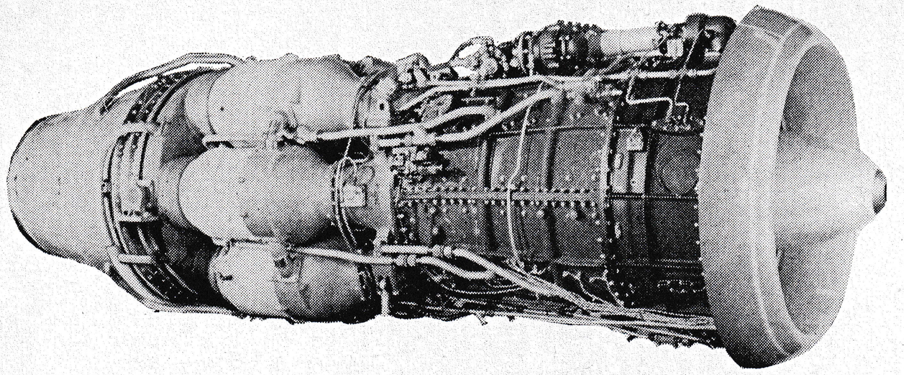


LEFT—The Avro Orenda, developing about 6,500 lb. thrust, has passed its RCAF 150-hour acceptance tests.

ARRIVAL OF JET POWER BRINGS NEW LANGUAGE

By J. W. TOMLINSON
Special to Canadian Aviation

WITH THE advent of the jet age has come a new and distinctive language still strange to many in aviation but destined to become more familiar as gas turbines loom larger in military and civil aeronautics. Terms such as "conrod," "wristpin" and "mag" may be expected to yield place to words and phrases unknown only a few year ago.

Familiarity with the terminology of the jet engine will become more and more important to those engaged in aviation. This article is an attempt to interpret this new language for those not already adept. It will refer specifically to the two major types of jet engine to be produced in Canada, the axial flow (Orenda) and the centrifugal flow (Nene) categories.

Certain main components of these engines are similar and carry the same designation although they are of different design. The terminology also will vary slightly in Canada, the United Kingdom and the United States but is basically similar in all three countries.

The terms used here are based on those issued by the British Standards Institution, supplemented by some used in the jet engine workshops of Canada and England.

Starting at the front of the engine and working to the rear and covering as far as possible both types, we have the NOSE FAIRING, sometimes called the INTAKE BULLET. This part is a streamlined lightweight casting which fits to the front centre of the engine. It is usually made of aluminum and more common to the axial flow type of engine where it forms a cover for the starter motor.

The INTAKE CASTING or INTAKE CASING, is a light alloy circular casting fitted to the front of the compressor. Engines having centrifugal type compressors such as the Rolls-Royce Nene, have double-sided impellers and an air intake casing is fitted to both front and rear of the compressor. The casing is usually webbed for strength with the centre boss supporting the starter, front bearing, and power take-off group in the case of the Orenda, and the wheelcase with its various accessories in the case of the Nene.

In most instances the casing is fitted with a screen to prevent the ingress of foreign matter of dangerous size, this feature being its main point of recognition.

The POWER TAKE-OFF is a term used in the production of the Orenda and it denotes the gear assembly which "takes off" the power from the front of the compressor shaft for transmission to the fuel pumps, oil pumps, and other accessories. The main casing is circular in shape with housing bores for the various gear assemblies. It fits inside the engine between the intake casting and the compressor.

WHEELCASE is a familiar name to piston operators and the term as applied to jet engines is the same, although in the case of the jet wheelcase it is fitted to the front of the engine instead of the rear, with the exception of some axial flow types. The wheelcase serves a similar purpose to that of the power take-off but in addition to carrying the gears to drive the various accessories, it provides mounting faces for the accessories themselves.

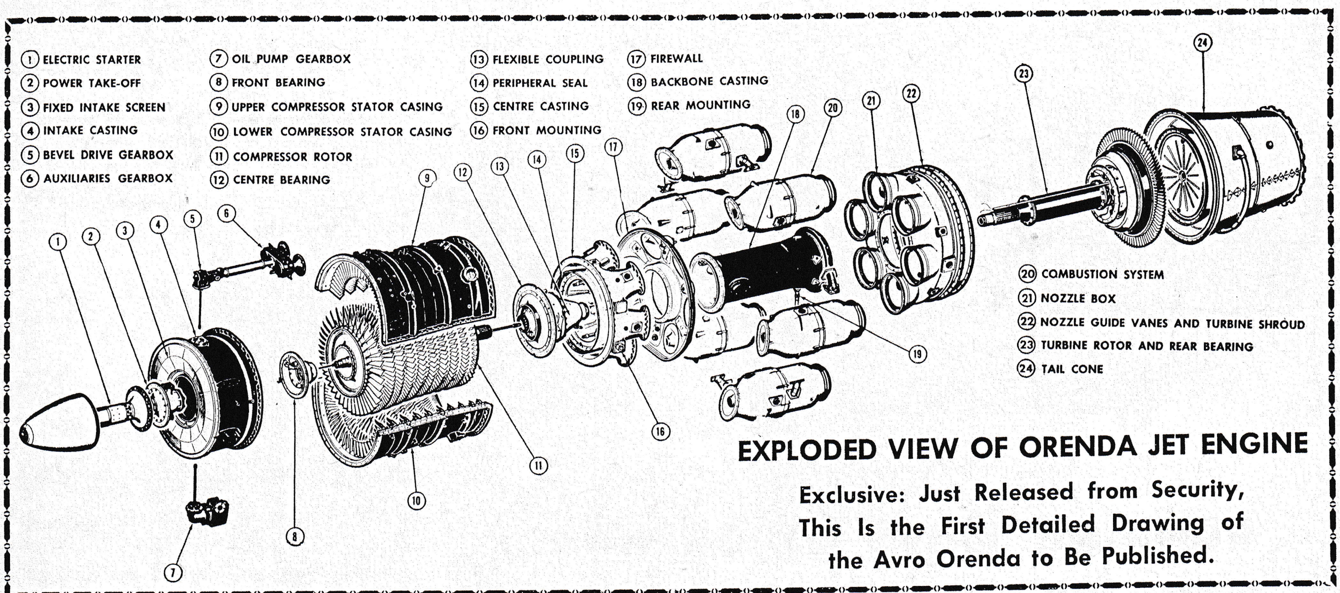
The COMPRESSOR ROTOR is common to both types of engine. In the centrifugal type, as with the Nene, there is only one rotor and this is often referred to as the IMPELLER. The part is machined from a light alloy forging or casting taking the form of a disc with equally spaced webs or vanes on one, or in the case of the Nene, on both sides.

To the centre boss of both sides is attached the front and rear sections of the ROTOR DRIVE SHAFT. The Rotor for the axial flow type (Orenda) is much more complicated, have 10 ROTOR DISCS to each of which are fitted from 40 to 80 ROTOR BLADES. The discs are mounted on ROTOR DRUMS which are made of light alloy and carry driving dogs onto which the discs locate.

The COMPRESSOR STATOR is used only on the axial type of engine and it consists of a large light alloy STATOR CASING made in two halves bolted together axially.

The axial joint is called the SPLIT LINE, a term used during assembling when the blade clearances are checked. To the inside of the casing are fitted light alloy sloted rings called STATOR BLADE RINGS. Each ring is fitted with 40 to 80 STATOR BLADES. Between each row of blades is a STATOR SPACER RING, these rings space the blades axially to fit accurately between the rotor blades. The whole assembly encloses the compressor rotor.

The part that takes the place of the stator casing on the centrifugal type of engine is called the COMPRESSOR CASING. This again is in two parts and in the case of the Nene these are called the COMPRESSOR FRONT CASING and the COMPRESSOR MAIN CASING. The latter is the largest casting in the engine and it is easily recognized by it nine elbows which form the



EXPLODED VIEW OF ORENDA JET ENGINE

Exclusive: Just Released from Security, This Is the First Detailed Drawing of the Avro Orenda to Be Published.

air ducts from the compressor to the combustion chambers.

Inside the casing and around the periphery of the rotor is the DIFFUSER RING. This is a ring of light alloy with tangential vanes which direct the flow of air from the rotor to the outlet elbows. Inside the elbows are more vanes for diverting the air; these are called CASCADES.

Another main casing which is peculiar to the axial flow type is the CENTRE CASTING. This is a large light alloy casting bolted to the rear of the compressor as in the case of the Orenda. Its function is to receive the compressed air from the compressor and pass it on to the combustion chambers through separate ducts. These ducts are the component's chief point of recognition, there being six of them on the Orenda. The casting also supports the CENTRE BEARING HOUSING which is a light alloy casting enclosing the centre bearing for the main rotating assemblies—the compressor rotor and the turbine wheel.

The CENTRE COUPLING is common to both engines and it consists of two main parts, these are the MALE COUPLING and the FEMALE COUPLING, both parts having driving teeth, external, and internal, respectively. The male coupling is attached to the compressor rotor rear shaft and the female coupling is splined onto the turbine shaft. When the female coupling is moved forward to engage the teeth of the male coupling, it is retained by the LOCKING COLLAR, thus connecting the compressor rotor to the turbine wheel.

Immediately to the front of the combustion chambers is the FIREWALL. This a circular sheet of heat resisting steel with a fireproof synthetic rubber seal around the periphery which fits to the firewall in the aircraft. The function of the firewall is to divide the hot half of the engine from the cool half, giving isolated control in case of fire.

The BACKBONE CASTING is peculiar to the Orenda. It is a tubular light-alloy casting which is bolted between the centre casting and the nozzle box. The combustion chambers fit around the outside of the casting and the turbine shaft passes through the centre.

HANDHOLES fitted with HANDHOLE COVERS are provided in the side of the casting for gaining access to the centre coupling. On the Nene engine the CENTRE BEARING CASING takes the place of the backbone casting.

The COMBUSTION CHAMBERS, familiarly called the "Cans," are fairly well known and easily recognized on both engines. Each chamber consists of three main parts. The domed portion at the front end is called the EXPANSION CHAMBER and is made of light alloy. The expansion is bolted to the OUTER CASING, sometimes called the AIR CASING, and inside the air casing, supported by the SUPPORT TUBE and BALANCE PIPES, is the FLAME TUBE, and again, inside the flame tube are the SWIRL VANES.

The tubes through which the flame travels from one chamber to the other during the initial "light-up" are called the INTERCONNECTORS. Fitted to two of the combustion chambers are the TORCH IGNITERS which provide the spark and the fine spray of fuel for starting. The two main parts of the torch igniters are the ATOMIZER and the SPARK PLUG, the former atomizes fuel and the latter provides the spark for igniting it. In the case of the Nene there is also an ELECTRIC-HYDRAULIC VALVE for supplying and cutting off the fuel. On the Orenda this unit is separate.

The NOZZLE BOX, common to both engines, is made of cast iron or fabricated steel and contains the NOZZLES and the NOZZLE GUIDE VANES the latter being commonly referred to as the NGVs. The box's main shape is circular and its position on the engine is between the combustion chambers and the exhaust cone. It can easily be recognized by the large hole through the centre surrounded, on the front face, by the part holes for the combustion chambers, and on the rear face by the NGVs, of which there are 40 to 60 equally spaced around the centre hole. The function of the unit is to receive the hot gases from the combustion chambers and divert them onto the turbine blades.

The TURBINE WHEEL one of the most important units of the engine, consists of three main parts, these are the TURBINE DISC, the TURBINE BLADES (sometimes called BUCKETS) and the TURBINE SHAFT.

The disc is a solid forging made from a special chrome-nickel alloy having heat-resisting qualities. Around the periphery of the disc are machined serrated grooves of FIR TREE section. The blades are made of nearly similar material,

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DEVELOP LANGUAGE TO FIT JETS

(Continued from page 35)

there being 70 to 80 with fir tree section BLADE ROOTS made to fit the grooves in the wheel.

The shaft is secured to the front of the disc and the drive is taken up through toothed flanges on the rear of the shaft and the disc stub shaft which is a machined extension from the disc. The function of the turbine wheel is to drive the compressor rotor.

The SHROUD RING is a steel ring which is bolted to the nozzle box and fits around the turbine wheel. It is an important part since its function is to restrict the flow of hot gases to the diameter of the turbine wheel.

The TURBINE WHEEL TIP CLEARANCE is checked between the tips of the blades and the bore of the shroud ring.

The TAIL CONE, sometimes called the EXHAUST UNIT, is the rearmost part of the engine proper. Although for convenience it is often listed as a part of the aircraft, it definitely belongs to the engine. It is a fabricated steel cylindrical component which is bolted onto the shroud ring and its function is to direct the flow of hot gases into a straight jet as it leaves the turbine.

The main outer piece is called the OUTER CONE and inside this, supported by airfoil FAIRINGS is the INNER CONE. The base (front face) of the inner cone is about the same diameter as the turbine disc, behind which it is closely mounted. The unit is surrounded by an INSULATING BLANKET made of metal foil covered with gauze.

The JET PIPE, as the name depicts, is simply a pipe. In appearance and construction it is similar to the tail cone except that it is longer and has no inner cone. Its length will be dependent on the type of aircraft to which the engine is fitted. As a rule the unit is classed as an aircraft part although it is supplied by the engine manufacturer. The unit is bolted to the rear end of the tail cone and its function is to direct the hot gases safely from the tail cone to the rear of the aircraft.

While these names and terms are given as being authentic and popularly used in the jet engine workshops of Canada and Britain it may happen that in some cases other names have been applied. The origin of these is often traced to the drawing board where the name is sometimes given without too much thought as to whether or not the particular part in question is already known in the industry as something else. This kind of thing can cause confusion and it is hoped that in the near future jet engine terminology for Canada will be standardized.

The importance of correct terminology cannot be over-emphasized. It is recalled for instance, that during the last war the RAF were definitely instructed to call an airscrew a propeller after someone ordered airscrews and received air crews!

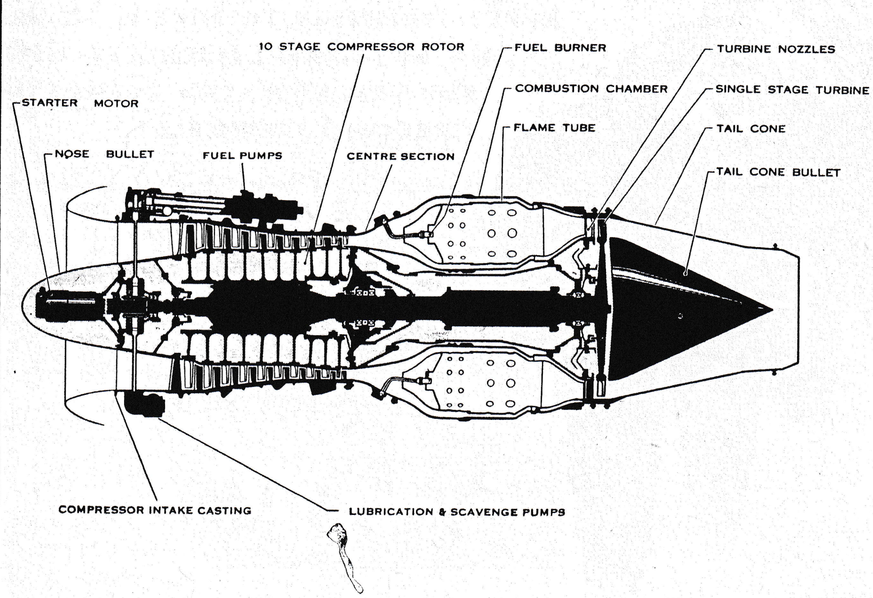

FIG. 1 DIAGRAMATIC SECTION OF ORENDA ENGINE

THIS IS THE ORENDA

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THE Orenda is an axial-flow jet engine having 10 compressor stages, six combustion chambers, a single-stage turbine and an exhaust cone. Under sea-level static conditions the version now in production has a thrust in excess of 6,000 lb., and a specific fuel consumption of 1.00 lb. per hour per pound of thrust. The dry weight is about 2,500 lb. The nominal diameter is 42 inches and the over-all length is very close to 10 ft.

Two mounting arrangements are possible. The first is a four-point suspension with two trunnions on the turbine nozzle box and two mounting pads on the centre casting. The second is a three-point pick-up having two trunnions on the centre casting and an adjustable strut on the backbone casting.

Compressor — The compressor intake is a magnesium alloy casting having an annular air entry around a housing which contains the drive gear box for the engine auxiliaries and the compressor front bearing. The housing is supported by six struts which contain the auxiliary drive shafts, lubrication lines, thermocouple leads, and starter cables. The electric starting motor is mounted on the housing and is covered by the entry bullet.

The rotor is composed of discs mounted on an internal drum. The first nine stages have aluminum discs while the 10th disc is steel. A stepped sealing ring projects from the rear of the 10th stage disc into a gland mounted on the centre casting. A small flow of air is permitted to escape past this seal and is used for cooling the rear face of the turbine disc. The blades are retained in the discs by a form of "fir tree" fixing for the first three stages and dovetails for the remaining ones. The first, second, third, and 10th rotor blades are steel. The rest are an aluminum alloy. Rotor and stator blades are unshrouded. The rotor is supported on a bearing in the intake casting and on the centre bearing in the centre casting.

The compressor stator casings are of magnesium alloy. The stationary blades are mounted by dovetails in rings which are retained in place by lips on interstage spacers which in turn are bolted to the stator cas-