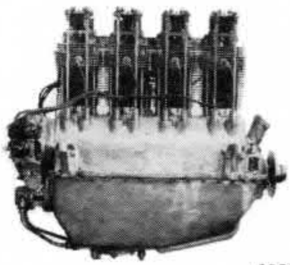
ROLLS ROYCE

OPEN DAY
LEAVESDEN

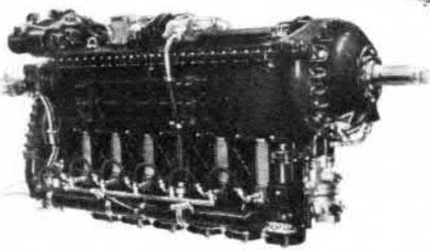
SOUVENIR PROGRAMME 30p

50 YEARS OF EXPERIENCE

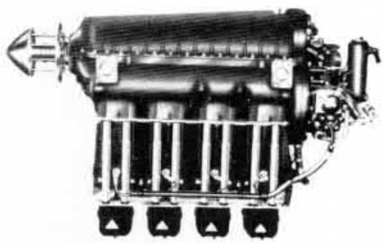
1924 Air-Disco - powered the de-Havilland 53



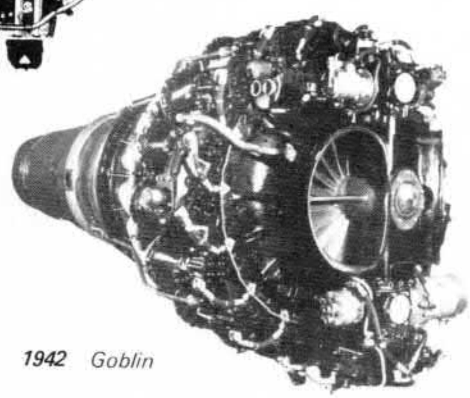
1927 Gipsy 1



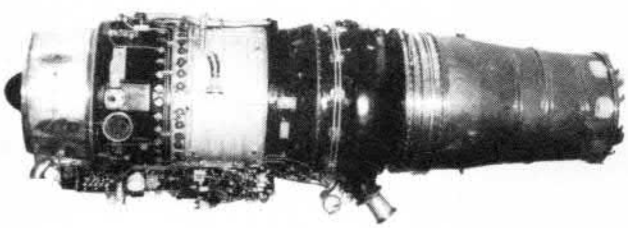
1946 Gipsy Queen 70



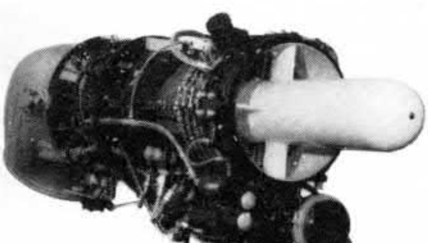
1929 Gipsy Major 1



1942 Goblin



1955 Gyron Junior

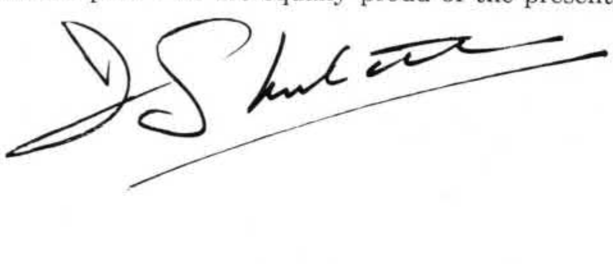


1959 Gnome

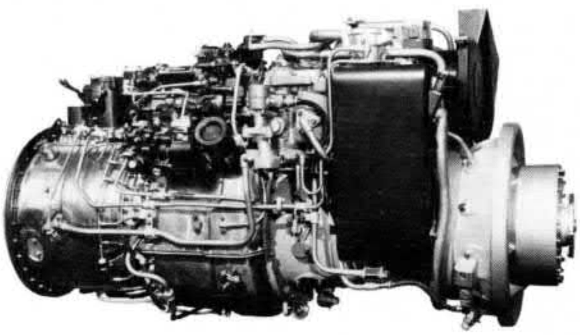
1969 Gem - powers the Westland Lynx

from THE MANAGING DIRECTOR

On behalf of all the members of the Small Engine Division, I am delighted to welcome you to our Open Day.
I hope you will take advantage of the opportunity to get to know something of our work here - work in which we take a justifiable pride. A short time spent on this site quickly brings about a realisation of the tremendous impact that has been made here on the history of aviation.
The years of this century have seen a breathtaking acceleration in the speed of travel, from the Wright brothers' brief flights in 1903 to trans-atlantic flights in a few hours. Much of this has been within the memory and experience of many of the members of this Division, who recall with pride the pioneering characters of aviation, such as Amy Johnson whose aircraft was manufactured, maintained and prepared for her historic flight round the World in May 1930. Jim Mollison began his aviation days with us and his Puss Moth, described by some of our fitters as tailormade to fit him alone, was manufactured and prepared at Stag Lane, from where he flew, taking 32 hours to reach Newfoundland.
We have also made our contribution to the history of communications in other ways. The delivery of British newspapers to Europe began here when Captain Hope flew regularly to Paris with copies of the Times and Telegraph, eagerly sought by British expatriates. Francis Chichester, a very recent hero for his solo sea voyage around the World, is also well remembered as flying a DH60 Moth, manufactured and maintained by members of this organisation and used by Chichester in 1930 for an historic 42-hour flight to Australia.
These famous names would be the first to admit that their individual exploits relied to an enormous extent on the skill and experience of people such as you will mingle with today.
Life has moved with amazing rapidity. We have come a long way from the days when the organisation had to have a truck standing by that would go out and dismantle aircraft that, having made forced landings in fields in the area, were unable to take off again.
Much of the acceleration was due to the war years, with Mosquitos being built here and Halifax bombers repaired. And then the start of a new era, with the first commercial jet engine in the World to receive a Certificate of Airworthiness and used to power the Comet Aircraft being developed and manufactured by employees of this organisation.
Over the years, many mergers of different companies have taken place as international competition in the aircraft industry grew fiercer but the spirit of innovation, so essential in our development, has always been retained. At Leavesden, we draw great strength from being a part of Rolls-Royce but we are aware of a size where we are able to maintain our individuality.
We believe we must continue to be conscious of our heritage and that our aim must be to take the best of the past to build a better future.
Our business is now small gas turbine engines. The engine is small - the market is large and continues to grow. We export our engines to over 25 countries and more than 80 operators use our products. Our business has a very special character and plays a major supporting role in the fabric of day-to-day society. The rapid development of North Sea oil is very dependent of the ability of the helicopter to move people and parts many miles out to sea, at times under hazardous conditions.
When you next read in your National newspaper of the mercy flights by helicopters of the R.A.F. saving life at sea, or rescuing people from remote locations, the aircraft will have been powered by engines, some of which you will see today.
So - in less than a lifetime, we have played our part in the development of the aircraft industry.
We are rightfully proud of our past - we are equally proud of the present - we eagerly anticipate the future.



PRODUCTS AND APPLICATIONS



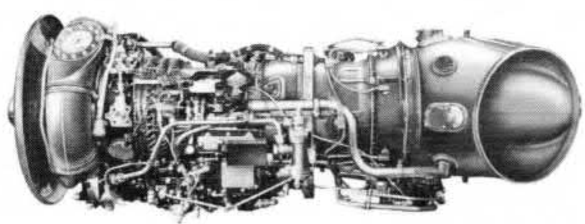
The 900 shaft horse power GEM turboshaft engine

Two GEM engines power the Anglo-French Lynx helicopter

Current engine production at Small Engine Division is centred around Rolls-Royce designed Gem, Gnome and Nimbus free turbine turbo-shaft engines and Turbomeca designed Astazou III.N and Turmo III.C.4 turboshaft engines. In addition continued support is provided by manufacture of engine spares and overhaul facilities for the Gipsy range of engines also Artouste auxiliary power units and Palouste air starters.

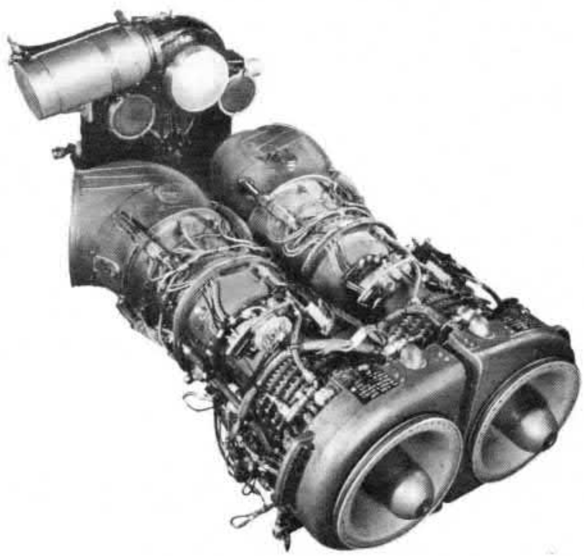
The Gem is a new and advanced design light weight two spool turboshaft engine, designed, developed and manufactured at Leavesden. Classed as one of the most advanced engines of its type, the design of the Gem benefits from the experience of Rolls-Royce of advance technology engines and the accumulation of many years' operational experience in helicopter turboshaft engines. Currently rated at 900 shaft horse power, Gem engines have been ordered in quantity for twin engined Westland Lynx multi role helicopters for the armed forces of Great Britain and France.

Well proven by years of world wide service in helicopters, the Gnome combines the advantages of high power output, compactness, low specific fuel consumption and light weight making it an ideal helicopter power unit. Developed over the years Gnome engines progressed from power output of 1050 shaft horse power to the latest mark of Gnome which



A Gnome H1400 - 1 turboshaft engine, the latest in the Gnome family of engines

Westland Sea King helicopters have been ordered by nine nations



Two Gnome engines coupled by a single gearbox

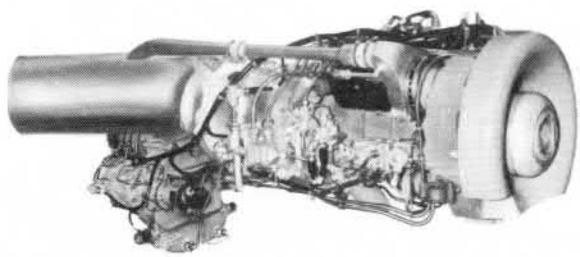
Westland Wessex Helicopters are in operation throughout the world

is rated in excess of 1600 S.H.P. Gnome powered helicopters in service today include Westland Whirlwind, Wessex, Sea King and Commando also Agusta 204B and Boeing Vertol 107. Gnome powered helicopters are in service with commercial operators in United Kingdom and overseas also with, or on order for the armed forces of Sweden, Norway, Holland, Austria, Italy, Brazil, Qatar, Iraq, West Germany, India, Pakistan and Belgium.

Backed by extensive bench development, the Nimbus has been proved by Naval and Military operation in the worst desert, jungle and Arctic conditions on land and at sea. Nimbus engines are in world wide service in Scout and Wasp helicopters as Army support, police duties and anti-submarine duties from frigates. Operators include the British Army, Royal Navy and the armed forces of South Africa, Australia, Netherlands, Brazil, New Zealand, Uganda and Bahrain.

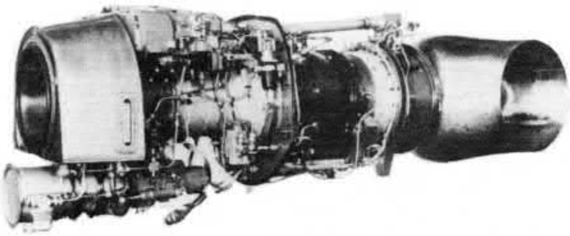
The Artouste is a single shaft gas turbine airborne auxiliary power unit which provides air bleed and / or shaft power for starting main engines, ground servicing or cabin conditioning. The Artouste entered service in 1959 and at present operates in the BAC VC10, HSA Trident, Short Belfast, Canadair CC - 106 and Victor aircraft.

The Palouste air starter delivers a maximum air delivery of 2lb / sec and is used extensively in three applications - air starting trolleys, airborne air starter pods and lightweight helicopter



Nimbus turboshaft engine, powerplant of the single-engine Wasp and Scout helicopters

Westland Scout helicopter in British Army livery



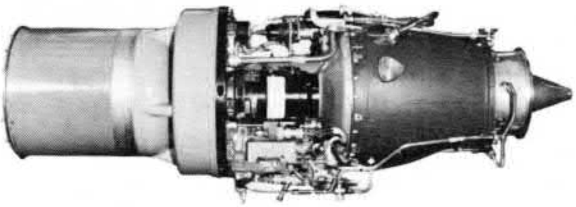
Turmo III C4 turboshaft engine, subject of a collaborative build agreement between Britain and France

Anglo-French Puma helicopter, in service with the Royal Air Force and the French Army

starter packs for the Royal Air Force and the Royal Navy.

Under an agreement between the governments of France and the United Kingdom, Rolls-Royce Small Engine Division is participating in the manufacture of all engines for large numbers of S.N.I.A.S. Gazelle fire-seat helicopters powered by a single Turbomeca Astazou III.N, the S.N.I.A.S. Puma 15 seat transport helicopter powered by two Turbomeca Turmo III.C.4 engines, and the Westland Lynx eleven seat multi-purpose helicopter powered by two Rolls-Royce Gem engines. The Rolls-Royce Small Engine Division has complete design and development responsibility for the Gem engine and shares production of the other two engines with Turbomeca S.A.

These aircraft meet the military medium and light helicopter requirements of the two countries and are also offered for sale to world markets.



Astazou III N, another engine in the anglo-French collaborative arrangement. We also build the Astazou 16 turboprop for Jetstream aircraft ordered by the Royal Air force

The Astazou powered Gazelle helicopter, many of which are in service with British and French forces

OUR ENGINES AT WORK

Gnome powered SRN6 Hovercraft

Shore to rig communications have vastly improved by use of Gnome powered Wessex helicopters

Sea King helicopters of the Royal Navy based at Royal Naval Air Station, Culdrose in Cornwall saved many lives during the gales around the South Coast earlier this year

AROUND THE DIVISION
Introduction

In this part of the programme we show you some of the main areas in the Division. We apologise beforehand for some of the highly technical terms but we know you will appreciate that the aero-engine industry is itself a highly technical industry and getting more so every day.

Within the Division's 220 acres, we have among our 3,500 employees representatives from nearly every trade and profession. We have plumbers, photographers, electricians, printers, sheet metal workers, instrument repairers, computer programmers, architects, builders, buyers, motor mechanics, aircraft controllers and marshallers, nurses, legal experts, carpenters, a doctor, a patents officer and even a supermarket manager. Our engineering staff represent every branch of that highly technical profession. The Division is almost a self-sufficient community.

We have an advantage over many other industries in that we not only see the end product go out of the door but we can follow its progress in whichever part of the world it is being operated until it is life expired. In addition, we read in the newspapers where our engines are instrumental in saving life. Last year, R.A.F. Search and Rescue helicopters powered by our engines saved over 200 lives around our coastline. We are part of a tough, highly competitive but rewarding industry.

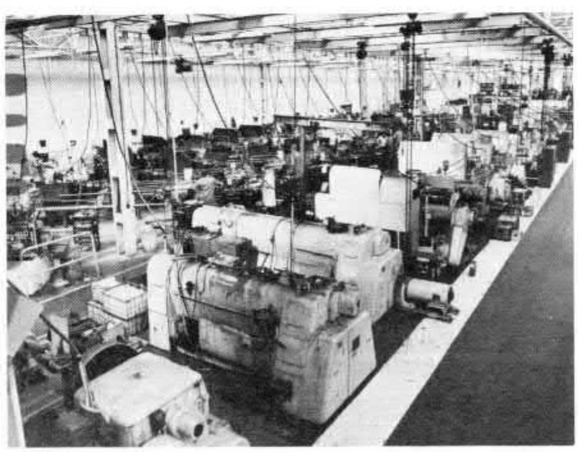
The Factory Area

There are two main factory areas in the Division; L2 just inside the main gate on the left and L1 which is half a mile away roughly behind the control tower on the main building.

L2 is the Experimental and Development area where the engines are designed and developed. L1 is where the production engines are built and components machined.

The types of engines manufactured and repaired at Leavesden spans four decades - from pre-war Gipsy Major piston engines to modern gas turbine engines such as our new engine the Gem. This range of engines entails the manufacture of nearly 10,000 different components, many of them being highly complex.

The main machine shop area at L1 contains the normal range of general purpose machinery for turning, milling and grinding. But there is also a great deal of high technology equipment such as tape controlled machines, curvic coupling grinding, five-axis impeller mill and plasma metal spray. In addition, we cut our own gears using the most modern equipment.



Part of the main machine shop area at the Leavesden factory

The tape or numerical control section incorporates up-to-date methods for taking the ache out of turning, milling or drilling and ensures the minimum of scrapwork.

On your way round the machine shop you may see many machine tools which in appearance appear to be in the vintage era. These are necessary to some process of production and although old in design they nevertheless turn out the goods.

The L2 factory area could be described as a factory within a factory because here is represented every department in the main machine and sheet metal area. The work in the development area calls for one-off jobs and the skills of all of our range of craftsmen are necessary.

Here at L2 there is a complete unit for blade manufacture including a high production flow line producing blades for our engines and others. For instance blades for the Spey engine power plant of the BAC III airliner is one of the sub-contract jobs carried out for the Derby Engine Division.

As design requirements become more stringent the demands of the manufacturing area are more exacting necessitating the continual development of new techniques to produce parts for tomorrow's engines.

Hatfield Test Establishment

In addition to the 220 acres at Leavesden, the Division has a test establishment employing about 170 people at Hatfield. At this Hatfield site, which is situated in a corner of the Hawker Siddeley Aviation aerodrome, we test our development engines.

Even for engines which are well into production there are development programmes to increase their power or to strive for even greater efficiency. This is where the long and complicated test programmes are carried out.

An amount of Production Engine Testing is undertaken at the site on Gipsy, Astazou, Artouste and Palouste engines for which 5 Test Facilities are available. Overflow Production Engine Testing from Leavesden is also undertaken on the site using the Development Test Beds when the programme and priority deem it an efficient thing to do. The Gnome and Gem engines fall into this category.

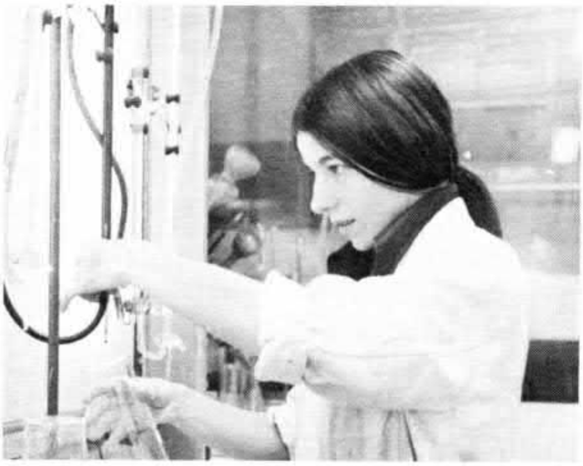
A number of Production Nimbus Engines built in the Leavesden Production area are tested at Hatfield at the moment until such time as a Nimbus Facility is completed at Leavesden.

A gas turbine engine being subjected to a thorough test before delivery to a customer

Materials Laboratory

Some 70 people work in the Materials Laboratories which are concerned with mechanical behaviour, chemistry and non-destructive testing. Mechanical behaviour includes physics, mechanical testing, stress analysis, creep and fatigue. The first two are largely occupied in calibration of instruments and thermocouples, the determination of standard physical properties (friction, expansion and so on) strengths, hardness and impact resistances of all manner of materials and components.

Let's consider just two aspects, creep and fatigue. Curiously human words to apply to metals. Creep in this context is the plastic deformation - stretching - that takes place in components when a jet engine is operating. Our technicians can measure changes of one millionth



One of our laboratory technicians determining nickel content in a sample taken from the process plating plant

of an inch at up to 1000° C in tests that may run for as long as 3 years.

Just as people fatigue, so do metals and the worst thing for both is repeated stress. So the Fatigue Laboratory repeatedly stress all manner of new materials to see just how far they can go. The Metallurgical Dept. or Micro Lab, so called because so much of its work demands the use of powerful microscopes. Optical equipment gives magnifications of up to 2000 times, but the recently acquired scanning electron microscope can magnify by as much as 50,000 or even, with some loss of definition, 80,000 times.

Production Laboratory

Primarily responsible for controlling the large number of metallurigical and chemical processes in use at Leavesden. The mechanical testing section is equipped with machines to determine the strength of the various materials used in aero engine construction.
The X-ray and Non-Destructive Testing sections are equipped to examine castings, forgings and component parts for defects. Three powerful X-ray sets are housed in lead-lined cells and are remotely operated to ensure complete protection from powerful radiation. This laboratory also has a chemistry section, a welding section and a heat treatment section.

The Halford Laboratory

The Halford Laboratory, named after the late Major Frank Halford, is the Division's centre for aerodynamic research and development testing of gas turbine engine components. Built in 1947 and extended in 1952, the building covers 1½ acres on the Hatfield site.

The majority of tests carried out in the Laboratory require large quantities of compressed air, either to simulate the working environment of a component under test, or to drive air turbines when shaft horsepower is required. Up to 50 lb/sec of air can be supplied from five electrically driven industrial compressors totalling some 9000 H.P. This air is ducted via a network of pipes and valves to twelve test areas or cells. Each cell is equipped for testing a particular type or application of an engine component and test faciltities in these cells are modified or rebuilt as new requirements evolve.

The main instrument gallery in the Halford Laboratory

One of the principal activities over the past 15 years has been the performance testing of gas turbine engine compressors. Two of the large cells are equipped for this purpose - one for testing compressors for the Division's current and future range of engines - and the other is the 18000 H.P. facility built in 1956 to test compressors for the De Havilland Gyron family of engines. This plant, which is still the highest powered compressor facility in the R.R. group,is driven by four 'Comet' Ghost engines and is nowadays engaged on sub-contract work for the Bristol Engine Division testing compressors for Olympus 593, (Concorde engine) Pegasus and R.B.199 engines.

At present the Laboratory has a complement of 15 Fitter / Testers and 3 Workshop Tradesmen under a Foreman and a technical staff of 8 Test Engineers.

In recent years, facilities for machanical testing of main reduction gearboxes and high speed bearing investigations have been added to the Laboratory and modern equipment is now being installed to enable combustion chamber testing to be resumed after a gap of four years. Also planned for this year is the installation of a computer controlled data logging system, and in the near future a high temperature turbine development programme will commence on the High Pressure Core Demonstrator Vehicle.

Apprentice School

At present there are about 200 apprentices undergoing training in the Division. There are several apprentice schemes and they cover craft, engineering / technical, commercial, secretarial and administrative.

During their periods of training, which can vary from 2 years to 5 years according to the type of apprenticeships, the apprentices are given paid release for studies at local colleges and if necessary release can be continued beyond the training period. Student and undergraduate apprentices on sandwich and full-time courses at Colleges, Polytechnics and Universities are paid while with the Company.

Apprentices are encouraged to join the Apprentice Association which is organised and run entirely by themselves. The Association provides social and sporting activities as well as arranging educational events such as visits to other companies.

An apprentice under tuition in the Apprentice School

The Computer

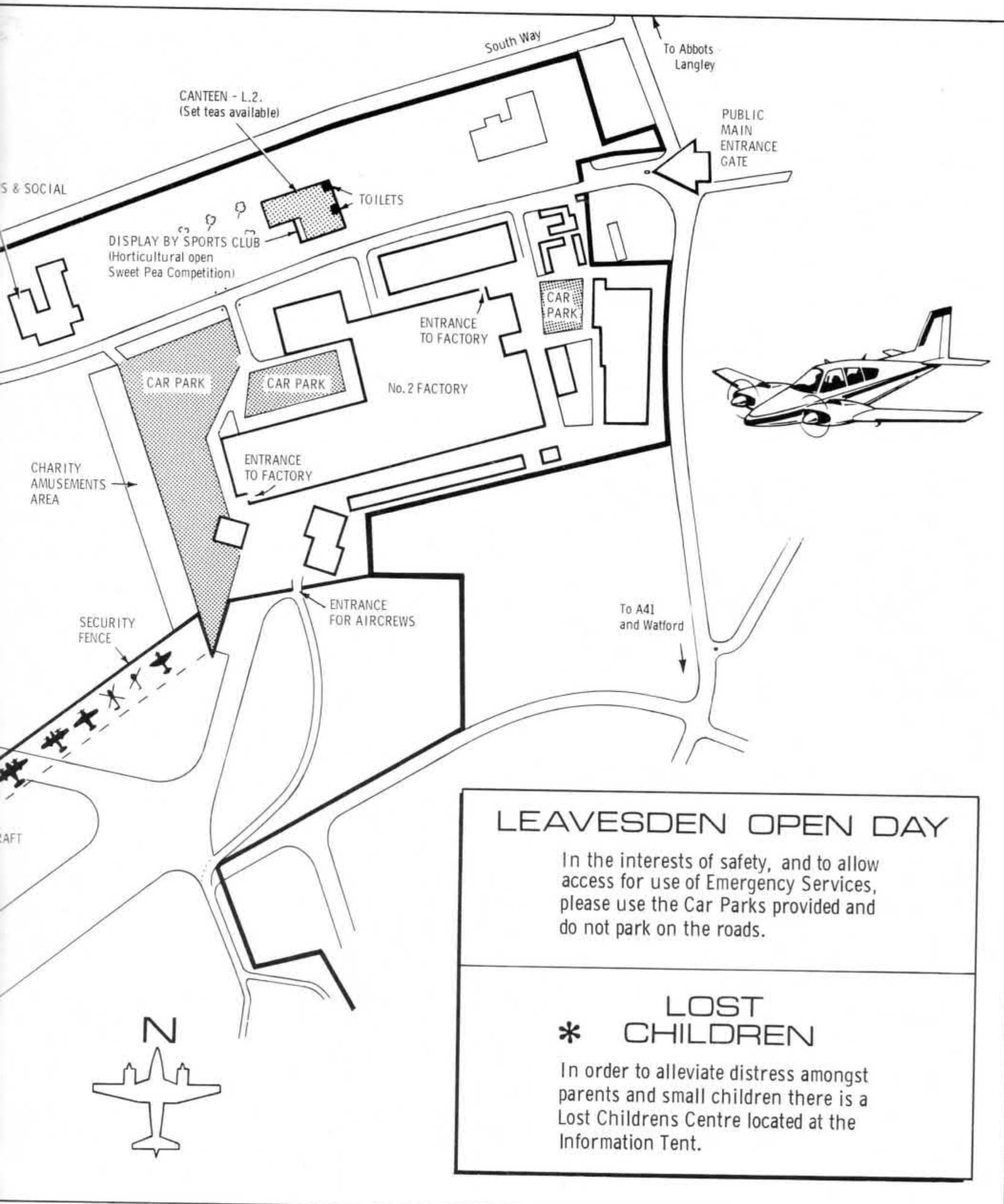
The Division has an IBM 360/40 Computer with 262,144 characters of memory and an internal cycle time of 0.625 micro seconds. The Computer is supported by magnetic disc storage capacity of 351 million data characters together with magnetic tapes and high speed printer. Six operators and 3 specialists care for this on a 5 day two shift arrangement in a multi-programming environment.

Data is entered via a CMC 5 key to disc system with its own mini computer utilising video display units. The 11 ladies who work on this equipment work at speeds in excess of 12,000 key depressions per hour and deal with over 2½ million characters per week.

continued/

SITE PLAN

MODEL RAILWAY (Rides for Children)
GO KART CIRCUIT & STATIC VINTAGE CAR & M/C DISPLAY
Tennis Court
Bowling Green
To Hunton Bridge and A41
CAR PARK
RESERVE CAR PARK
RESERVE CAR PARK
PUBLIC REFRESHMENT TENT
CANTEEN L.1.
SHOP
PUBLIC ENTRANCE
CAR PARK
LOST CHILDREN CENTRE
INFORMATION CENTRE & PRESS TENT
No. 1. FACTORY
ENTRANCE TO FACTORY
COMPANY TENT
TOILET
SERVICES DISPLAY AREA
TOILETS 1st. FLOOR
FIRE STATION & FIRST AID DEPT.
ENTRANCES TO FACTORY
CAR PARK FOR OFFICIALS ONLY
CAR PARKS FOR GUESTS ONLY
MAIN RUNWAY
TOILETS
GUESTS & AIRCREW REFRESHMENT TENT
SECURITY FENCE
CONTROL TOWER
AIRCRAFT STAND (PUBLIC FLIGHTS)
PUBLIC FLYING CHECK OUT



LEAVESDEN OPEN DAY

In the interests of safety, and to allow access for use of Emergency Services, please use the Car Parks provided and do not park on the roads.

* LOST CHILDREN

In order to alleviate distress amongst parents and small children there is a Lost Childrens Centre located at the Information Tent.

Computer systems are developed by a team of 11 Analysts in conjunction with the user areas, and they are currently engaged implementing an integrated computer file on which all of the information necessary to plan and control the Division's commercial, production, planning, stores and accounting procedures will be available.

The interpretation of the Computer systems into a language understood by the computer is the responsibilty of our 8 programmers whose task is becomming increasingly more interesting and exciting as we consider the installation of on-line video terminals for both enquiry and up-dating routines.

The implementation of new computer procedures is only successful if planned to coincide with the necessary office re-organisation, revised documentation and proper clerical and support procedures. Our team of 8 Organisation and Methods specialists is responsible for this overall planning and for providing technical expertise on procedures and equipment.

Product Support

As its name implies, the objective of the Product Support Department is to provide the customer with an after-sales service. If the service is good the customer will come back to us again when he needs new engines. If not, he will go elsewhere.

Four groups are involved to carry out this task. First, the **Customer Service Project Group**.The boys in the front line. The engineers who visit the customer, regularly to ensure that any problems are tackled at source. They are helped by the **Customer Support Planning Group**.Mainly, this group helps where the customer wishes to overhaul his own engines. They provide a complete service whether the job is large or small. Back-up is provided by the **Technical Services Section** who tackle technical and operational problems with a view to enabling the customer to get the most out of our engines. The **Operational Reliability Group** monitor reliability trends of our engines all over the world. Close monitoring will often spot an adverse trend needing quick remedial action. **Technical Publications Department**. Members consisting of technical writers and illustrators compile the overhaul and maintenance manuals, vital to the fleet operator to enable him to carry out the work himself.

The Product Support Department look after nearly 3,000 engines in service . These engines have accumulated 2½ million flying hours in 10 years.

Customer Training Centre

Royal Australian Navy instructors become pupils on a Gnome engine course

Aero engines are precision built and need lots of care and attention - far more than a motor car. So when we sell a customer an engine we take on the responsibility of training his staff to look after it in the manner we recommend. That's where the customer training centre comes in.

The courses provided include engine operation and handling for pilots; servicing, repair and overhaul for aircraft engineers. In addition, technicians and apprentices of Rolls-Royce receive training here.

About 300 students from all over the world attend courses each year. Recent visitors have come from Germany, France, the Middle East, South Africa, Bangladesh, Pakistan, India, the Netherlands, Australia, Norway, Argentina as well as military and civil helicopter operations within the U.K.

The Centre is staffed by a fully experienced team of instructors.

People of the Small Engine Division

There can be no doubt that the greatest asset any organisation has is its people.

It is the people of this Division that have made, and will continue to make, everything that you see today possible.

A large part of our team is composed of specialists from many different backgrounds who contribute not only their knowledge and their skill, but their individual characteristics. It is the common sense of purpose and the continuing search for creativity that brings many diversified people into an effective team.

People come to the Small Engine Division along many differing routes. Our Apprentice Scheme takes in young men at the ages of 15 or 16 and develops them in the craft and technical skills so essential in this specialised industry. It is also at this stage that the importance of team work and the interaction between specialities begins to be developed.

The Divisional Telephone Exchange

Gnome engine assembly

Another branch of our Apprentices scheme is the stage at which young people join us after taking A-levels and are then sponsored through College or University. This programme is a very demanding one requiring as it does, much work within projects in the Division as well as the challenging University discipline.

Each year we also intensively work through the Universities to find those people suitable for our Organisation who are finishing their College or University course. The skills and knowledge of these people are different, but equally important. They may move into Research , where their concentration will be into the complex world of tomorrow's products. They may move to Design, to Development, to Production Engineering, or one of many other areas, but as with all our other staff, it is their ability to retain their individuality, at the same time blending quickly into the team that will determine the success of their progress and that of this Division.

Of course not all our staff are technical. Some of the students joining the Small Engine Division come into our Commercial and Marketing areas where very special skills will need to be developed in the interaction with customers and also each year a selected number of girls join us to train in our Clerical and Secretarial programmes. Many of these girls, inspite of their non-technical background, work in highly technical areas and very quickly acquire an appreciation of what our products do and how they are made. Their training too, provides them with an opportunity to understand the importance of their role within the team and how they contribute to the success of the Division.

In addition to the routes described, there are those people who come to us who have gained their knowledge or skill with other companies.

An engine is a very complex product. It takes many years to progress from the stage of an idea, through Design, Development and then into Production. This complexity demands the highest dedication and the final product requiring as it does, the highest possible standards of quality, is wholly dependent on the enthusiasm and skill of the people of the Small Engine Division.

The Social side

Housed in a modern Clubhouse which was opened in 1970 by comedian Dick Emery, the Sports and Social Club comprises comfortable lounges, a spacious dance hall, fully equipped games rooms, changing rooms, a snack bar, colour T.V. and all the amentities which must surely make it the most up-to-date clubhouse for many miles around.

A major function of the Club, apart from its varied sporting activities is entertainment. Clubnights, discos, group and bingo evenings, film nights, orchestral evenings and olde tyme music hall are slotted in throughout the year and varied to suit every taste.

Many famous names in the entertainment world regularly appeared on theatre nights.

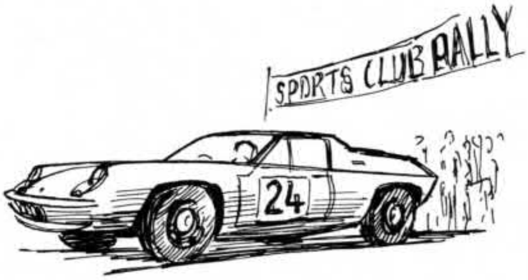
There are 21 different sections to which a member can belong. Too many to mention in detail they include angling, archery, model engineering, bridge, off-shore sailing, rifle shooting and wine making.

Members relax in the modern, well appointed lounge of the Clubhouse

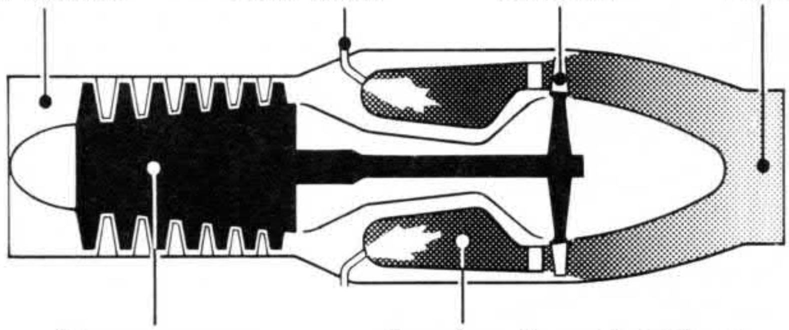
The Club is run by employees of the Division and any member of the firm and their family may join.

A full-time general secretary is responsible for the day-to-day administration.

GOAL! Five-a-side football on the playing field (photo by G. Diamond: Sports Club Photographic Section)



HOW THE JET ENGINE WORKS



The gas turbine, popularly referred to as the jet engine, is an internal combustion engine which, like the piston engine, produces power from the controlled burning of fuel.

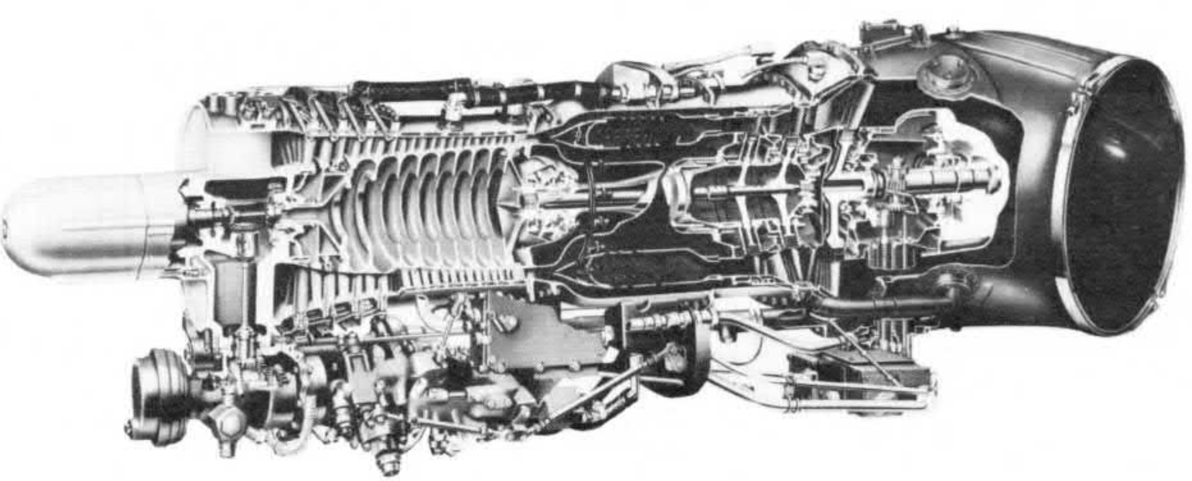
In both types of engine a mixture of fuel and air is compressed and ignited and expands vigorously as a result of the heat generated. In the piston engine this expansion moves a piston and crank to produce rotary power; in the jet engine the expanding gas is forced through a jet pipe or nozzle and its acceleration produces an opposite force acting on the aircraft through the engine mountings. A simple example of this reaction principle is seen when a child's balloon is blown up and released.

Basically, the jet engine has four sections:

A compressor to compress air
A combustion chamber in which fuel is mixed with the compressed air and burned
A turbine which absorbs sufficient energy from the hot gases to drive the compressor
A nozzle through which the gas is expelled thereby producing a forward-acting force

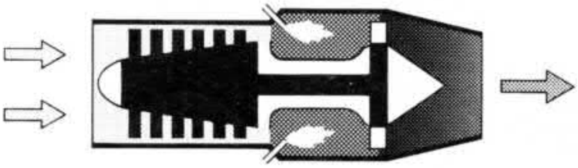
The energy remaining in the exhaust gas after driving the turbine is the propulsive energy of the engine and is normally measured as 'thrust' to give an indication of an engine's power. The units are usually measured in pounds force (lbf) or kilogrammes force (kgf) but these are being succeeded by the international unit, the Newton (N).

The jet engine is traditionally associated with aircraft propulsion, though today it is being used in an ever-widening sphere of application - ships, boats, trains, hovercraft, road vehicles, power stations and pumping equipment are all benefiting from the gas turbine's inherent qualities of high power, low weight and small size.



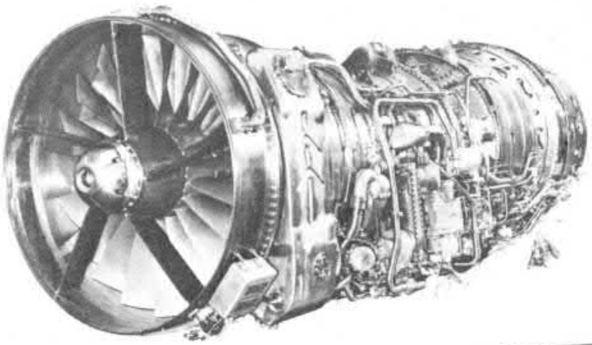
Rolls-Royce gnome H 1400-1 turboshaft engine

Turbojet

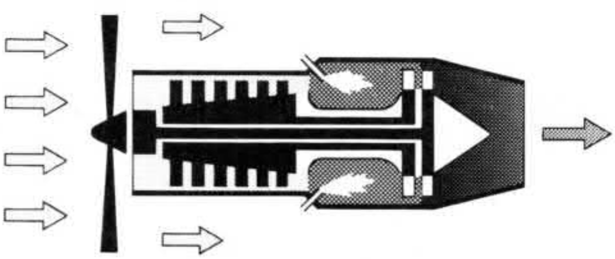


The simplest form of gas turbine, the turbojet, is used mainly in high-speed aircraft, where small frontal area and high thrust are at a premuim to enable high speeds, often into the supersonic range, to be achieved.

Examples are the OLYMPUS 593 in Concorde and the AVON in a wide variety of military aircraft.

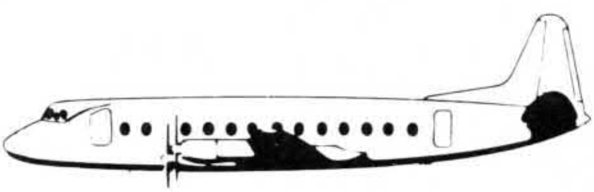


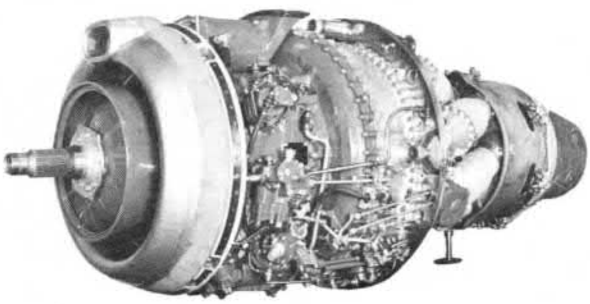
Turboprop



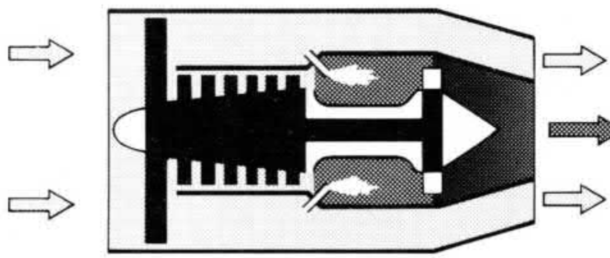
The turboprop is virtually a turbojet with extra turbine stages which absorb the majority of energy from the exhaust stream to drive a propeller through a reduction gear. Only a small amount of residual jet thrust is available from the exhaust system. The turboprop is the most efficient power unit for aircraft intended to fly at moderate speeds and altitudes - nominally up to 450 mph and 30,000 ft.

Examples are the DART in the HS 748, Friendship and Viscount, the TYNE in the Transall C-160 and Atlantic, and the PROTEUS in the Britannia.



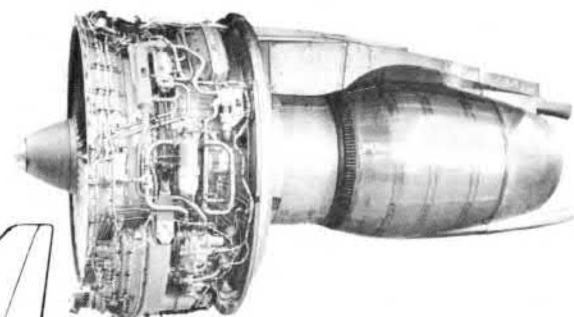


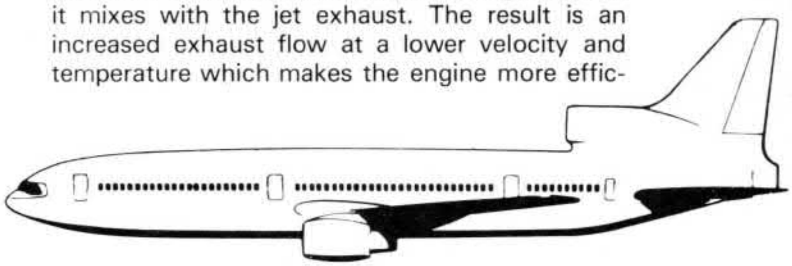
Turbofan



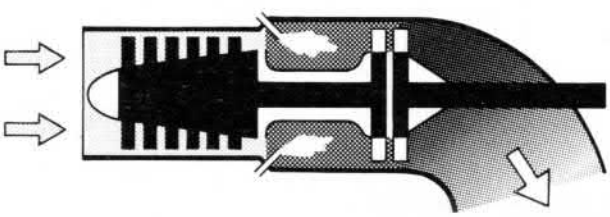
The turbofan combines the advantages of the turbojet and turboprop. It has an extra compressor or fan which provides more air than is required by the combustrion system and turbine, and the excess air is ducted to the rear of the engine where it mixes with the jet exhaust. The result is an increased exhaust flow at a lower velocity and temperature which makes the engine more efficient, economical and quieter than the turbojet. The turbofan is the optimum engine for aircraft designed to fly at high subsonic speeds.

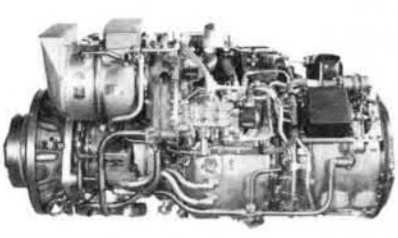
Examples are the RB 211 in the TriStar, the SPEY in the One-Eleven, Fellowship and Trident, the CONWAY in the VC 10 and Victor and the M45H in the VFW 614. The PEGASUS in the Harrier is an adaptation of the turbofan.





Turboshaft

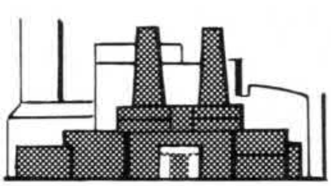


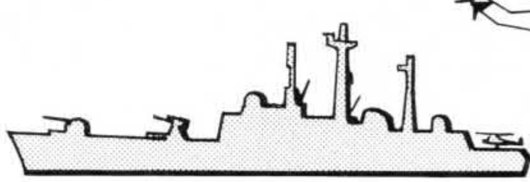


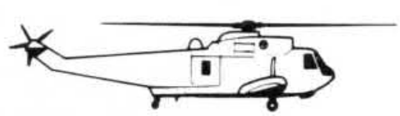
The turboshaft is, in effect, a turboprop without the propeller, the extra turbine being coupled to a reduction gearbox or directly to an output shaft. As with the turboprop, most of the gas energy remaining after driving the compressor is used to provide shaft power and the residual thrust is very low. The power of these engines is therefore normally measured in shaft horse-power (shp) or kilowatts (kW).

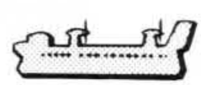
Turboshafts are mainly used in helicopters to drive the main and tail rotors but are also used in hovercraft, ships, trains, power stations and pumping equipment, where the engine is a 'gas generator' which drives a separate power turbine carrying an output shaft.

Examples are the RS 360 and Olympus industrial and marine engines.

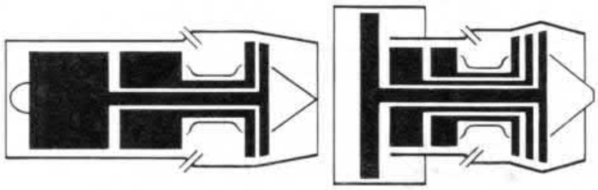








Variations.....



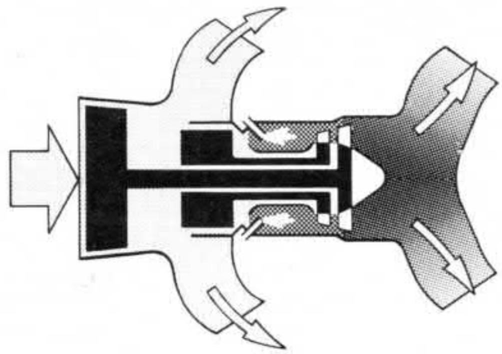
MULTI SPOOL ENGINES

The higher the compression ration of a modern jet engine the narrower the speed range over which the compressor will run efficiently, if all blades are fixed to the same shaft. To overcome this, the compressor is often split into two parts, each part being driven by its own separate turbine. As a result of this, flexibility of operation is improved, since each section can run at its optimum speed independent of the other.

Such an arrangement is known as a two-spool (or two-shaft) engine and is typified by the OLYMPUS, SPEY and RS 360. In the RB211 yet a third spool is added.

VECTORED THRUST

Thrust vectoring is employed on certain V/STOL (Vertical and Short Take-Off and Landing) engines to direct the exhaust from vertically downward for take-off and landing, through an arc to horizontally rearward for conventional flight. This is achieved with linked swivelling nozzles - in the case of the PEGASUS turbofan, two nozzles discharging the cold fan air and two discharging the hot exhaust gas.



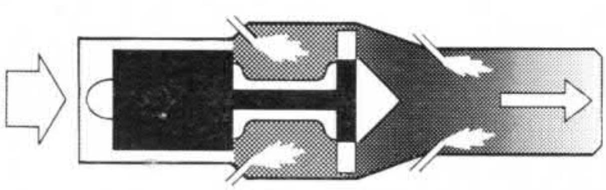
LIFTJETS

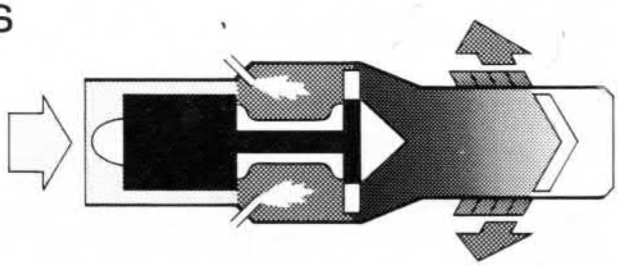
These are turbojets which are installed vertically to provide purely vertical thrust for take-off, hovering and landing. They are shut down during other phases of flight.

......and Additions

REHEAT

Reheat or afterburning provides a means of increasing the thrust of a jet engine without enlarging its frontal area. Unlike a piston engine, the fuel in a jet is burned in an excess of air, so there is still a certain amount of oxygen present in the exhaust. These gases will therefore support combustion and it is possible to burn additional fuel in the jet pipe to increase the exhaust velocity and consequently raise the total thrust of the engine. Thrust increases up to 70% are possible by this method, which is typically used to give a short-duration thrust boost and is more usually applied to military engines.





REVERSE THRUST

Thrust reversal is simply a method of altering the direction of jet reaction, like thrust-vectoring, to meet an aircraft operational requirement, in this case slowing the aircraft during landing. Deflection is usually achieved with a pair of doors which move to blank off the jet pipe and direct the exhaust gases forward through cascades.

HOW THE HELICOPTOR FLIES

Fixed-wing aircraft are sustained in the air by the lift created by air flowing over the wings. Consequently, the whole aircraft must move through the air at considerable speed before sufficient lift is generated to sustain the machine in flight.
In the helicopter, lift is also generated by the airflow over "wings" but in this case the wing system consists of the main rotor whose baldes are, in effect, narrow chord, high aspect ratio wings which gain the necessary speed through the air by rotation. Even when hovering the helicopter's rotor blades (or wings) are passing through the air at high speed and forward translational speed is not therefore necessary to sustain the aircraft in the air.
The plane of rotation of the rotor blades is known as the rotor disc, and the net force generated by the blades may be taken as acting at the centre of the disc and at right angles to it.
When the helicopter is hovering, the net force generated by the rotor is vertically upwards and is exactly equal and opposite to the weight of the aircraft acting vertically downwards through the centre of gravity. In such circumstances an increase of blade pitch and power will cause the helicopter to rise vertically and vice versa.
If we now tilt the helicopter nose down, so that the rotor disc is also tilted forward, the net force generated by the rotor will be similarly inclined so that part of it will be acting in a forward direction and will pull the helicopter forward. (Observation will show that helicopters fly foward in a nose-down attitude, the inclination being in the order of 10 degrees at top speed and proportionately less at low speeds).
In exactly the same way, if it is desired to fly backwards or sideways the rotor disc and consequently the whole aircraft must be inclined slightly in the appropriate direction.
In the majority of helicopters tilting of the rotor disc is achieved by giving a cyclic variation to the incidence of the blades, that is to say, each blade in its rotational path has its incidence varied so as to produce an extra thrust on one sector of the disc and a lessened thrust on the opposite sector as necessary to tilt the rotor disc in the required direction. The mechanism in the rotor head which applies the cyclic variation is operated by a conventional control column known as the "cyclic pitch" or "azimuth" control. By the pilot's left side there is a separate lever known as the "collective pitch" control, which can change so as to vary the total thrust for ascent or descent.
A considerable torque reaction is, of course, set up in driving the rotor and if this were not taken care of, the whole body of the aircraft would tend to rotate. This tendency is neutralized by a small rotor fitted at the end of the tail boom and revolving in a vertical plane at right angles to that of the main rotor. The tail rotor is driven by extension shafting from the main rotor drive and incorporates a variable pitch mechanism which is operated by the pilot's rudder pedals. Directional control of the helicopter is achieved by pitch variation of the tail rotor.
In the event of a power failure in a helicopter, very briefly, landings are made in "auto-rotation", that is, with the main rotor revolving under the action of the air alone in much the same manner as the rotor of an autogiro, the helicopter meanwhile is descending in a glide.
This is catered for by providing an over-running clutch between the engine and the main rotor which allows the main rotor to "free-wheel" automatically should the engine fail. Since the tail rotor is driven by the main rotor the former also continues to revolve and complete control can be maintained.

In the normal power-off landing, a gliding approach is generally made to within some 20 feet of the ground, when the descent is checked by putting the helicopter in a slightly nose-up attitude and allowing it to settle gradually at some 25 miles per hour. Alternatively, just before making ground contact, the pitch of the main rotor blade is momentarily increased, utilizing the rotational energy stored in them, and the touchdown can then be made with little or no forward speed.
In the transition from "power-on" to auto-rotational flight it is, however, necessary for the pilot to decrease the pitch of the main rotor blades by pushing the collective pitch control down—an instinctive movement which can be effected so quickly that almost any helicopter flying at 40 miles per hour or more could make a safe landing from any altitude.
Gliding speed auto-rotation can take place in vertical descent, the rotor will still revolve and check the rate of descent appreciably and if the pitch is increased immediately before contact the helicopter would touch down with the same vertical speed as a body falling freely from some 5 or 10 feet.
Such an emergency landing has been recorded following a complete engine stoppage when hovering at 60 to 70 feet. The helicopter came down vertically and sustained only minor damage to the tail cone and nose wheel structure while the pilot sustained no injury whatsoever.

LEAVESDEN AIRPORT

Leavesden Aerodrome is operated by Rolls-Royce (1971) Limited, on a public licence granted by the Civil Aviation Authority. This Licence is renewed annually after a thorough inspection by the Authority that the standards required have been continuously complied with.

The Aerodrome is used in the main by executive and general aviation operators using aircraft which range from small Beechcraft types to the larger Jetstream and Beechcraft airliners. Helicopter operators also use the aerodrome together with Companies who carry out servicing of aircraft and internal charter flights.

Leavesden Aerodrome is equipped with modern runway lighting and aids to navigation such as direction finding and radar. The Air Traffic Control unit is staffed by fully licensed control officers who provide, in addition to aerodrome control, various services to aircraft flying in the local vicinity. Most of the over-flying aircraft under the advisory control of Leavesden operate at altitudes below 2500 ft. This is due to the large amount of controlled air space being used by London control which covers the area above Leavesden. Most of these movements are never seen by the staff who provide a service which gives a safe flow of traffic in the local area.

Customs facilities are available to certain operators of aircraft and much business is carried out by Companies who own and operate industrial concerns in and around the area of Leavesden Aerodrome.

The airtaxi helicopter takes today's businessman up and away from the traffic jams

Air traffic control at Leavesden is carried out by a highly trained team of controllers

ACKNOWLEDGMENTS

On behalf of the Committee, I wish to thank all concerned for the excellent co-operation and assistance we have received in planning this Open Day.

Gratefully acknowledging the presence of the military and civilian flyers who contribute so much to the success of the day, we are also indebted to the individuals, departments and organisations, both from the local area and within the Division, for their support. These include the Watford Round Table and The Watford Rotary Club (any monies collected at their side shows will be donated to charities), various sections of the R-R Sports & Social Club, the RAF Association, our caterers - Batemans and all our fellow employees who will be on duty.

Our thanks are also due to everyone who comes to enjoy the event.

ROLLS-ROYCE (1971) LIMITED, SMALL ENGINE DIVISION, LEAVESDEN, WATFORD WD2 7BZ
Tel: GARSTON 74000

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OPEN DAY
LEAVESDEN 1974

ROLLS ROYCE

Saturday July 13th
Main Gates Open 1-00pm
Admission Free

ROLLS ROYCE (1971) LIMITED SMALL ENGINE DIVISION

On The Ground

- ★ SECTIONS OF BOTH FACTORIES OPEN TO VIEW
- ★ AT THE CANTEEN NEAREST MAIN GATE - Open Sweet Pea Competition and Horticultural Show - Set teas
- ★ MODEL RAILWAY DISPLAY
- ★ GO-KART RACING - pedal cars for the Children
- ★ VINTAGE CAR AND MOTORCYCLE DISPLAY - near the tennis courts
- ★ MODEL AIRCRAFT FLYING
- ★ SIDESHOWS FOR THE CHILDREN (profits to local charities)*
- ★ INFORMATION TENTS
  - About the "Small Engine Division"
  - Lost children and Information Centre
- ★ REFRESHMENTS - large marquee in public enclosure

* Donations to Charity

The organisers of the various sideshows will donate the proceeds to:

1. Local organisations for Mentally Handicapped Children
2. Watford and District Blind Centre
3. Springfield School Swimming Pool for Handicapped Children
4. North Watford Rehabilitation Centre
5. The Youth Volunteer Workshop
6. The North Watford Darby and Joan Club
7. Watford Old People's Welfare Association
8. Watford Round Table Christmas Parcels Appeal for the old and needy of Watford.
9. The Samaritans

NOTICE:

Visitors entering Rolls-Royce Small Engine Division on the day do so entirely at their own risk. No liability will be accepted by the Company for any loss or damage to persons or property whether due to negligence or otherwise howsoever caused.

WARNING:

VISITORS ARE PARTICULARLY REQUESTED NOT TO GO BEYOND THE BARRIERS OF THE PUBLIC ENCLOSURE OR DEVIATE FROM THE ROUTES ALLOCATED FOR FACTORY VIEWING.

Y PROGRAMME 1974

In The Air

Provisional flying programme from 3·00pm onwards

1. PITTS SPECIAL - Aerobatics International
2. ZLIN - Aerobatics International
3. MOSQUITO - Hawker Siddely Aviation, Hatfield
4. SEA KING HELICOPTER - Royal Naval Air Station, Culdrose
5. WASP HELICOPTER - Royal Naval Air Station, Portland
6. WESSEX HELICOPTER - Royal Naval Air Station, Yeovilton
7. LANCASTER - Royal Air Force, Coltishall
8. NORD - Privately Owned
9. SPITFIRE - } Royal Air Force, Coltishall
10. HURRICANE } Royal Air Force, Coltishall
11. LAKE AMPHIBIAN - Webster Aviation
12. PISTON PROVOST - Shuttleworth Collection
13. SPITFIRE - Rolls-Royce (1971) Limited
14. SCOUT HELICOPTER } Army Air Corps HQ Middle Wallop, Hants.
15. GAZELLE HELICOPTER } Army Air Corps HQ Middle Wallop, Hants.
16. SKEETER HELICOPTER } Army Air Corps HQ Middle Wallop, Hants.
17. LYNX HELICOPTER - Ministry of Defence
18. PIPER AIRCRAFT (VARIOUS) } Webster Aviation
19. HORNET MOTH } Webster Aviation
20. GNAT - Royal Air Force, Valley
21. CESSNA AIRCRAFT (VARIOUS) - Ambrion Aviation
22. BEECHCRAFT AIRCRAFT (VARIOUS) - Executively Owned
23. JETSTREAM - Morgan Crucible Company
24. JET PROVOST MK5's "THE SWORDS" - Royal Air Force, Leeming

★ Pleasure Flights at times to be announced during the afternoon

NOTE·

At the time of going to press, the flying programme is the best forecast of participants and the order in which they may appear. It is emphasised that for reasons beyond our control, last minute cancellations and changes could occur and sincere apologies are offered in advance should these be necessary.

The Westland/Aerospatiale Lynx helicopter, now in production for the British Armed Forces and the French Navy, is powered by two 900 shaft horse power Gem turbo-shaft engines manufactured at Rolls-Royce Small Engine Division