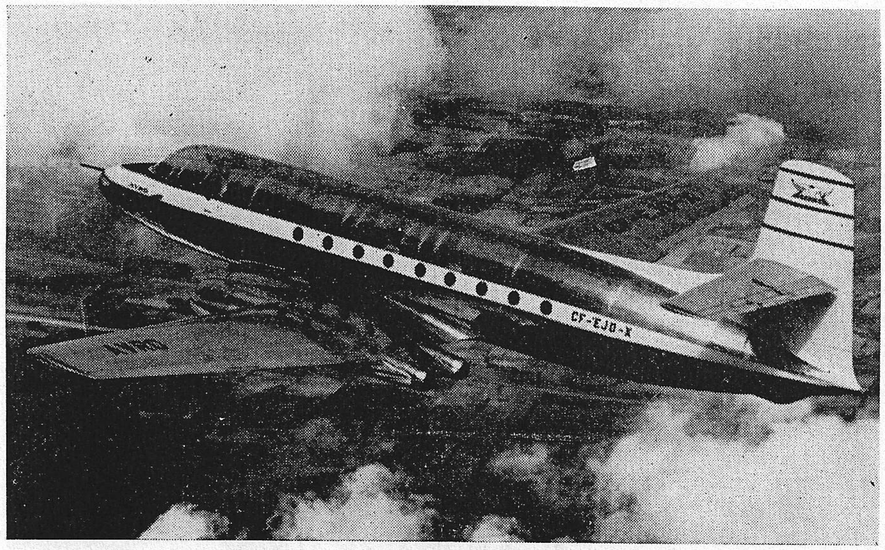
AVRO JETLINER SETS NEW STANDARD



CANADIAN TURBINE PLANE PIONEERS IN N. AMERICA STARTS SHAKEDOWN TRIALS AFTER WHEEL-UP LANDING SPECIALIST IN DOMESTIC MAIN LINE AIR SERVICE

ABOVE — Test pilots reported the Jetliner easy to handle, as agile as a fighter, on trial flights.

CANADA'S entry in the turbine transport market, the Avro C-102 Jetliner is designed to set a new and blistering pace along the air routes of the next decade. First of its kind in the skies of North America, the Jetliner has an estimated maximum cruising speed of 427 mph at 30,000 ft. with all-up weight of 60,000 lb.

Custom built to fit short and medium routes stages such as on the TCA domestic main line, the 102 has a maximum still-air range, without emergency allowances, of 1,400 miles. Carrying its average assignment of 50 passengers, and with allowances for taxiing, climb to altitude, stooging, fuel for alternate, etc., the range is approximately 500 miles.

The Jetliner was designed for its most economical use on stages from 200 to 600 miles. While Trans-Canada Air Lines has made no commitment, the Canadian domestic airline was consulted in the early design stages and, in fact, wrote a specification which guided Avro in developing the project.

Power is supplied by four Rolls-Royce Derwent 5 jet engines, mounted in pairs in underslung circular nacelles. Total thrust is 14,000 lb. The aircraft has exceptionally clean lines. The fuselage is of circular cross-section, with external flush rivetting.

TOP MANAGEMENT — Walter N. Deisher, right, general manager of Avro Canada, and Fred T. Smye, his assistant, check air photos of the Jetliner after its maiden flight.

Distinguishing features of the jet airliner are the close proximity of the engines to the fuselage, the remarkably short undercarriage (with no prop clearance to consider), and the high location of the horizontal tailplane (well clear of the jet blast).

Other special-interest features concern the control surfaces. The aileron, for example, is hinged and operates in two sections. Normally the rear surface only is used but under unusual circumstances, such as a tail-down landing with forward CG, the full double aileron can be used.

Similarly, the rudder has two surfaces. In the event of an engine failure, the second surface, which is power-operated, comes into action automatically to keep the aircraft in line. (Actually, the close-in location of the engines should minimize the swinging tendency with engine failure.)

The prototype Jetliner now flying has two sets of hinged flaps, one outboard, the other inboard of the engines. The outboard flaps are the normal approach flaps while the inboard set are dive flaps to retard speed during steep descents. The second prototype will have, in addition, a third set of flaps between the engine nacelles, to be used for diving as well as approach. All flaps on the second plane will be double slotted.

Length of the Jetliner is 82 ft. 5 in. (11 ft. less than the North Star). Span is 98 ft. 1 in. Height of the vertical stabilizer is 26 ft. 5.5 in. Wing loading, with full payload and all allowances,

ABOVE — Trim lines, tapered wings, underslung nacelles and high-set tailplane are apparent in this profile view of the Jetliner in flight.

is 51.86 lb./sq. ft. Cabin diameter is 10 ft.

Fuselage—There are four main components of the fuselage: 1. Nose Section; 2. Centre Section (including centre wing); 3. Rear Centre Section; 4. Rear Section (including lower fin).

Construction consists of circular formers (10 ft. diameter). longitudinal stringers, and stressed aluminum skin with external flush rivetting. The formers are spaced at about 20 in. in the cabin and are intact, there being no cut-outs for the stringers, which are external to the outside former flanges.

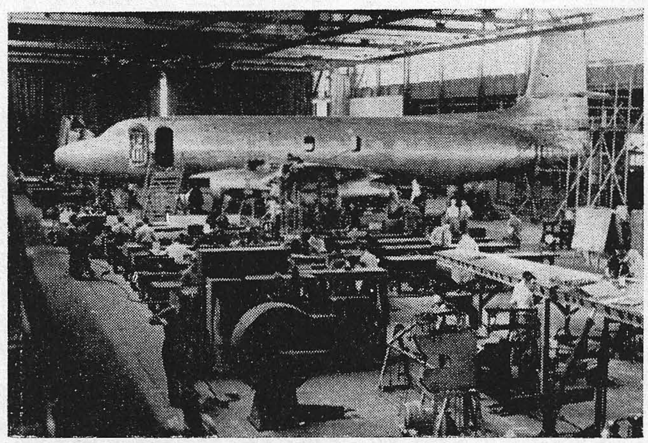
The pressurized cabin is sealed fore and aft by pressure domes. One is located immediately ahead of the main instrument panel and isolates the nosewheel compartment. The rear pressure dome is clamped between the rear centre section and the rear section.

The floors are of sturdy construction. The centre panels, in the aisle, are removable for servicing the flying and engine controls, electrical conduits, junction boxes and ventilation ducting.

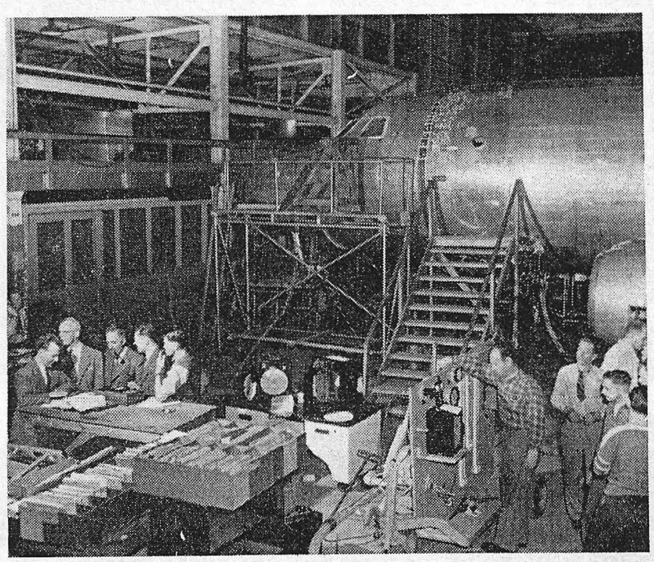
Four side escape hatches, opening inwards and quickly removable from inside or outside are provided in case of emergency in the passenger cabin. There is an additional escape hatch in the flight deck for the crew.

The windscreen structure is a high-strength aluminum alloy casting. The three centre windscreen panels are of special sandwich construction incorporating the "NESA" system of electrical de-icing. The vinyl core ensures pressure being retained in the cabin in the event of wind-screen damage. The two direct vision windows, and two aft windows, are of

ABOVE — Close-together location of engines and short undercarriage, made possible by absence of props. are evident here.



RIGHT — Where the C-102 was born. Portion of the experimental shop with the Jetliner nearing completion.



RIGHT — Pressure testing the front section of the fuselage. Note the cluster of electrical strain switches around the door.

plexiglas. Non-misting circular, double windows are provided in the passenger cabin.

Pressure-sealed entrance doors for passengers and crew are located on the port fuselage side, at each end of the main cabin. An additional loading door may be provided on the starboard side for the rear baggage compartment.

Mainplane—The mainplane is a fully cantilever construction, built in three main sections, with detachable wing tips.

The centre portion of the mainplane is integral with the fuselage centre section. The structure of the centre section which carries the four power plants comprises a conventional two-spar arrangement with chordwise ribs, and heavy gauge skin covering. The spars are of the twin-boom, solid shear-web type.

The outer wings are attached to the centre section by continuous butt-strap joints, ensuring continuity and efficient use of the stressed skin structure.

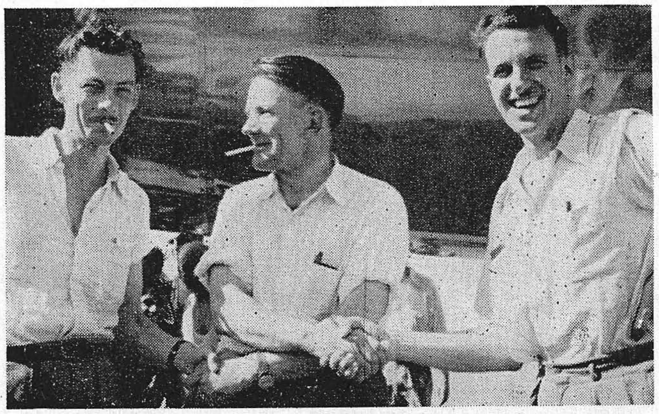
In the outer wings the two-spar arrangement is used, but heavy gauge skin and stringers take the place of concentrated spar booms, and at the same time, provide the high torsional stiffness necessary for increased speeds. In this component, 75 ST material is used extensively to ensure maximum strength-to-weight ratio.

The inner portions of the outer wing between the spars form the integral **fuel tanks.** Ther are four tanks, two port and two starboard, the inboard tanks extending between ribs 1 and 7, and the outboard tanks, between ribs 7 and 14.

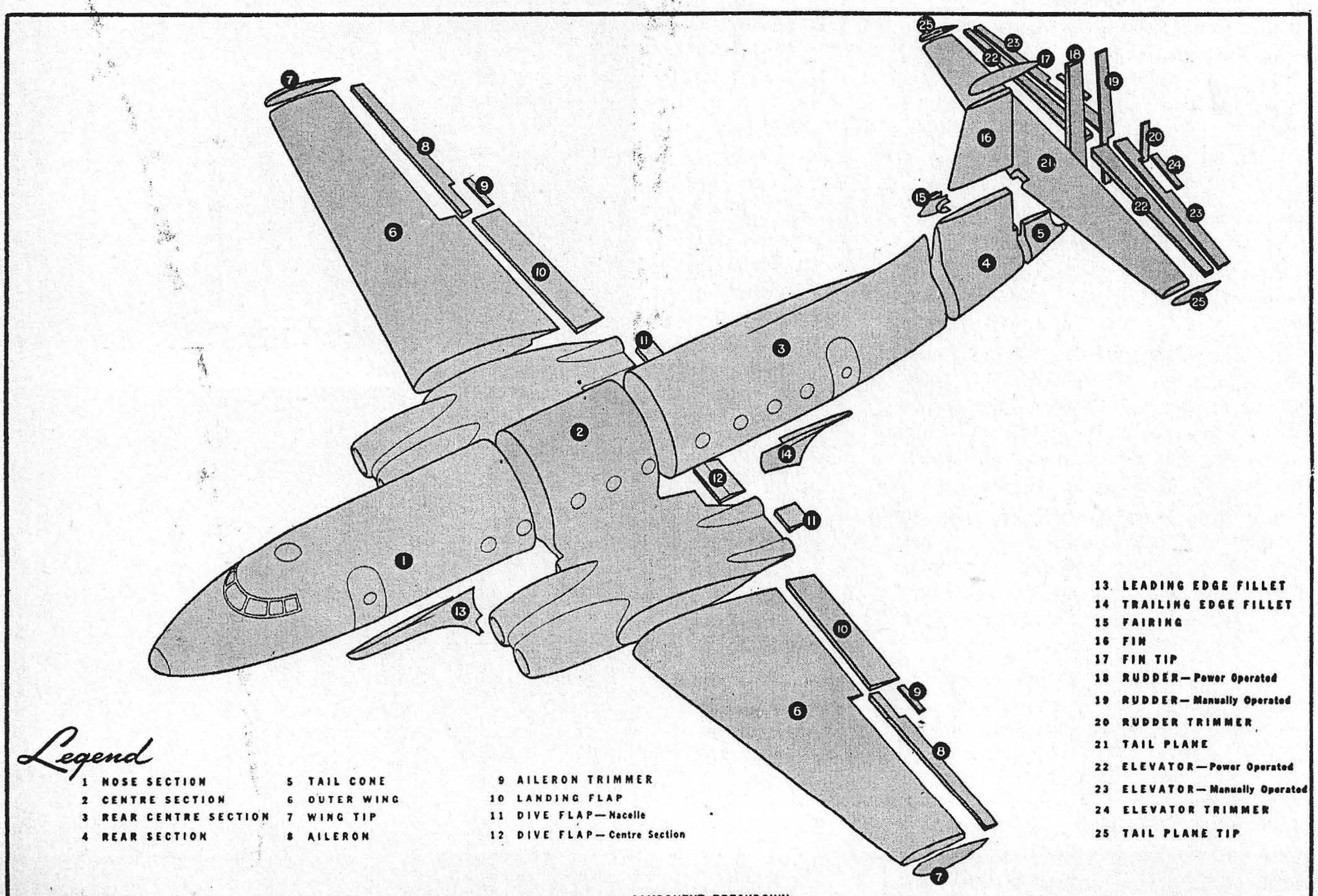
The **ailerons,** which extend along approximately 53% of the outer wing-span, are of all-metal construction, unbalanced aerodynamically, and power-assisted hydraulically in the ratio of 5 to 1. The connection to the mainplane is by piano hinges on the upper surface, giving a completely sealed surface. Internal mass balances are employed, and a manual trimmer is fitted.

The **landing flaps,** hydraulically operated, are of the split type, metal covered, and extend from the outer wing root to the aileron. Additional **dive-flaps** of the split type are fitted on the centre wing, and the aft section of the nacelle. The split flaps on the centre wing can also be used as landing flaps. Extension or retraction time is approximately 10 seconds.

Empennage—The empennage com-



FLIGHT CREW — Chief Test Pilot Jim Orrell, centre, shakes hands with Don Rogers, test pilot, at right, and Bill Baker, flight engineer, after maiden flight in the Jetliner.



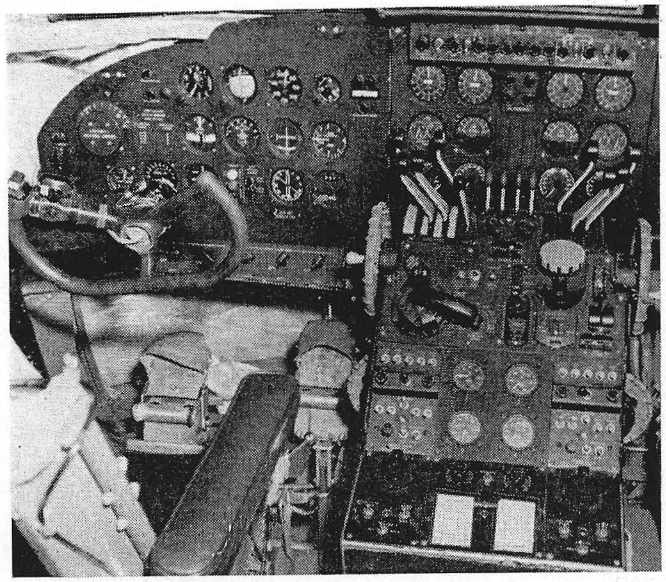
COMPONENT BREAKDOWN

Flying the Jetliner Is Simple

FLYING a jet airliner actually is simpler than the same assignment in a piston-powered transport, according to the evidence of Don Rogers, Canadian test pilot, who has flown the C-102. The close-in location of the engines means that in the case of an engine failure on take-off, the swerving effect is much less than conventional pilots are accustomed to. Even this rather mild swing is taken care of on the Avro Jetliner, however, with an automatic powered rudder correction. The approach in the C-102 is made at about 120 mph. Deceleration is less than in the piston plane when power is chopped, because of the absence of propeller drag. Similarly, there is not quite the same immediate thrust without props with sudden application of power.

As evidenced by the cockpit illustration herewith, the layout is simplified with jets. The flight panel is the same, so are the trim controls, elevator, aileron and rudder, which are located on the throttle pedestal. There are the four throttle levers, duplicated, and, between them, four fuel selector levers.

Directly ahead of the throttle pedestal is the engine instrument panel which carries three rows of indicators: tachometers, jet pipe temperature gauges, and fuel contents gauges. It's just about that simple.



The Jetliner cockpit is comparatively simple. Note absence of pitch and mixture levers on throttle quadrant.

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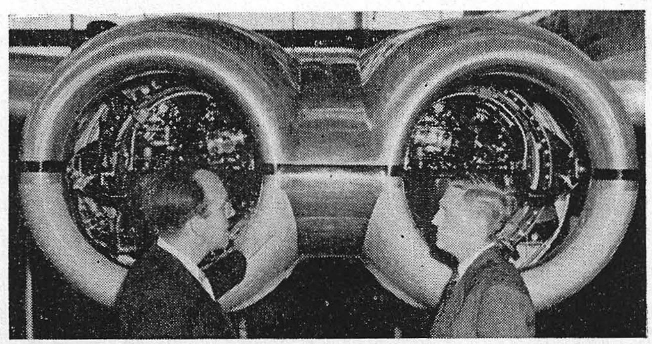
prises an upper and lower fin section with high tailplane, double rudder and double elevator surfaces.

The lower fin, which is integral with the fuselage, is of the two-spar, twin-boom, shear-web arrangement, with extra heavy gauge skin for torsional rigidity. The tailplane, also of the two-spar arrangement, is attached to the lower fin by high tensile steel pins through steel end fittings parallel to the tailplane spars. The top portion of the fin is fastened to the tailplane by the same method.



Gunnar Kristianssen, Swedish journalist, left, discusses the Jetliner with Bob Johnson, foreman of the C-102 Experimental Shop.

The elevators, which are attached by piano hinges to the tailplane, have double surfaces, the rear surface being operated manually, while the auxiliary surface is power operated. Electrical trimmers are fitted which can be operated manually if desired.

The rudder has two unbalanced surfaces, the rearmost manually-operated, and the other power-operated. Both are carried on piano hinges on the port side. Normally the manual surface only is required, the auxiliary surface being brought into play only in the event of engine failure at low speeds. A trimmer is provided, which can be manually operated during operation of the manual surface, but which is electrically operated when auxiliary surface is brought into play.

Undercarriage—A tricycle undercarriage of advanced yet extremely simple design is fitted, incorporating twin wheels on both main and nose units. The nosewheel unit retracts forward into the nose cavity in front of the forward pressure bulkhead, while the main units, which are hinged adjacent to the mainplane rear spar, retract forward between the spars, and in the "Up" position lie between the jet pipes. The undercarriage may be retracted in approximately eight seconds.

The nosewheel shock unit is of the liquid-spring lever suspension type, and the main undercarriage unit consists of a telescopic leg also utilizing liquid springing. The undercarriage operation is electro-hydraulic, as is the nosewheel steering.

The nosewheel, which is self-centring, self-trailing and incorporates shimmy damping, is steerable from the cockpit by a hand wheel adjacent to the first pilot.

Hydraulic brakes have been installed with foot pedal controls allowing differential braking. The differential units and hydraulic lines, as well as the source of hydraulic power, have all been duplicated to preclude any chance of failure. In the event of failure of the hydraulic system, the main undercarriage and nosewheel will lower under gravity.

Flight Deck—Use of jet engines has simplified the complete instrumentation and number of controls required, and has resulted in a very simple and straightforward layout.

The instruments have been grouped in accordance with the requirements of radio navigation and automatic and blind landing aids. The main electrical panel is in the roof within easy reach of either pilot, while the air conditioning control panel is to the left of the Captain, and the oxygen and de-icing control panels to the right of the First Officer. The circuit breaker panels for both electrical and radio equipment are on the rear bulkhead of the flight compartment.

Space is available behind the First Officer's seat for the crew's baggage. The main aircraft batteries are also located on the floor in this position, and are removable through the main

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Jetliner Sets New Pace

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forward entrance door. A jump seat hinging on the battery box is available for an observer.

Direct-vision windows which may be swung inwards and secured in an open position are provided for landing under extremely adverse weather conditions.

Flying Controls—The three main controls are operated by push-pull type aluminum alloy tubes. The tubes are supported in roller guide bearings. Conventional aileron handwheels are mounted on the control columns.

The ailerons are power-assisted by a hydraulic unit located on the rear spar at centre line of the aircraft, giving a five-to-one boost to the pilot's effort.

The auxiliary rudder flap which is only required in the case of engine failure, is operated automatically.

The rear elevator surface is operated manually in the conventional manner, while the auxiliary elevator surface is automatically operated.

Landing flaps are hydraulically operated by means of a flap selector switch and an actuator switch mounted on the control pedestal. The selector switch is for selection of the desired flap angle, and the actuator switch is a simple "On-Off" switch. This switch operates the outer wing slotted flaps and the centre section split flaps.

The dive flaps are hydraulically operated by means of an electric switch located on the control pedestal directly above the landing flap switch. This switch actuates the nacelle flaps and centre section flaps.

Pioneer PB.10 Autopilot is fitted, modified especially for use on high speed transport aircraft.

Engine Controls—The engine controls are of the push-pull type, operated from the central control pedestal in the flight deck by means of a system of bell cranks and levers.

The engine starting system is operated from a 24-volt d-c. aircraft supply or external ground supply. Engine starting is controlled by a timing panel set in motion by the depression of one of the starter buttons. The timing panel automatically sequences the starting motor relay and operation of priming pump and booster coils. Once an engine has been selected and the starting timing sequence set in motion, a second engine cannot be started until the starting cycle of the previous engine has been completed.

A relight switch is incorporated in the system for starting in the air, as well as a safety "On-Off" switch and master switch.

Cabin Arrangement—In the 40 to 50 passenger version double cabin seats are arranged on each side of the cabin, with a centre aisle. For high-density work, up to 60 passengers can be carried by using five seats abreast and with an aisle clearance of 19 in.

Power Plants—The four Derwent 5 jet engines are mounted in pairs in two underslung nacelles which also house the main wheels of the retractable undercarriage.

The lower half of the cowlings consists of two large doors swinging to the sides of the nacelle and one door swinging to the rear, providing access to engines and accessories. This permits each engine to be replaced in a very short time by uncoupling the jet pipe, drive shaft, connectors, detaching the engine from the mounting and lowering it directly to the engine trolley.

The nacelle contains two engine bays separated by a fireproof bulkhead. Each of the engine bays is divided into two compartments, each separated also by a fireproof bulkhead. The front compartment contains the intake and plenum chambers.

The rear compartment, which houses the hot part of the engine, extends in the shape of a tunnel back to the outlet of the jet pipe. This compartment is lined entirely with stainless steel sheet and sealed against infiltration of fuel or oil. Engine fire would be confined within the fireproof compartment out of reach of electrical and fuel control lines or the aircraft structure.

The fire extinguishing installation, using methyl bromide, permits the filling of each engine bay with methyl bromide vapors in quantity sufficient to extinguish the most critical fires in the air or in case of crash landings.

A water methanol system is fitted to increase thrust for take-off under hot weather and altitude conditions.

Fuel System—Fuel is carried in four integral wing tanks located in the outer main-planes between the spars. Each group of two engines has its independent fuel system. Fuel from any tank, however, can be delivered to any engine.

Engines are fed normally from inboard tanks with a total capacity of 1,320 Imp. gal. Fuel from outboard tanks of 980 gal. total capacity is transferred into inboard tanks continuously at a controlled rate, thus relieving the pilot from the necessity of manual selection of tanks. If required, engines also can be fed directly from the outboard tanks by means of by-pass valves.

Booster pumps located in each tank deliver fuel free of vapor and air to the engines at a steady pressure of 6 to 8 lb/sq. in. at any operational altitude. The engines can, however, function with the booster pumps inoperative.

Any appreciable difference in weight of fuel carried on either side of the aircraft is indicated by a warning light, which enables pilot to correct the trim of the aircraft by manual selection of tanks.

The tanks can be refueled through underwing connectors (one on each side of the aircraft), at the rate of 200 gpm through each connector. Selector valves integral with the underwing connectors permit fueling or defueling of each tank individually.

Hydraulic System— This is a high pressure system operating at a normal pressure of 1,800 lb/sq. in.

The following components are operated hydraulically by the main system: (a) Undercarriage; (b) Brakes; (c) Nosewheel Steering Gear; (d) Landing Flaps; (e) Dive Flaps; (f) Aileron Power Booster.

Emergency Operation—In addition, the more important of the above services may be operated by the emergency system as follows:

Undercarriage: The undercarriage can be extended for landing by operation of a switch located adjacent to the main undercarriage control on the pedestal.

Brakes: No action is required by the pilot other than operating the brakes in the normal manner to provide full emergency braking. Complete hydraulic duplication is provided.

Landing Flaps: The flaps can be extended or retracted to the desired setting by operation of a momentary contact switch located close to the main flap control on the pedestal.

Aileron Power Booster: When the emergency power pack is switched on no additional action is required by the pilot to enable the aileron power booster to function.

De-Icing System—The system comprises resistance wire embedded in pads attached to the leading edges of outer wings, fin and tailplane, together with cycling relays to turn power on and off. A warning light system is installed to indicate im-

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proper functioning of the system to pilot.

Air Conditioning and Pressurization

The air conditioning and pressurization units are integrated into a completely automatic system to supply fresh air to the passengers at a comfortable temperature and pressure for all conditions of flight.

Either filtered or ram air is passed from wing intakes to the two cabin superchargers, one on each power plant gear box. Each supercharger has a capacity of approximately 30 pounds of air per minute at 30,000 ft. altitude against a cabin differential pressure of 8.3 lb./sq. in.

A constant flow of about 60 lb. of air per minute at all altitudes is maintained by automatic regulation. Either supercharger is capable of delivering this flow up to 13,500 ft.

Automatic control of cabin pressure is maintained by a discharge valve, set to provide sea level conditions up to 21,500 ft. At 30,000 ft. the cabin pressure is equivalent to 4,000 ft. altitude. The rate of pressure change in the cabin during the climb and descent is also automatically controlled, and may be preset to the desired value by the pilot.

The ventilating air is conditioned as to temperature by equipment in the accessory compartment. Heat is supplied by a combustion type heater of 200,000 BTU per hour capacity. Cooling is provided by heat exchangers and a cooling turbine. The operation of this equipment is automatically controlled.

British Air Show

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tails of its static thrust. I hazarded a guess that, as it was the successor to the Derwent which gave 3,500 lb. thrust, and the Nene which gave 5,000 lb. thrust, the Avon will give 7,500 lb.

The nacelles which house the two Avons are considerably bigger in cross-section than any previous motors we have seen in the Meteor, and it was announced that the Meteor, which can climb to 40,000 ft. in four minutes, is the fastest-climbing airplane in the world. We watched it climb from ground level, almost vertically until we lost sight of it in the clear blue sky.

There were two quite new fighters which had been on the secret list till the day of the show. These were the **DH 112**, and **DH 113**, both developments from the Vampire. The 112, is named the **Venom** and was flown to perfection by John Derry who had taken it for its first flight the day before the Show. His confidence in it is shown by the fact that he did two rolls on its very first flight; and he flew it at Farnborough as though he were quite accustomed to it.

The power plant is a new version of the **Goblin** turbo-jet which gives 66% greater thrust than the Goblin fitted to standard Vampires. The leading edge is slightly more swept back than on the Vampire which will give it a higher Mach number. As it is a development of the Vampire, having identical fuselage and tail unit, it will not need the usual two or three years' development trials. As all the factory tooling for the Vampire can be used for Venom production, this "fighter of tomorrow" is available almost at once. Moreover, it has the handling characteristics of the Vampire.

The DH 113 is at present named the "Vampire two-seater," for like the Venom it is a development requiring most of the Vampire tooling. It is primarily a night-fighter with a two-seater nose with full radar, on the lines of the Mosquito night-fighter.

We also saw, for the first time, a Meteor and a Vampire whose motors were adapted for "re-heat." This is