test conditions.

The Orenda altitude facility provides a wide range of simulated altitudes and Mach numbers by means of either supplying pressure and temperature controlled air to the engine intake, or controlling the engine exit pressures. Provision has been made for the measurement and automatic recording of both engine and facility variables.

The facility is equipped for engines of up to 350 lb./sec. air flow and has been specifically designed for extension of the operating envelope, if future requirements demand.





## Development engine test

Development engines are tested in six spacious fully equipped test cells. At the Orenda Malton plant there are three separate, self-contained units comprising two cells each. Each individual cell has a silenced exhaust system, a large silenced air intake, a servicing area, and all the latest safety features.

A large portion of the engine data is communicated to a central recording room where it is automatically printed or recorded for future analysis. Constant scrutiny of engine stress and vibration levels and other vital information is maintained.

The test cells are designed for testing engines with air flows fifty per cent in excess of the largest known today.

1. Development engine ready for testing
2. Installing engine on test bed
3. Central control room
4. Development test cells



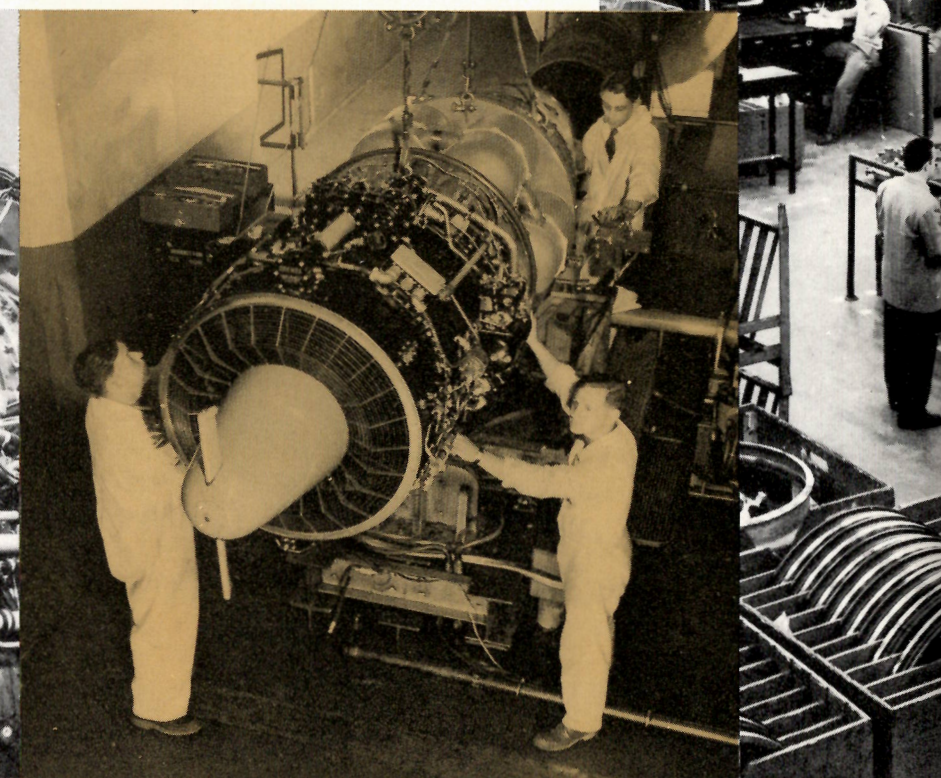
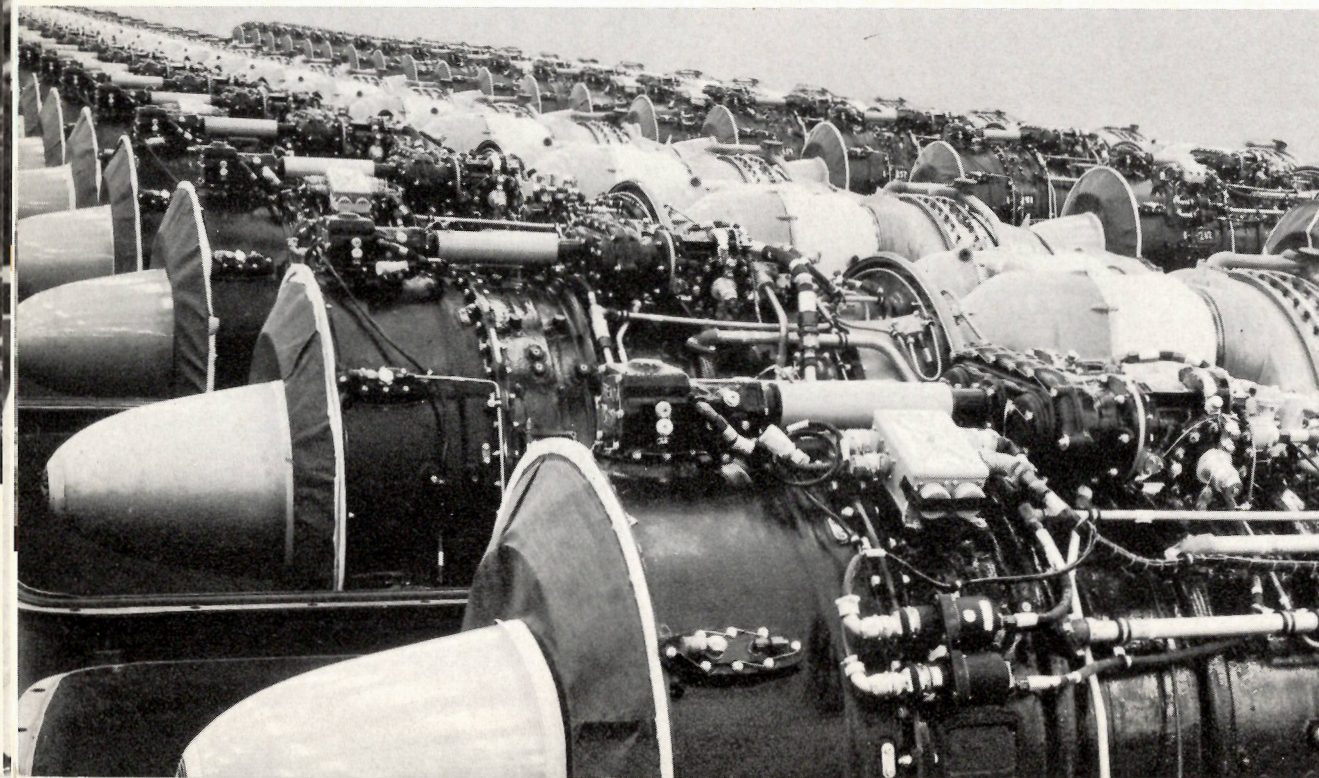
# Production

The Orenda Engines Limited production facility is located at Malton, Ontario. It comprises 800,000 square feet of floor area on one level, fully air conditioned, temperature and humidity controlled. The plant was laid out to permit rapid expansion and maintain a calculated flexibility. Over 4,000 Orenda engines have been produced from this plant at a competitive cost. Tooling for the more powerful Iroquois engine was completed in record time.

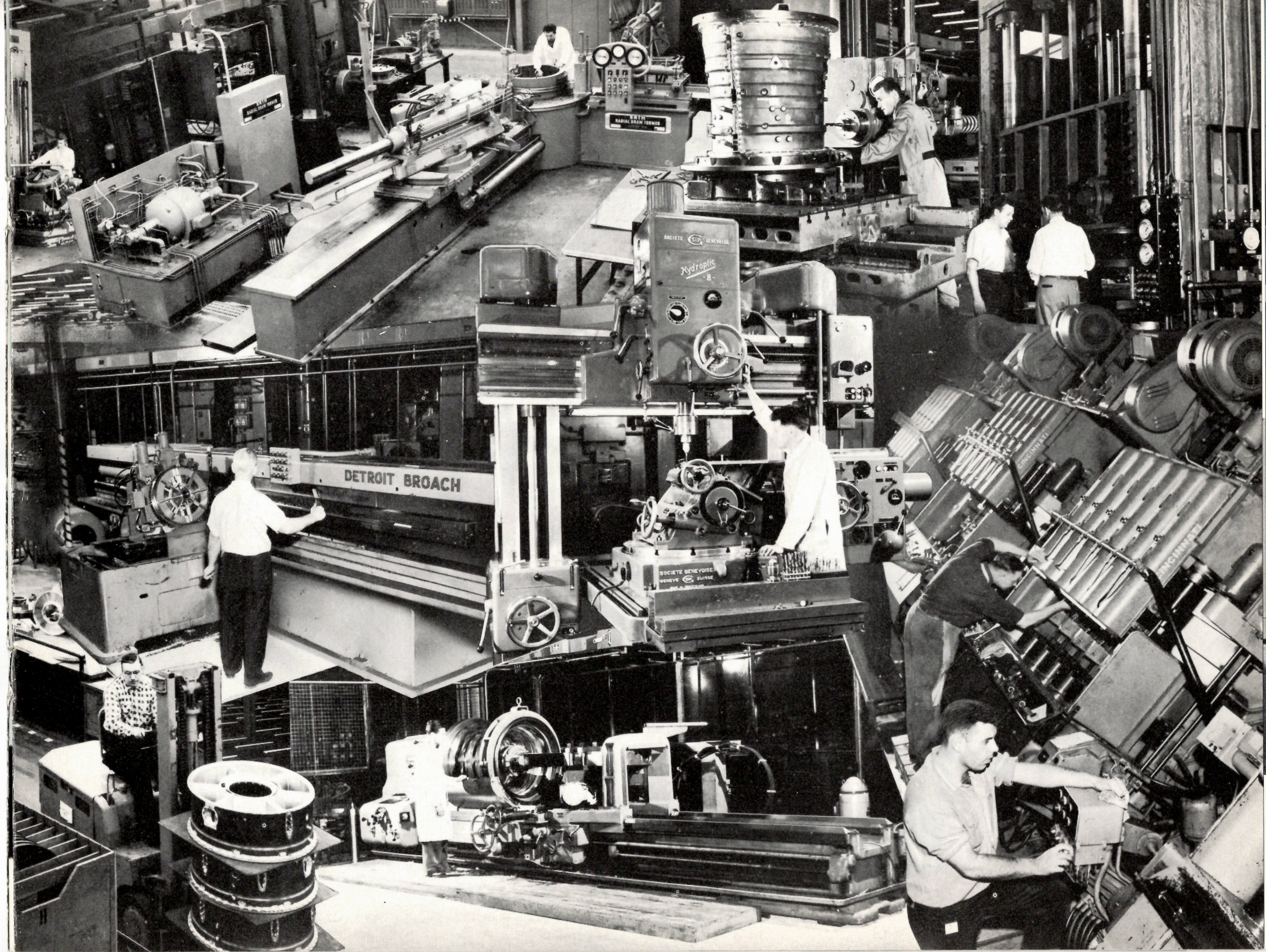
Characteristics of this plant are—modern, multi-purpose

machine tools, a heat treatment department featuring automatic equipment, a self-contained blade shop having batteries of automatic and semi-automatic machinery, and fully equipped sheet metal and pipe shops.

The production engineering group, with their wide experience and scope, have developed the use of advanced machining and fabrication techniques, which in collaboration with the engineering department, has led to reduced engine weight and cost.









# Production

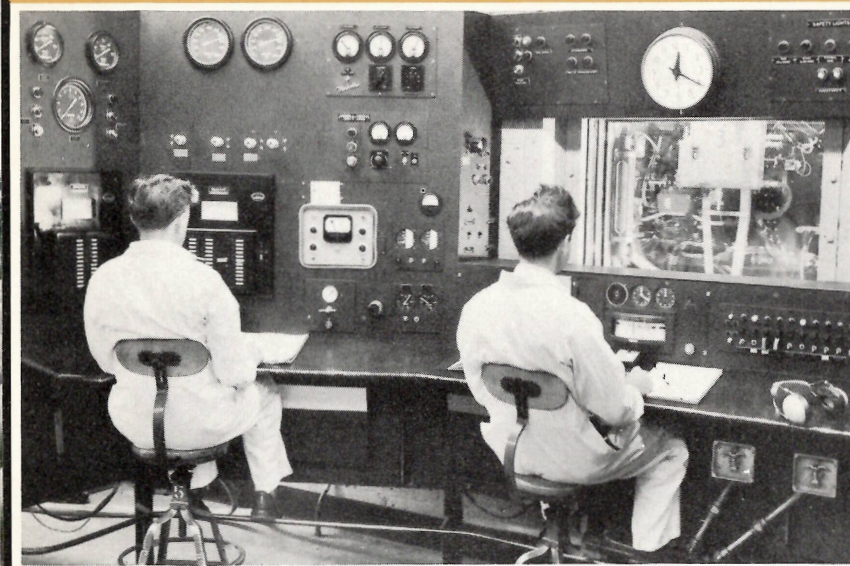
## ASSEMBLY AND TESTING



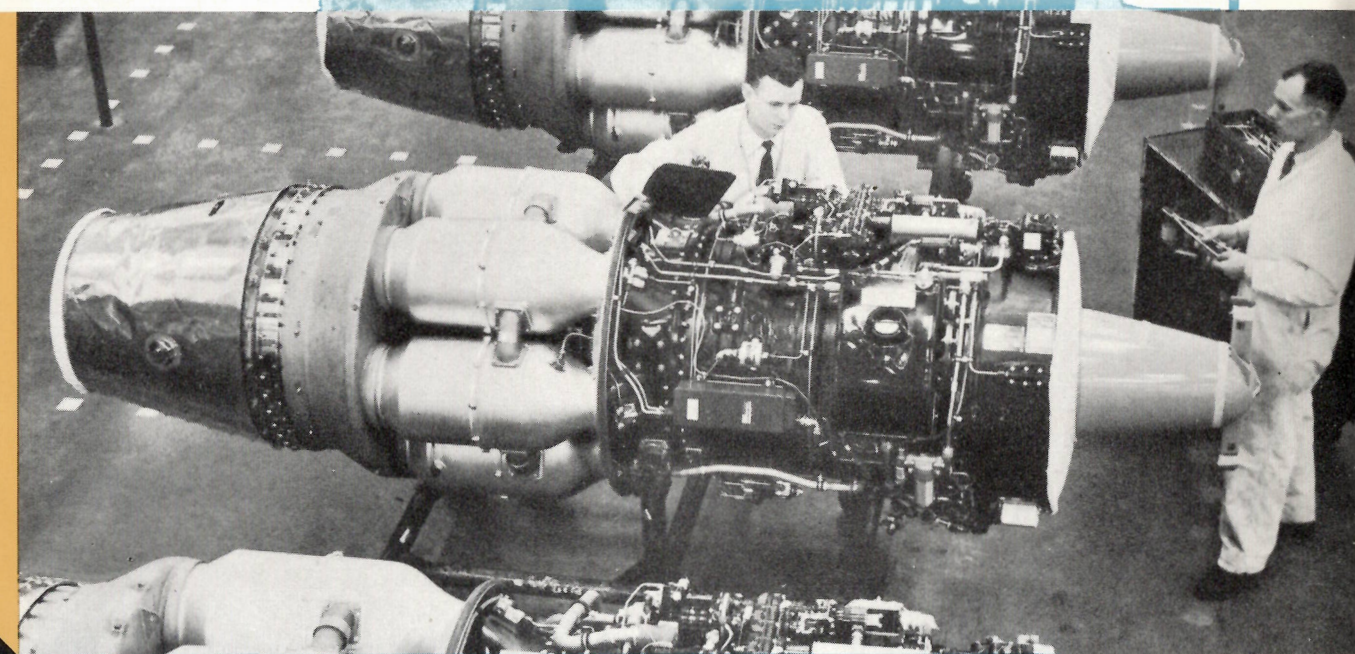
*An assembly line*

Volume engine build-up is attained by using major sub-assembly sections with well designed transportable fixtures, leading to a final assembly line where engines pass from station to station on a timed cycle.

Production acceptance testing is carried out in six production test cells, which are fully instrumented. Each engine must fall within a narrow band of acceptable performance, prior to delivery to the customer.

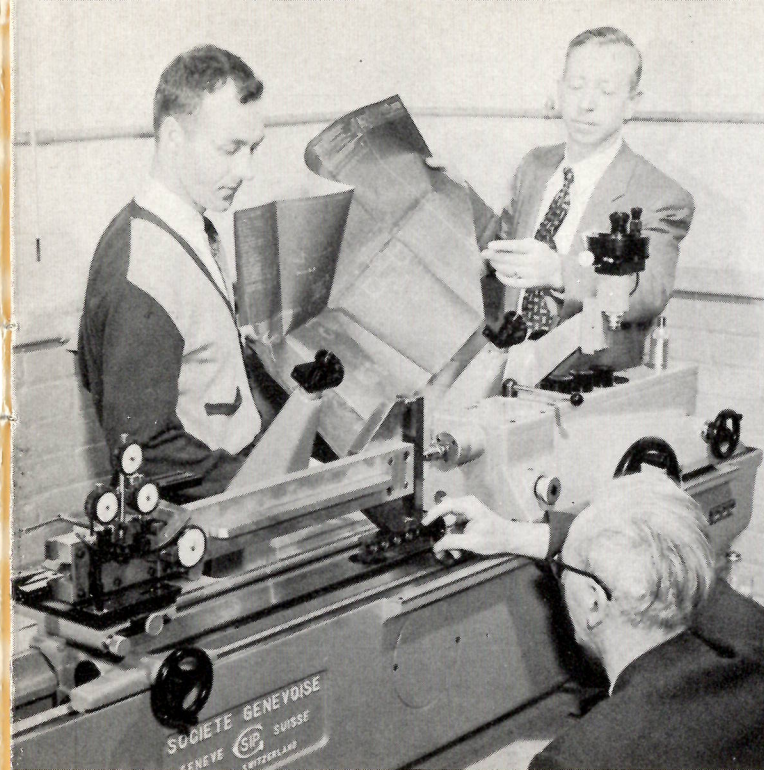


*Testing a production engine*



*Final check after test*





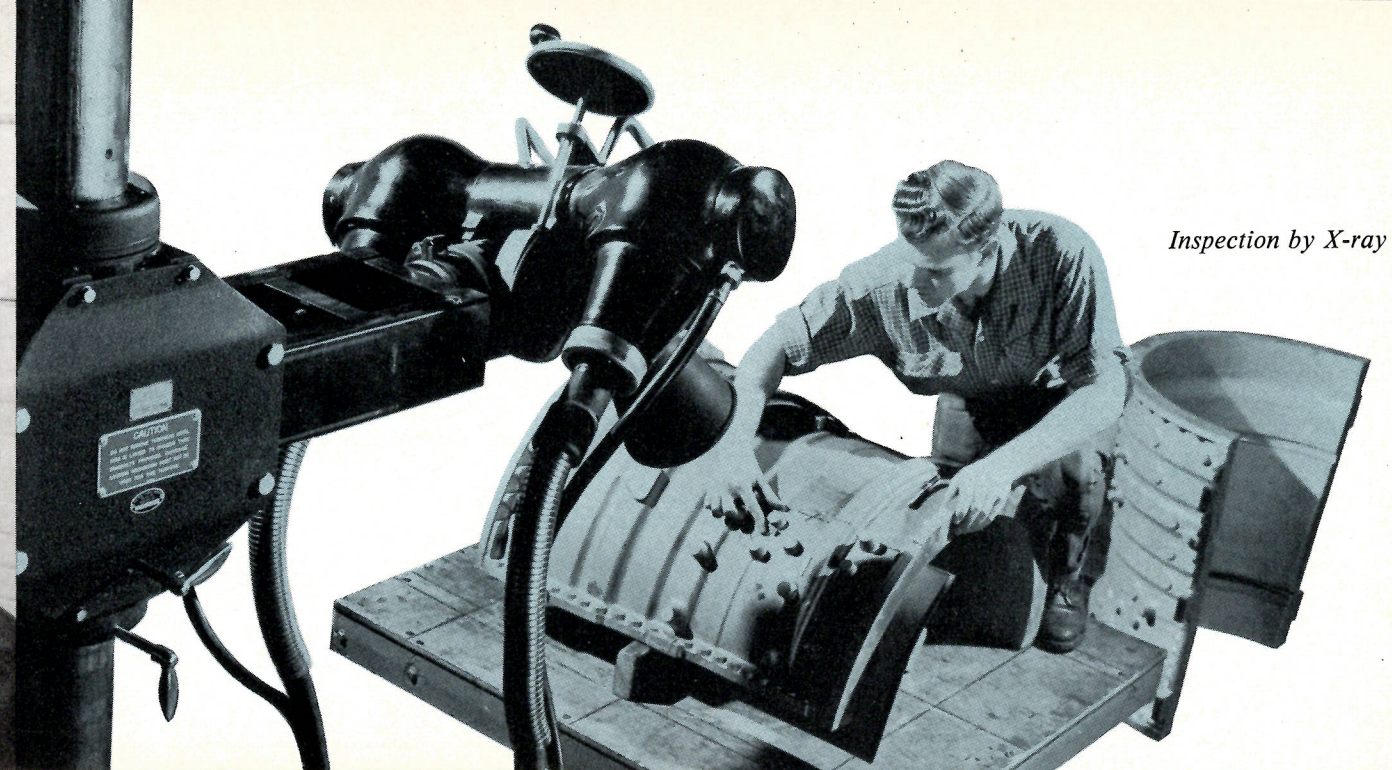
*Corner of standards room*

## QUALITY CONTROL

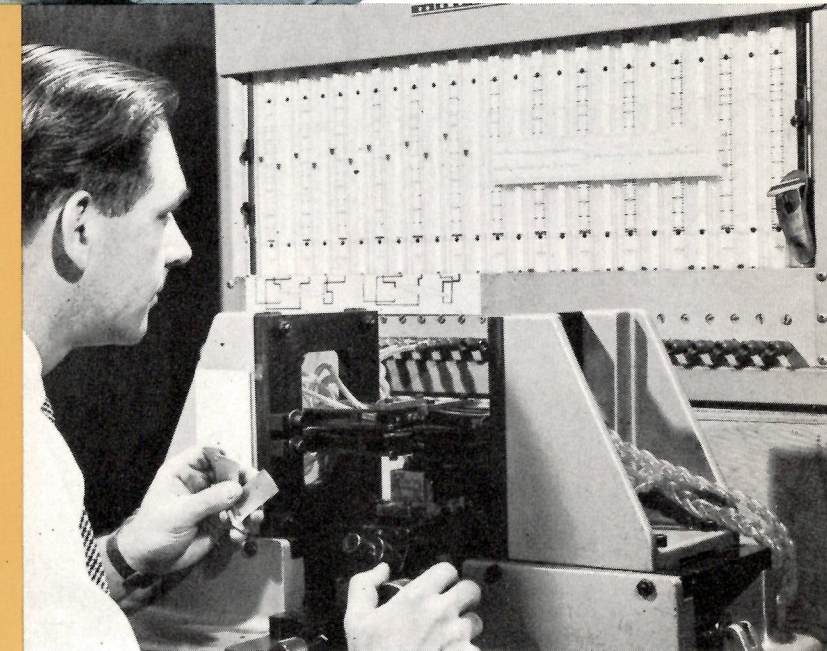
To maintain the high degree of control over the quality standards demanded in this field of precision engineering and in the manufacture of modern turbojet engines, Orenda Engines Limited maintain an experienced quality control and inspection group, furnished with the latest developments in mechanical and electronic testing and inspection equipment.

The application of rigid inspection and quality-control standards by this group, assisted by such modern methods as the ultrasonic and X-ray techniques, assures that only materials meeting the desired specification are used in manufacturing the products of the company.

Evidence that these high standards of quality are consistently maintained is indicated by the acceptance of Orenda products throughout the aviation world.



*Inspection by X-ray*



*Precision inspection of blades*



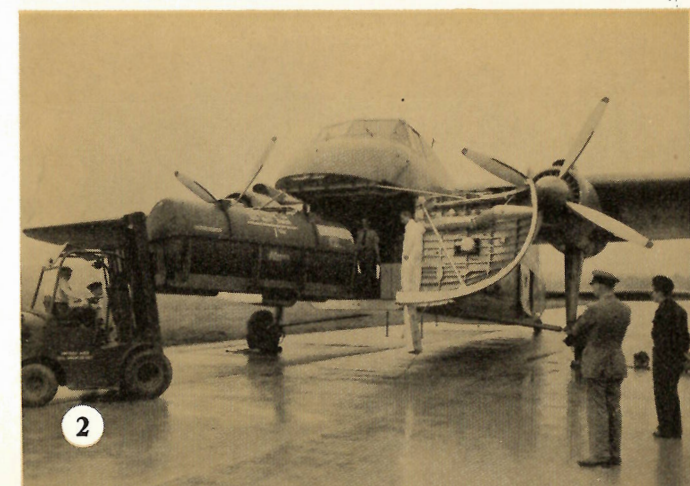
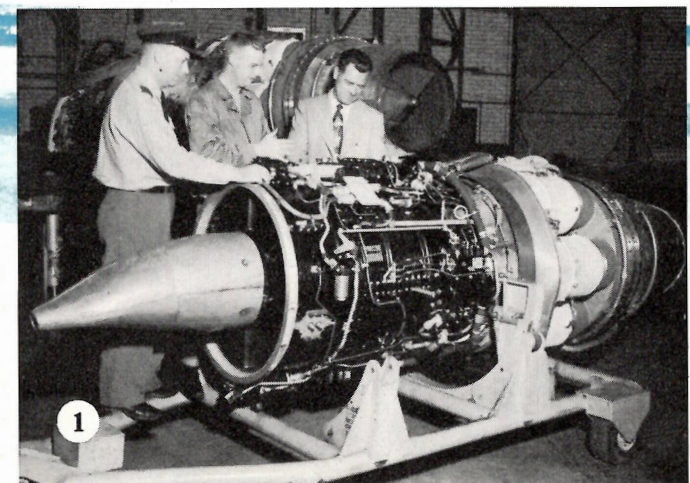
# Service



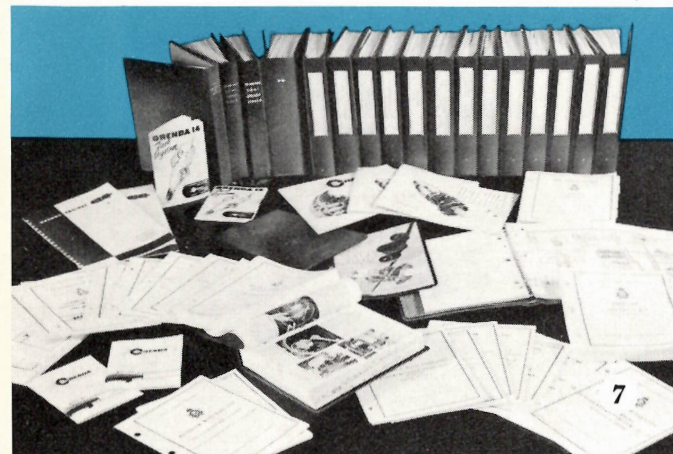
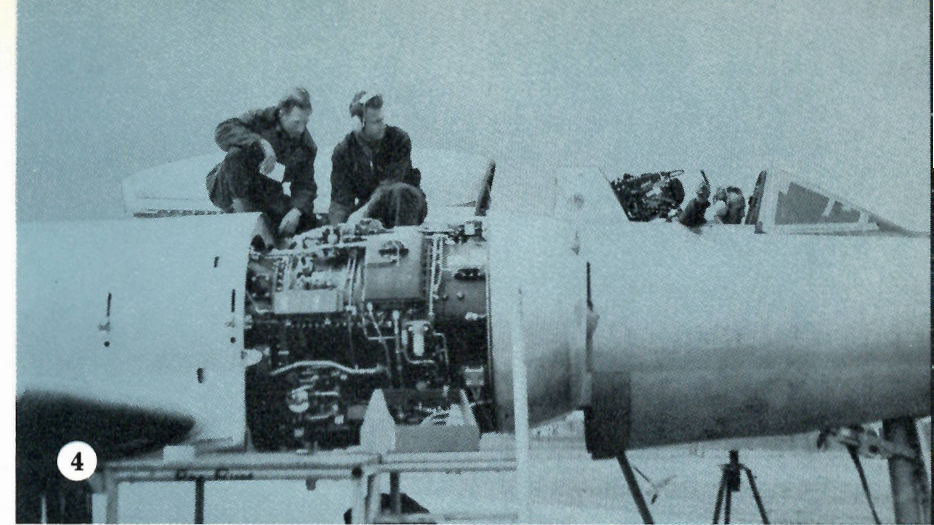
A very vital requirement of an engineering firm such as this is to assist customers in the efficient operation of their equipment. Orenda's Service Department is organized to maintain surveillance over its products in service and to efficiently and quickly answer queries.

Technical Service Representatives are located in the areas in the world where Orenda products are in use. Publications, manuals, and bulletins are prepared and distributed to cover all aspects of operation, servicing, modification repair and overhaul. Engineers trained in techniques developed by Orenda are available to assist in setting up repair and overhaul facilities to meet the operator's requirements.

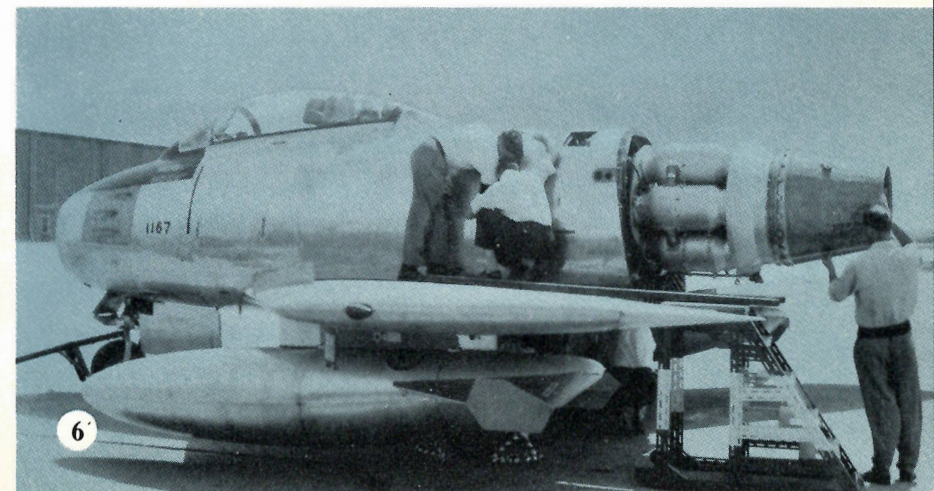
A Training School located at Malton provides training facilities of the required technical standard, to assist the customer in obtaining the optimum efficiency and serviceability from his Orenda products.







1. Orenda representative at operational base
2. Shipping an engine by air
3. Modern storage and dispatching of spares
4. Engine control adjustment by Orenda representative
5. Instruction at Orenda training school
6. Servicing a Sabre 6 in the field
7. Orenda publications



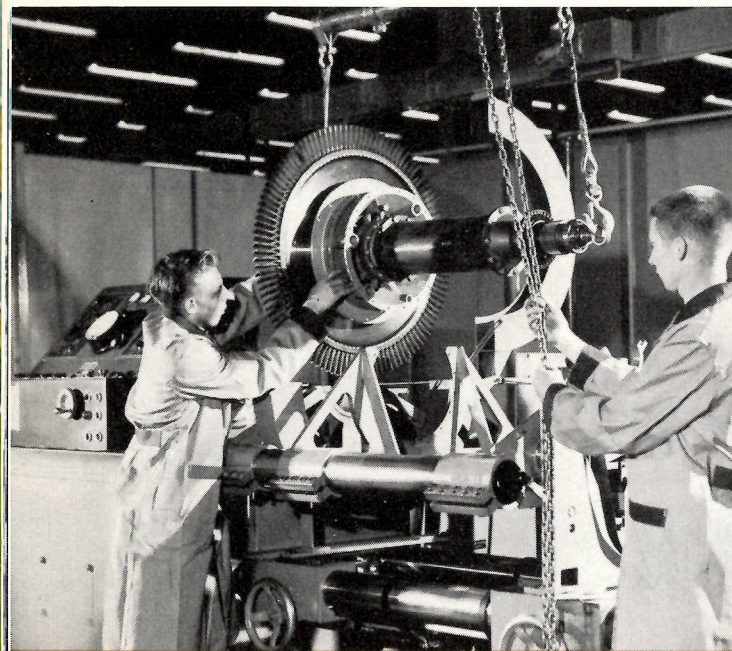


## REPAIR AND OVERHAUL

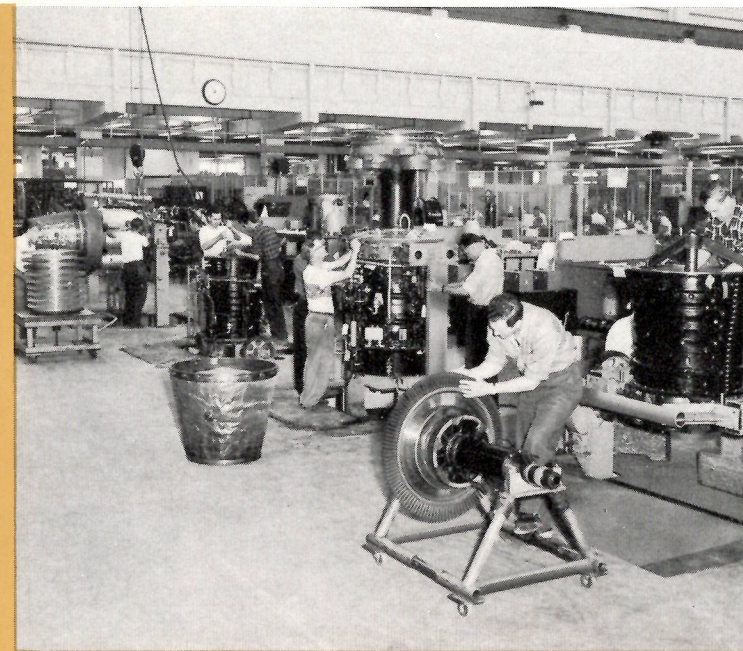
An extensive repair and overhaul organization operates at Malton in conjunction with the production facility and shares its comprehensive equipment.

New engine quality is achieved at overhaul at a competitive cost in a minimum time. An integral part of the repair and overhaul process is an engineering team who are constantly analyzing the operational statistics gathered from Orenda's products in the field throughout the world. This with the added support of the Engineering and Experimental Departments provides a comprehensive service to the customer.

Existing capacity at Malton can be adapted at short notice to accommodate the overhaul and repair of other manufacturers' products.



*Dynamic balancing*



*Assembly line*

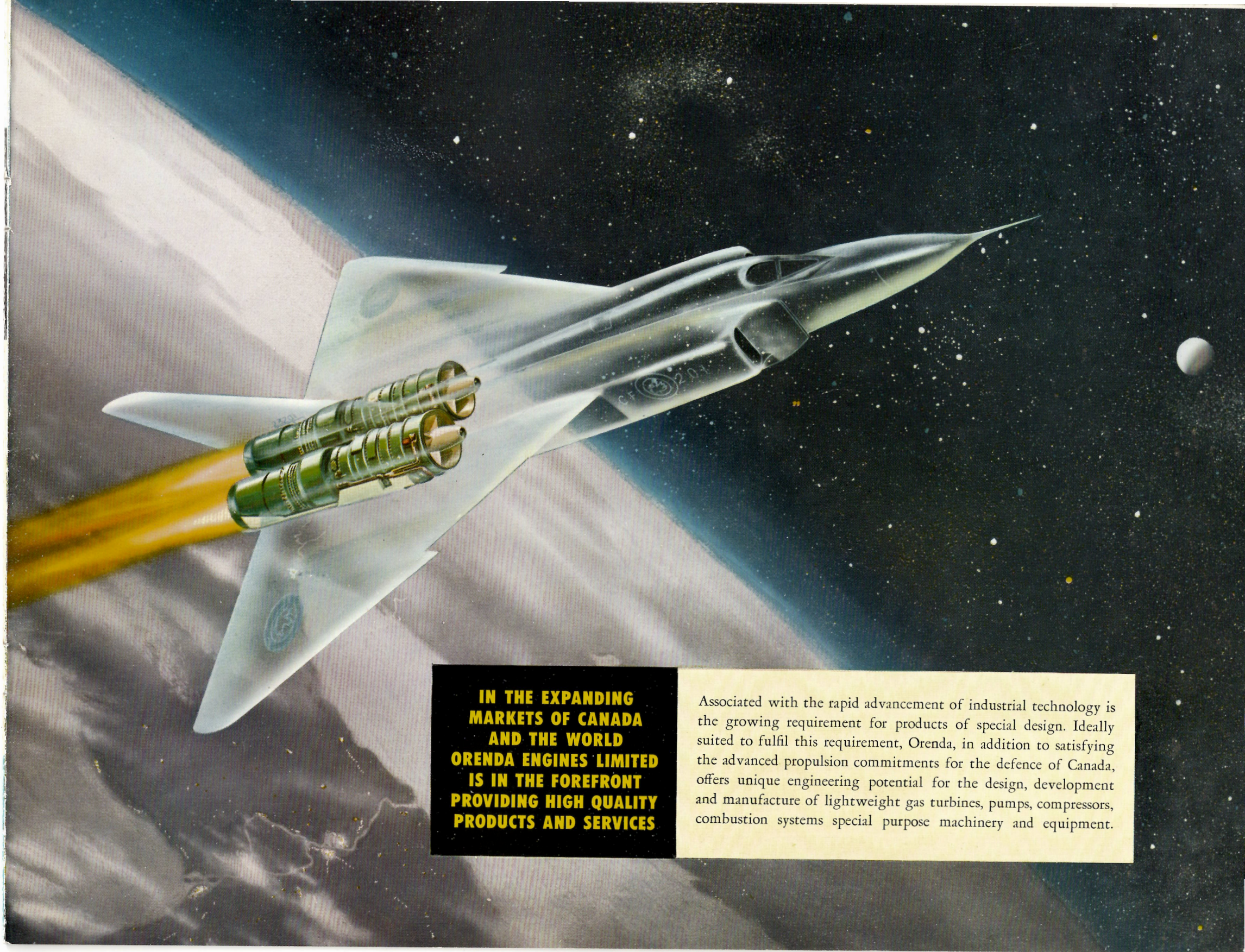


## SALES ENGINEERING

Qualified engineers familiar with all company operations and having first hand knowledge of Orenda's broadening range of products, present information on design, performance, installation and cost to the customer.

Market research and customer liaison are also important functions of this group and contribute to offering a specialized service on the company's products.





**IN THE EXPANDING  
MARKETS OF CANADA  
AND THE WORLD  
ORENDA ENGINES LIMITED  
IS IN THE FOREFRONT  
PROVIDING HIGH QUALITY  
PRODUCTS AND SERVICES**

Associated with the rapid advancement of industrial technology is the growing requirement for products of special design. Ideally suited to fulfil this requirement, Orenda, in addition to satisfying the advanced propulsion commitments for the defence of Canada, offers unique engineering potential for the design, development and manufacture of lightweight gas turbines, pumps, compressors, combustion systems special purpose machinery and equipment.





ORENDA ENGINES LIMITED

GAS TURBINES

ORENDA INDUSTRIAL LIMITED

in Canada

ORENDA INDUSTRIAL INCORPORATED

in the United States

DIESEL ENGINES

ELECTRICAL EQUIPMENT

INDUSTRIAL POWER UNITS

ORENDA ENGINES LIMITED, BOX 4015, TERMINAL 'A', TORONTO, ONTARIO, CANADA

ORENDA INDUSTRIAL LIMITED, TORONTO, MONTREAL, VANCOUVER, HALIFAX and NEW YORK

*Member: A. V. Roe Canada Limited and the Hawker Siddeley Group*