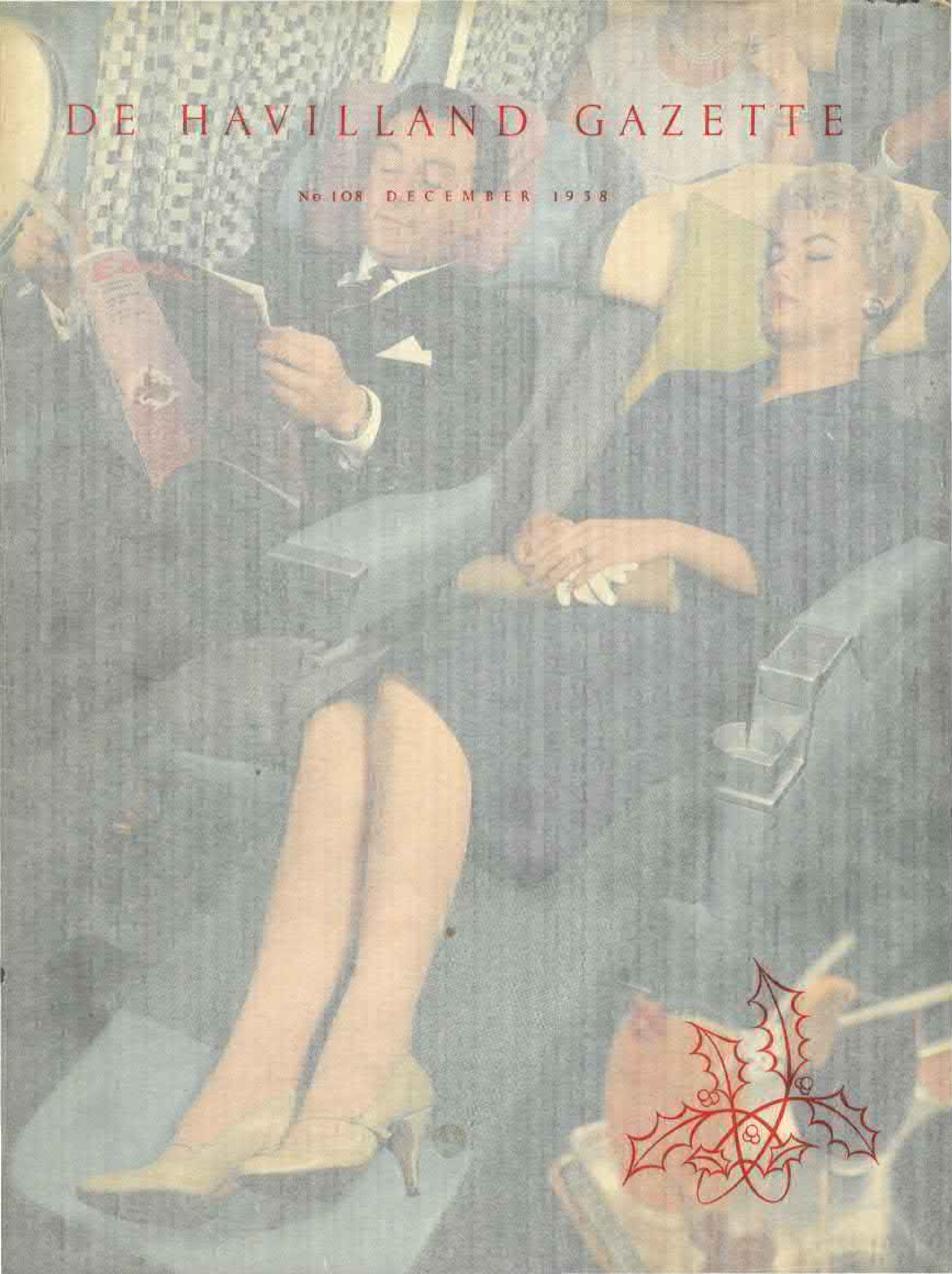
DE HAVILLAND GAZETTE

No. 108 DECEMBER 1958



Memories at Christmas time — John Young's painting of some famous Gipsy winners of the King's Cup Race is reproduced here in response to many requests.

1928	Gipsy Moth	*Wally Hope*
1932	Fox Moth	*Wally Hope*
1933	Leopard Moth	*"D.H."*
1935	Falcon Six	*Tommy Rose*
1936	Vega Gull	*Charles E. Gardener*
1937	Mew Gull	*Charles E. Gardener*
1938	Mew Gull	*Alex Henshaw*
1949	Gemini	*Nat Somers*
1950	Hawk Trainer	*Eddie Day*
1953	Chipmunk	*Pat Fillingham*
1955	Mew Gull	*Peter Clifford*
1956	Auster Alpha	*Jimmy Denyer*

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Contents

For the definitions quoted on pages 210 and 211, we are indebted to the U.K.A.E.A.'s "Glossary of Atomic Terms."

Acknowledgments for some of the photographs reproduced in this issue are gladly made to: Wm. Langley, Dallas, Texas; British European Airways; J. Stone & Co. (Charlton) Ltd., London; Gloster Aircraft; Australian Photographic Agency, Sydney; B.O.A.C.; Kemsley Picture Service, London; Crown Copyright; and to Mrs. George Bambridge for her permission to use two lines from "WHEN EARTH'S LAST PICTURE IS PAINTED" by Rudyard Kipling.

Christmas Greetings Around the World

THE December issue of this *Gazette* is the Christmas card of the Enterprise, and with it goes a warm de Havilland greeting to friends and relations throughout the world, with best wishes for a merry Christmas and good health, happiness and fortune in the year 1959.

Never have de Havilland men had more reason to be appreciative of the kindness of others in the ordinary course of business than in the year that is drawing to a close. That perhaps is because in no previous year has there been such an intensity of contact with the world at large. The increasing necessity of travel with the penetration of distant markets, and the growing facility with which long journeys are made, bring us all together a great deal more, and what a good thing this is.

The de Havilland companies, long established and widely spread about the world, depend upon trade, and the reason why our people are so frequently to be seen arriving at overseas airports wearing hopeful smiles is the plain one that we need business. Our products are on offer, we seek to provide service for payment, in order that we may purchase the materials needed for our sustenance and our manufacture. We have not the wherewithal to give a great deal away free, we require a fair price for our labours, and we strive to contribute to the maintenance of decent standards of living, health and education in the countries where we are producers. We thrive in the healthy atmosphere of enterprise and expect no unfair advantage in competition.

The basis of our relationships is thus a simple one and that may account in no small measure for the goodwill which we meet with on all hands and in all countries.

Britain is but one of the homes of de Havilland creative and productive activity. The individual units work out their separate destinies, serving aviation where they are and striving for export trade and exchange. The outlook of the engineer pervades the efforts of all, and it is an outlook which producers have in common with users.

May our communications and understanding continue to improve, and may de Havilland service be found to represent good value.

Airlines Plan World-wide Comet 4 Operations

Initial users will fly 50-million miles a year

THE British Overseas Airways Corporation's plan to start daily Comet services between London and New York on November 14 was achieved as the *Gazette* closed for press. The honour of having operated the first ever jet service on this blue-riband route (from October 4 when a westbound, *and* an eastbound service were flown) was thus followed by operating the first daily-frequency service between these two cities. An engineering labour difficulty had delayed a little the B.O.A.C. crew-training programme and had interfered with the intended weekly frequency from October 4 to November 14, so that in fact westbound services were flown on October 4 and 10, eastbound services on October 4, 6 and 12.

Excellent progress in the earlier stages of training, satisfactory completion of the 100-hour shake-down trials in August and September (recorded in the October *Gazette*) and prompt delivery of the first four Comet 4s to the Corporation have meant much to the overall effort to bring the Comet 4 into service earlier than was originally intended or expected.

By April, 1961, the 19 Comet 4s of B.O.A.C. should be flying at the rate of 73,000 aircraft-hours a year, which is equivalent to more than 32 million miles.

Aerolineas Argentinas are planning an annual utilisation of 3,000 hours per aircraft shortly after their inaugural Comet jet service to New York in May, 1959, and this will later be increased to 3,800 hours. By June, 1960, their fleet of six Comet 4s will be covering some 10 million miles per year.

To this must be added the operations of East African Airways (two Comet 4s) and B.E.A.'s six Comet 4Bs. Assuming a conservative utilisation of 2,250 hours a year for each of B.E.A.'s Comet 4Bs and 2,500 hours a year for each of the East African Comets, these eight aircraft together will produce a further 18,500 flying hours, more than 8 million aircraft miles a year.

The geographical extent and timing of these plans are shown on the following page.

The shake-down trials, from Hatfield to New York and back (August 10–12) for P.N.Y.A. quietness approval (granted October 3), to Hong Kong and back (September 8–14), and to Canada, Central and South America and back (September 16–27) were made without any spare-parts' backing along the routes flown, yet there were no delays in schedules which had been strictly laid down in advance. The British Air Registration Board had required that only one aircraft (it was G–APDA) be used for all of these flights as a demonstration of satisfactory operation and serviceability before allowing the type into public service.

Attention is drawn to an article on page 204 which discusses the ability of the Comet 4 to comply with the Port of New York Authority's conditions for the use of Idlewild International Airport. Compliance involves no weight restrictions or difficulties whatever in the case of the Comet 4.

Because the airfield performance of G–APDA in the course of the shake-down trials attracted marked interest from airline operations managers and air crew (many of whom were on board for various sectors of the flights) the following extracts from the co-pilot's report are reproduced to afford more specific information in respect of particularly interesting airports among the many that were visited:

The Comet showed its low-speed docility at Bombay on September 10 during a demonstration to Air India officials. A monsoon shower lowered the already poor weather conditions to 350 ft. and 1 mile of visibility. A visual circuit was nevertheless made in these conditions—a task rendered more difficult by the presence of a large hill on the extended centre-line of the runway. The final roll-out onto the QDM of the runway was made at 100 ft., a tribute to the powerful ailerons and low wing-loading of the Comet.

The Comet's runway performance at Mexico City surprised local airline executives. The aerodrome has a runway of only 8,200 ft., and yet is 7,340 ft. A.M.S.L. The temperature at the time of take-off was plus 18° C., i.e. 17° C. above standard. The Comet lifted off after a run of only 6,900 ft., and then proceeded direct to Lima, a distance of 2,680 statute miles. All other aircraft, limited by runway performance, have to make one or more fuel stops en route.

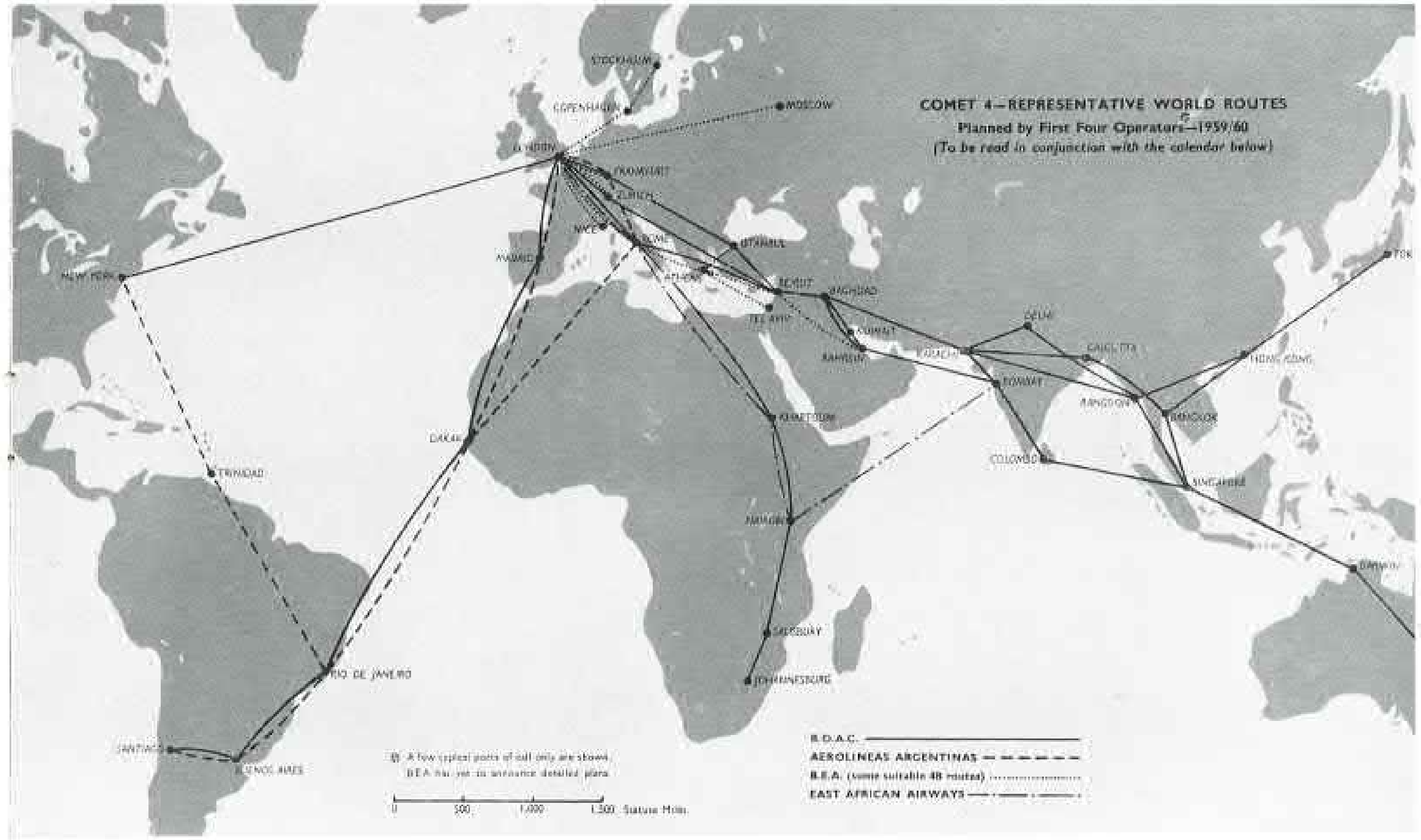
The Comet's performance was outstanding on the Rio-Caracas sector. This stage is 2,830 statute miles and the track lies directly across the "Matto Grosso." The single runway at Rio, although almost at sea level, is only 7,300 ft. long.‡

For this long sector, we were loaded to 156,000 lb. A.U.W. Taking off at mid-day, in zero wind, with the outside air temperature at plus 27° C., we passed the end of the runway at 300 ft., gear up, well established in the initial climb. The Comet then devoured the intervening distance in 5 hr. 51 min., arriving overhead Caracas with enough fuel to divert to San Juan.

The immediate success of B.O.A.C. Comet 4 operations, and the speed and comfort of turbo-jet flying have resulted in an immediate demand for seats; already there is a waiting list for passengers, which it is to be hoped will be shortened with the increase in frequency.

‡(Editor's Note: There is no need to lengthen the runway—7,300 ft. is a reasonable length for a sea-level airfield by Comet standards.)

First-class Comet service. The 48-seat layout is well suited to B.O.A.C.'s luxurious Monarch service. The cabin staff seen at work in the forward cabin (16 sleeper-seats) served in G–APDA on the Hong Kong proving flight in September. As the fastest trans-Atlantic carrier the Comets carry the G.P.O. mail.



COMET PLANNING CALENDAR *For First Four Comet Operators*

	B.O.A.C. (*from London*)	AEROLINEAS ARGENTINAS (*from Buenos Aires*)	B.E.A.† (*from London*)	EAST AFRICAN AIRWAYS (*from Nairobi*)
October 1958	Weekly to New York			
November 1958	Daily to New York			
May 1959	4 a week to Tokyo	4 a week to New York 2 a week London (2 routes) 7 a week Santiago		
July 1959	2 a week to Hong Kong			
August 1959	Increase to 6 a week to Tokyo			
September 1959	2 a week to Singapore			
December 1959	5 a week to Australia via Singapore		Some suitable routes: Nice Rome, Athens, Istanbul Cyprus, Tel Aviv Persian Gulf Moscow German traffic centres Swiss traffic centres Scandinavian capitals	
Jan./Feb. 1960	2 a week to Santiago			
February 1960	4 a week to Johannesburg			
April 1960	1 or 2 a week to Salisbury			
June 1960		Increase to daily New York 4 a week to London Santiago services as above		*In 1960* To London Also to Bombay

†B.E.A. has yet to announce detailed plans.

New York–London at 580 m.p.h. — The inaugural trans-Atlantic eastbound flight on October 4 was also an "unofficial" record. Mr. Basil Smallpeice (B.O.A.C.'s Managing Director) and Captain Tom Stoney, D.F.C. (Comet Flight Manager) have reason to look pleased. The Comets are now flying the Atlantic twice a day, once in each direction.

Captain G. T. Greenhalgh, M.B.E., Flight Manager (Designate) of B.E.A.'s Comet 4B fleet, has a long and distinguished airline career with more than 15,000 hours, which include experience on several de Havilland types. Captain Greenhalgh is currently serving as Flight Manager, Viscount No. 3 Flight.

B.O.A.C. expects to have five Comets by the end of November, and more than 1,000 hours of Comet 4 flying experience; the further extension of services is dependent upon the rate at which crews can be trained. Ten crews had to be trained for New York services and ultimately more than 100 Comet crews will be required to fulfil B.O.A.C.'s plans.

Crew-training is straightforward and B.O.A.C. plan 8 hours' flying for pilots with Comet 2E experience, 10 hours for those with early Comet experience and 12 hours for those without previous jet experience. This is actual first-pilot time and a similar number of hours are spent in a training capacity in the "jump seat" between the pilots. Ground training for those without recent Comet experience takes five weeks.

An important part of the syllabus — for both air and ground crews — is familiarisation with the Comet's systems. Much of this is done on the Comet 4 Systems Trainer designed and built by de Havilland to cut down training time.

The Systems Trainer (described separately at the foot of this article) has proved invaluable for giving instruction in the handling of the Comet's power-supply system and for practising emergency cockpit procedures, etc. The time spent in this relatively inexpensive trainer will reduce the heavy demands on the Redifon Comet Flight Simulator.

Comet 4 commercial operations across the Atlantic have been notably trouble-free and B.O.A.C. justifiably feel, as a result of Comet 4 experience, and because of their previous Comet experience amounting to almost 30,000 hours, that the Comet has already passed through the early stage during which on all aircraft minor operating difficulties may be encountered and defects in the various systems can be expected to cause delays in service.

de Havilland have had some experience of operating the Comet 3 from ice and snowbound runways, and the Comet 1As of the R.C.A.F. have encountered no difficulties in Arctic conditions. Nevertheless, B.O.A.C. Comets are being fitted out with thrust reversal next year, this fully proven system having been publicly demonstrated this year on the Comet 3B at the S.B.A.C. Flying Display at Farnborough, and described in the October *Gazette*, page 167.

Practical experience confirms that there are no unusual crew problems associated with Comet 4 operations, pilots having no difficulty with conversion. From the navigator's point of view work may in theory be at a rather higher intensity because of the compression in time of flight; in practice, however, trans-Atlantic Comet navigation has proved easy. Good Loran coverage is available for most of the flight and radio contact with either side of the Atlantic or the two weather ships, *Charlie* or *Juliet*, is maintainable through all but fifteen minutes or so of the flight; the Comet provides a smooth platform for Astro if required. Navigational aids that are directly interpreted by the pilot are however invaluable and it is probable that Decca/Dectra will shortly be installed in B.O.A.C. Comets, providing the pilot with a continuous pictorial indication of his exact position throughout the flight.

Passenger reaction has been unanimously favourable; the four-abreast standard-class seating is deservedly popular and there is plenty of room for the cabin staff to provide the usual incomparable B.O.A.C. Monarch service.

From the public address system, over which the Captain briefs his passengers on the new and exhilarating experience of jet travel, to the serving of a luxury meal in conditions as steady, and as smooth as (and somewhat quieter than) a West End restaurant, B.O.A.C. takes good care of you. The size and arrangement of the passenger accommodation enable the operator to provide a personal element in the cabin service which travellers particularly appreciate.

The Comet has proved by practical demonstration to leading airline people the world over that it goes anywhere using to-day's runways without extension or restriction. Now the passenger will decide.

Comet 4 Systems Trainer

One of a number of D.H. training aids designed to save operators' money

The de Havilland Comet 4 Systems Trainer has been designed to provide a representative range of indications to allow both normal and emergency flight procedures to be practised for the Comet's operational systems.

Typical emergency condition indications can be introduced from a fault introduction console, appropriate drills at the respective panels then being necessary for their cancellation or alleviation.

The layout is arranged to represent the Comet 4 flight deck, suitably extended to permit a typical class of six students and an instructor to use the Trainer.

With this object in view, and to keep down overall size, no crew seating is provided. The positioning of the panels is such, however, that the student's eye-line is similar to that of a seated crew member.

The instructor's fault introduction console (left of photograph) is situated at the rear of the Trainer where there is a small dais for the instructor's use. Also at this position and conveniently to hand are the main supply switch and indicator.

The Trainer, though robustly constructed, is easy to dismantle into separate sections for transport, while assembly is simplified by the use of clamp-type terminal blocks suitably coded to mate with the associated multi-core cable ends. The specification of the Trainer takes into account available power supply and usually includes finishing in a colour scheme appropriate to the airline.

Mr. R. Humble (Electrical Designer, D.H. Service Department) introduces faults at the instructor's console. Captain R. A. Nelson takes appropriate action. Captain J. G. Woodill is on the right. B.O.A.C. is already putting the Trainer to good use at London Airport.

BEAVER HONOURED IN ANTARCTICA

The de Havilland Canada Beaver has literally "made a name" for itself in the world!

The Australian Minister for External Affairs, the Hon. R. G. Casey, recently informed The de Havilland Aircraft of Canada that three physical features on Antarctica have been named in honour of the DHC.2 Beaver.

The three features, which were discovered in 1956, have up to this time been mere co-ordinates on the map, but henceforth shall be known as: Beaver Lake, Beaver Glacier, Beaver Island.

The first of three Beaver aircraft used by the ANARE (Australian National Antarctic Research Expedition), went to the cold continent in 1956, and to quote Mr. Casey: "There is no doubt at all that the use of the Beaver from Mawson in 1956 very greatly increased the scope and range of our work."

In that first expedition the Beaver compiled a very remarkable and versatile record in operations which included: photographing 350,000 square miles of terrain in which 18,000 negatives were taken; photographing 1,200 miles of coastline; flying 500 hours in temperatures as low as −50°F.; carrying 150 "passengers"; transporting nearly 15 tons of food, fuel and equipment.

de Havilland is proud that its products have been able to contribute to the success of these important undertakings and that the Australian Government has seen fit to honour the Company in this manner.

ANOTHER AUSTRALIAN DOVE AMBULANCE

The Australian Minister for Health, the Honourable Dr. D. A. Cameron, recently accepted on behalf of the Commonwealth Department of Health, a new Dove Aerial Ambulance.

In a ceremony at Bankstown, N.S.W., the Managing Director of de Havilland Aircraft in Australia, Mr. Lester Brain, formally handed over the aircraft to Dr. Cameron.

The Dove, VH-DHH, is fitted with a full-length stretcher and a reclining chair with leg rest for a recumbent patient and an executive-type chair for the doctor or nursing sister. Drug and medical cabinets, hot-water urn, washbasin and an oxygen supply for the patient are also installed.

The aircraft is to be based in Darwin and operated by Trans-Australian Airlines on behalf of the Northern Territory Medical Service and will prove a welcome addition to the fleet of aircraft already operated by this Service.

Dr. Cameron gave some interesting figures relating to the growth of the Aerial Medical Service. In the twelve months to June 30, 1948, the Service flew 66,540 miles and carried 115 patients. In the twelve months ended June 30, 1957, it flew 127,970 miles and carried 520 patients, and in the last twelve months it flew 151,505 miles and carried 549 patients.

Readers will recall that in November, 1957, a Dove similarly equipped was handed over to the Commonwealth Department of Health. Both aircraft were manufactured by the de Havilland Aircraft Company in England and modified in Australia by de Havilland to meet the special requirements of the Northern Territory Medical Service.

More than 500 Doves are in service throughout the world, many of them in Australia.

FIRST ROYAL FLIGHT IN COMET 4

His Royal Highness Prince Philip made his first flight in a Comet 4 on October 28 — 3,400 miles from London to Ottawa non-stop in 8 hours 29 minutes. He was attending the world conference of the English Speaking Union. He returned via R.C.A.F. Moncton. From Moncton's 6,200-ft. runway the Comet could have crossed the Atlantic but insufficiency of jet fuel there made it necessary to call at Gander. The crossing to Leuchars, Fifeshire, took 4 hours 5 minutes. Seen with His Royal Highness prior to the foggy departure from London Airport are (left to right): Mr. Basil Smallpeice (Managing Director, B.O.A.C.), Mr. G. J. H. Jeffs (London Airport Commandant), Sir Gerard d'Erlanger (Chairman B.O.A.C.) and Sir George Cribbett (Deputy Chairman, B.O.A.C.).

MR. JACK DAVISON, PRESIDENT OF C.I.S.

The Council of the Chartered Institute of Secretaries announced in London on November 10, that Mr. John Davison, O.B.E., F.C.I.S., of Johannesburg, has been elected President of the Institute for the forthcoming year, in succession to Mr. E. G. Hardman. Mr. Davison, well known as the Managing Director of The de Havilland Aircraft Company of South Africa (Pty.) Ltd., was co-opted as a member of the Council of the Institute last May. He has had a career of 28 years with de Havilland, having joined The de Havilland Aircraft Company of South Africa (Pty.) Ltd. when it was formed in 1930 and having become Managing Director in 1945.

This is the first occasion on which a Commonwealth Member has been appointed President. The South African Division of the Institute, of which Mr. Davison has twice been Chairman, is the oldest Division outside the United Kingdom, having been established in 1909. It will therefore celebrate its Golden Jubilee in Mr. Davison's year in the Presidential chair.

The Chartered Institute of Secretaries has always considered it an important part of its policy to encourage uniform professional standards throughout the British Commonwealth and this election is the latest evidence of that policy.

ARGENTINE AIR CREW COMET TRAINING

The first contingent of Aerolineas Argentinas air crew arrived at Hatfield at the end of October for Comet 4 ground and flying training. They join the 50 or so Argentine ground engineers, the majority of whom started their course in September. At least a further 40 are expected in England shortly.

Aerolineas courses cover all major flight and ground trades, specialist instructors being in charge of each aspect. The training period ranges from 5 to 10 weeks, the whole programme covering five months.

Each course has a nucleus of English-speaking members; this (and the enthusiasm of the Argentine personnel) overcomes any language problems.

Other Comet courses running concurrently include those for B.O.A.C., B.E.A., and Royal Air Force Transport Command.

Some of the first 50 engineers from the Argentine are seen here, in the Hatfield Assembly Hall, examining the Ekco Cloud Collision radar scanner in the Comet's nose.

"Those were the days…"

" Please assure her that she will arrive without the feeling of having travelled."

" Sine sensu motionis, eh Madam? Just like domum dulce domum . . ."

" Like the Comet, eh? Not too big, not too small, but just right. And she'll go anywhere, and pay her way . . ."

" How would we look in granite, Skipper?"

" Lucky to get her. I'm told she was ' discretamente retirada de una linea competitiva . . .' "

" And the interior designer once said you do really need any, we go so fast . . ."

" The lady says she's so comfortable she doesn't want to leave the ship."

" Well, yes, I did put up quite a few ideas myself when de Havilland were designing the thing . . ."

" Easy enough to pick out our passengers from the flogged-victims of the old horse-drawn wooden-wheeled airliners . . ."

Following the successful acceptance trials of Firestreak carried out by the Royal Air Force and Royal Navy at Woomera, delivery of the missile to the Services has begun. These photographs were taken at R.A.F., West Raynham.

Firestreak with the Royal Air Force

Missile Deliveries to the Services Have Begun

A Firestreak is loaded onto the starboard outer pylon of a Gloster Javelin Mk. 7. The missile can be installed in, and fired from, any modern fighter. Its design ensures that it cannot be jammed or deflected from its target by extraneous sources of radiation.

A Firestreak is unloaded from a Javelin after flight. The missile is light and easy to handle, a point appreciated by R.A.F. groundcrew.

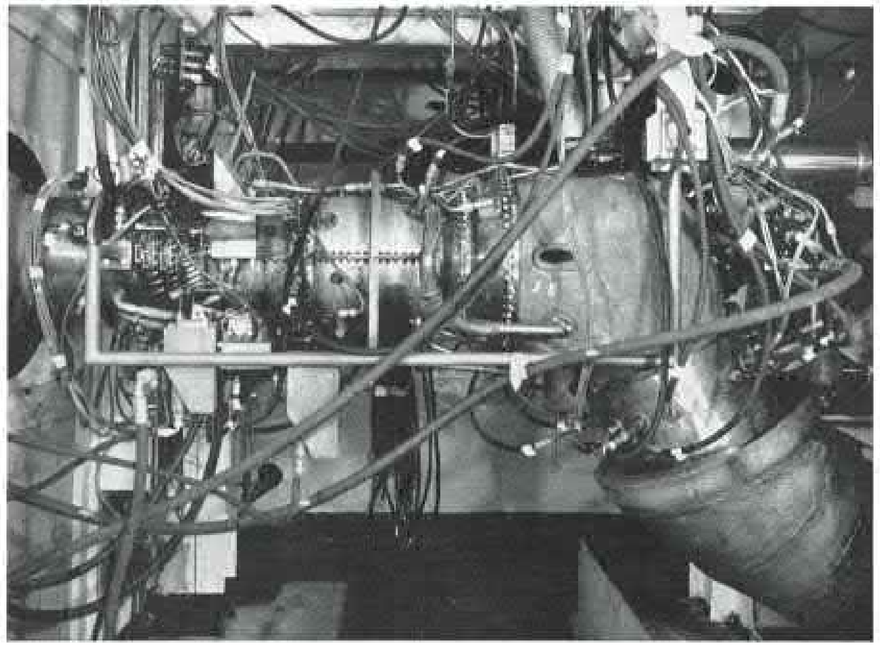
A formidable combination against air attack — an R.A.F. Javelin carrying four Firestreaks.

Air Commodore E. L. Colbeck-Welch, O.B.E., D.F.C., until recently Commandant of the Central Fighter Establishment, with Wing Commander G. H. Melville-Jackson, D.F.C., Commanding Officer of the R.A.F. All-weather Development Squadron, which is based at West Raynham, and Flight-Lieutenant R Jones.

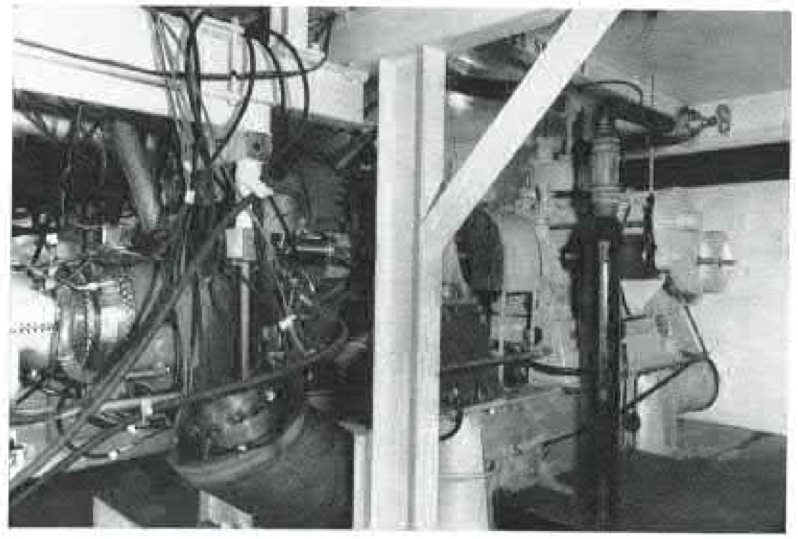
The small size of the Firestreak missile may be appreciated as a Javelin, ready for flight, is towed from the hangar.

Gnome Progress

Production of the new Gnome turboshaft engine is planned to start during 1959, and for some months now extensive work has been under way at the de Havilland Engine Company and at a number of major sub-contractors to ensure that manufacture proceeds according to schedule. The photographs on this page illustrate some of the facets of this concerted effort.



Development testing of the Gnome was initiated towards the end of August and has proceeded at a high pace since then. The engine is shown here on a specially modified test bed at the Engine Company's Test Establishment at Hatfield. The engine exhaust is ducted away at the bottom right-hand corner of the picture.



The power developed by the Gnome during test running is absorbed by a Heenan and Froude water brake, via an intermediate step-down gearbox — the connecting shaft-cover between this and the rear of the engine is apparent at the centre of the picture.

Among the suppliers of light alloy castings to the Gnome are J. Stone & Company (Charlton) Ltd. The oil sump is shown here being cast in magnesium alloy at the company's foundry. The moulder on the left is placing dried sand cores into a sand mould prior to the casting being poured.

The Gnome intake casing is a casting in magnesium alloy by Kent Alloys Ltd., and it is shown here (below, left) being poured. The three headers and risers are necessary to obtain a high quality casting, free of chilling or porosity defects. Following cooling, the hard sand mould is chipped off (below, centre), exposing the risers and runners which feed the metal to the casting (right). These are later removed.

Propellers for the de Havilland Gnome Engine

de Havilland Propellers Limited have under design, equipment catering for a wide range of applications.

WHEN the de Havilland Engine Company commenced the design and manufacture of a turboshaft version of the General Electric T58 engine — the de Havilland Gnome, de Havilland Propellers Limited, who were called upon to design the propeller equipment, were faced with several problems. The rated power of the Gnome, 1,050–1,250 s.h.p., is considerably less than that of any other turbine power unit for which the Company is currently manufacturing propellers; while certain piston engines fall in the same power range, it would be necessary to modify propellers designed for these engines to incorporate the latest safety features required in turbine propellers. Furthermore the versatility of the Gnome makes the engine suitable for many aircraft applications, implying a wide range of propeller diameters involving, in all probability, more than one blade root size. This same versatility is also likely to demand differing propeller control system requirements, ranging from a simple constant-speeding and feathering system to one incorporating the latest blade-angle (beta) control system for ground handling and reverse pitch operation.

After a detailed investigation by the design department it was decided that, for aircraft installations requiring propellers up to 13 feet in diameter, the most suitable configuration was a three-bladed propeller with a 2500-size root. The 3/2500/4 propeller is now in production for the piston-engined Scottish Aviation Twin Pioneer aircraft, and many of the components, including the split barrel, spider, dome, and the pitch change cams, can be used for the Gnome propeller. With regard to the possibility of varying control system requirements, three standards are envisaged: (a) constant speeding and feathering only, (b) constant speeding and feathering with fixed pitch reverse operation, similar to the Britannia propeller and (c) constant speeding and feathering with beta control for all ground operation, similar to the Vanguard propellers. The design is such that modification of the simplest of the three propellers to either of the reversing standards can be achieved by the addition of extra components.

Certain items are common to all three standards, including the blades, barrel, spider, pitch-change cams, mechanical and hydraulic pitch locks, spinner and feathering pump. The blades are of solid aluminium alloy with a rectangular planform; the diameter and blade width will, of course, depend on the aircraft requirements. The spinner is constructed from light alloy with fibreglass blade seals, and the feathering pump is an existing production model. Electric de-icing is provided for both blades and spinner by means of heater mats, while propeller r.p.m. and phase synchronisation can be provided in multi-engine applications in the interests of noise reduction. An important feature is the restriction of the use of electrics to de-icing, synchronising, a secondary means of feathering and the provision of certain warning lights.

The Constant-speeding and Feathering Propeller

In the simplest version there are no removable stops in the pitch-change mechanism and the pitch range lies between the fixed flight idle and feather stops. This is similar to piston engine practice and is possible because the free turbine type of engine does not require the propeller to be in minimum pitch for starting purposes. Included in the pitch-change mechanism are two important safety features which lock blade pitch in the event of propeller or engine malfunction, thus preventing serious propeller overspeed; these are a hydraulic lock, consisting of a spring-loaded valve which is immediately responsive to loss of control pressure and which traps the oil in the propeller dome, and a mechanical pitch lock which is responsive to propeller overspeed as well as control pressure loss. The mechanical pitch lock consists of two rings with mating ratchet teeth, normally held apart by hydraulic control pressure; in the event of propeller overspeed a flyweight type of governor in the propeller, responsive to propeller overspeed from the datum setting, routes the control oil to drain; the lock engages under the action of multiple springs. The lock is so designed to enable the propeller to move towards coarse pitch but not towards fine when it is engaged; thus it is always possible to feather the propeller after engine or propeller failure.

The propeller controller is mounted on the back of the engine reduction gear and contains the conventional flyweight type of governor and control valve, and an independent increase pitch valve operated by an electric solenoid which can be used as an alternative means of feathering; mechanical feathering is achieved by a control on the head of the governor interconnected with the engine condition lever which lifts the control valve to the full increase pitch position.

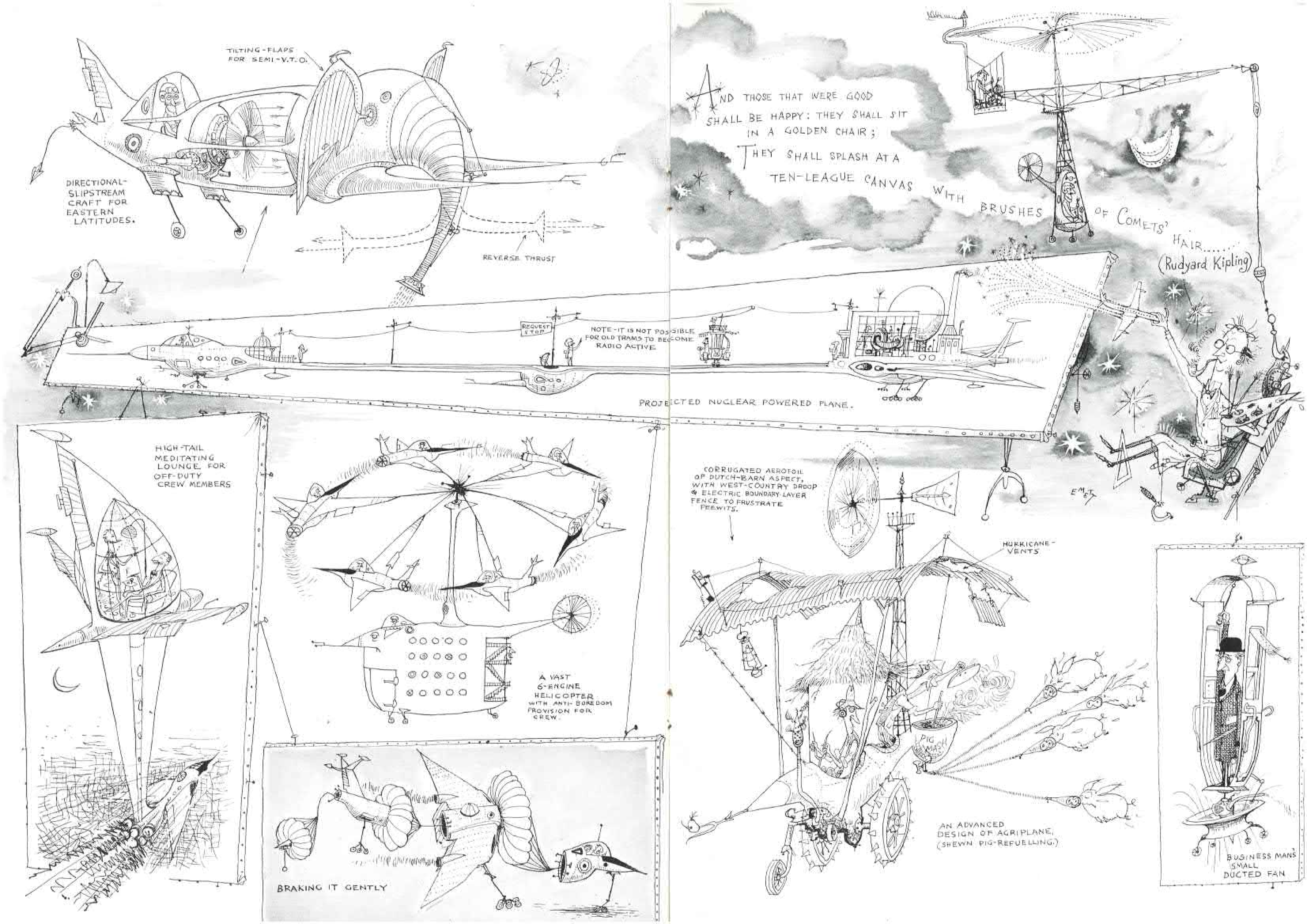
The Propeller with Fixed-pitch Reverse Operation

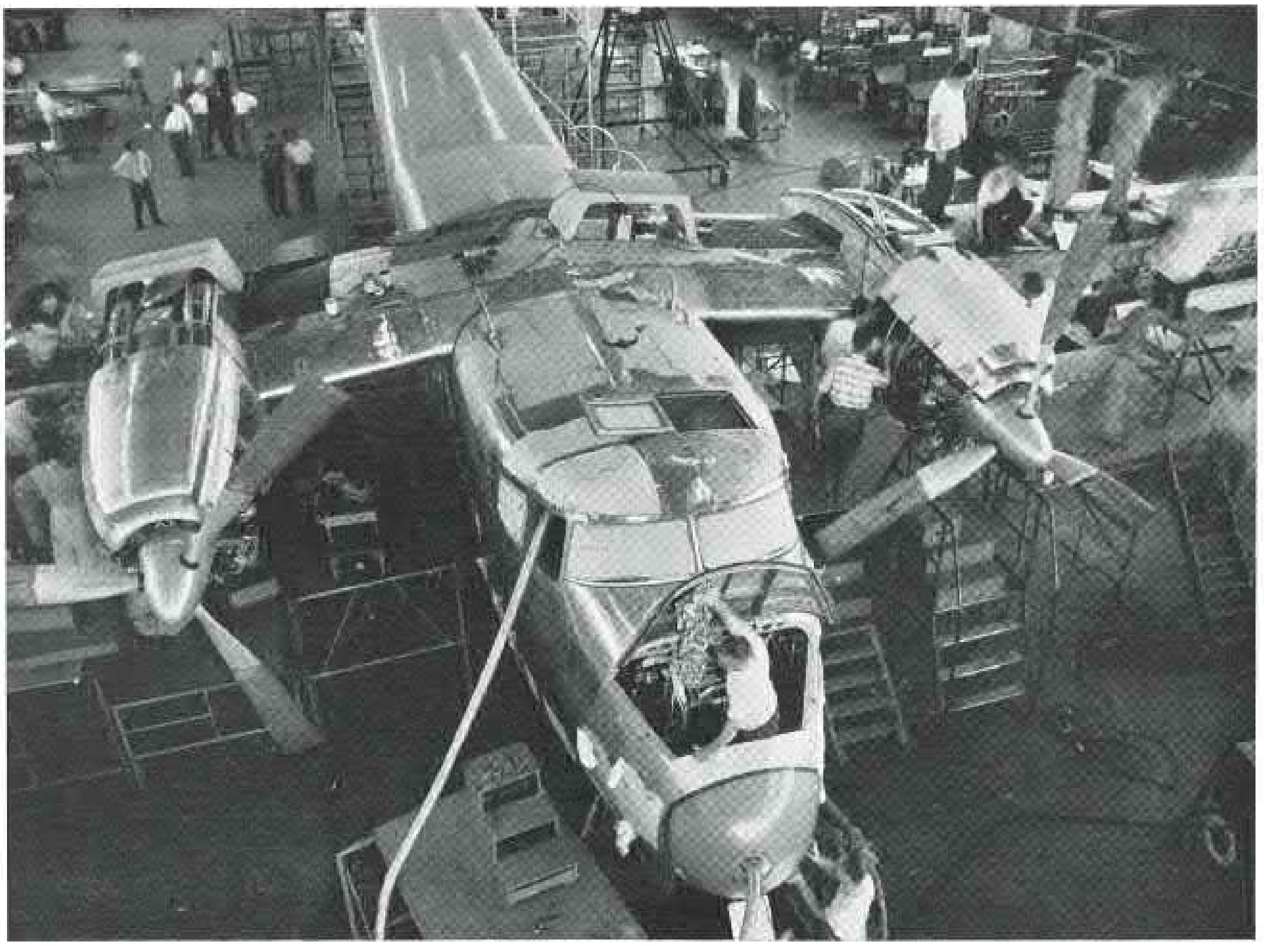
In the fixed-pitch reverse version the fixed flight-idle stop is replaced by a mechanical multi-latch type of stop which is withdrawn by an independent oil supply from the controller on landing, thus allowing the blades to go into reverse pitch; the pitch-change mechanism of the simplest version has been designed to accept this stop mechanism without special modification. Blade switches operate indicator lights in the cockpit to show when the blades are below the mechanical stop, and also energise the increase pitch solenoid should the blades move below this stop in flight. Cams on the head of the controller, operated by the pilot's lever, withdraw the flight-idle stop and override the main control valve for reverse pitch operation; variation of reverse thrust is obtained by variation of fuel flow.

The Propeller with Beta Control

In the beta control version the pilot's lever is used to select, below the flight-idle position, beta control and to schedule blade angle anywhere in the range between flight idle and full reverse. In addition to the stop-removal cam on the head of the controller a further cam overrides the governor mechanism and causes displacement of the control valve to increase or decrease pitch as required, whilst at the same time a fuel governor on the engine ensures the correct fuel flow for any given blade angle. As blade pitch changes a blade-angle feed-back linkage from the propeller moves a follow-up cam which restores the control valve to neutral when the scheduled angle is reached. The main advantage of this system is that precise control of thrust, either positive or negative, from flight idle to full reverse, is available to the pilot for all ground manœuvres.

The high power/weight ratio of the Gnome engine renders it particularly suitable for aircraft designed for short or vertical take-off and landing. Propellers for such aircraft differ from those for conventional types in that they are required to produce very high thrust/power ratios at very low speeds, and this in turn implies large diameter propellers. For diameters in excess of about 13 feet it will be necessary from strength considerations to increase the blade root size, and design investigations are in progress to define suitable propellers up to 16 feet in diameter. In addition to large diameters VTOL and STOL aircraft generally demand mechanical linkage of the propellers so that they are all operative even in the event of failure of one or more engines; this ensures that power failure is not followed by loss of control of the aircraft by reason of the large asymmetric moment which would result from the total loss of thrust from one power plant. The problems of the design of a suitable propeller control system for such aircraft demand a new approach, and much progress has already been made towards evolving a satisfactory system.


TILTING-FLAPS FOR SEMI-V.T.O.
DIRECTIONAL-SLIPSTREAM CRAFT FOR EASTERN LATITUDES.
REVERSE THRUST
AND THOSE THAT WERE GOOD SHALL BE HAPPY: THEY SHALL SIT IN A GOLDEN CHAIR; THEY SHALL SPLASH AT A TEN-LEAGUE CANVAS WITH BRUSHES OF COMETS' HAIR......
(Rudyard Kipling)
REQUEST STOP
NOTE - IT IS NOT POSSIBLE FOR OLD TRAMS TO BECOME RADIO ACTIVE
PROJECTED NUCLEAR POWERED PLANE.
HIGH-TAIL MEDITATING LOUNGE FOR OFF-DUTY CREW MEMBERS
A VAST 6-ENGINE HELICOPTER WITH ANTI-BOREDOM PROVISION FOR CREW.
BRAKING IT GENTLY
CORRUGATED AEROFOIL OF DUTCH-BARN ASPECT, WITH WEST-COUNTRY DROOP & ELECTRIC BOUNDARY-LAYER FENCE TO FRUSTRATE PEEWITS.
HURRICANE-VENTS
PIG MASH
AN ADVANCED DESIGN OF AGRIPLANE, (SHEWN PIG-REFUELLING.)
BUSINESS MANS SMALL DUCTED FAN



A DHC-4 Caribou takes shape on the assembly line at Downsview. I.B.M. high-speed electronic machines helped greatly in cutting time losses and expense in the fight against dates before the aircraft's first flight on July 30, 1958.

Mechanised Control of Aircraft Production

By GEORGE BLANCHARD

AT the present time industry is seeking more and more systematic and detailed planning to control all activities involved in the manufacture of products. To cope with this problem, a very substantial staff is usually required, especially if a wide variety of product types are being manufactured simultaneously. This situation is further complicated by frequent changes to programmes.

To cope with these problems without a prohibitively large staff and with a reduction in the time involved, the possibility of mechanisation was explored and developed by de Havilland of Canada. In order to make the new system operate, it was necessary to depart from the usual " Key " (indenture) programming, and a new " Block " and " Part-Division " system had to be introduced.

Requirements

The main purpose was to create a system where the regrouped information could easily be processed mechanically to obtain the following:

1. Continuous, uninterrupted and repetitive production throughout the life of the programme as long as this could be reconciled within the maximum admissible flow-time, rate of delivery being the deciding factor.

2. Flexibility, to put programme changes into effect in the shortest possible time.

3. Individual, even shop-loading in each shop involved in manufacturing, with the possibility of analysing machine load figures, and correcting them where necessary for manpower stabilisation.

4. Ability to schedule every operation of each part, or assembly, of the aircraft through its entire manufacturing cycle, without the necessity of considering, at the time of each aircraft batch release, breakdown relationships and operation sequencing conditions, part by part, or assembly by assembly.

5. Manufacture of spare-part requirements simultaneously with aircraft production requirements, in economical quantities, and having spare-part requirements ready at the earliest possible date, thereby enabling the scheduling department to give binding dates against any spares sales orders, quickly and efficiently.

6. Individual weekly programme lists, showing each shop's weekly volume of work to be achieved.

7. The supply of follow-up lists by which any job could be quickly and easily located in any shop during its manufacturing cycle.

8. Lists of sub-contracted parts for production and spares and their requirement date in the plant.

Data to be Incorporated

The basic data to be incorporated uniformly into each I.B.M. card had to be decided upon, to enable the equipment to produce documents. These data are as follows:—

(*a*) Part number of the finished part, or assembly.

(*b*) The quantity required for one aircraft.

(*c*) The code number of the component in the construction of which the part number is used, called horizontal code.

(*d*) The aircraft type in which the part number is used — common to all aircraft, common to all L-20 aircraft, peculiar to U.S. Army aircraft, peculiar to U.S.A.F. aircraft, or peculiar to civil aircraft.

(*e*) The part-division code of the part number — detail, sub-assembly, etc.

(*f*) The facility code of the part number, denoting whether it is manufactured in the plant or by a subcontractor. In the latter case, information is included regarding responsibility for supply of material.

Note.—Codes under (*d*), (*e*) and(*f*) grouped together, are called " General Code."

(*g*) The shop and machine code, indicating where the job is to be performed.

(*h*) The set-up time in minutes.

(*i*) The running-time in minutes and tenths of minutes required for the specific operation for one part.

(*j*) A four-digit sequence code, the first two of which denote the sequence position of a specific shop out of the total number of shops involved. The second two digits are control factors to check the number of punched cards involved for the same part number and their control for the required sequence. For practical use, this code is called " S.R.S." code — Shop Rotation Sequence.

(*k*) Previous shop code, denoting location of the operation preceding the one in question.

(*l*) Next shop code, denoting location of the operation following the one in question.

With the above information in each punched card, every single operation of a part being on a separate punched card, all steps can be performed and a final result reached.

Information Obtained

Some of the typical procedural steps give ability to reproduce:

All or part of the key-punch basic information in list form, for checking and verification purposes; or, to interpret the existing holes in a card into typewritten information on the same card, for the same purpose; or, to facilitate the extraction by sorting of certain cards having the same common information key-punched into them in the same location from the rest of the cards which contain different information pertinent to the same question; to facilitate the multiplication of the one-aircraft-off quantity of each part number by the required number of aircraft to be produced; and furthermore, to add to this result the quantity of spare parts required in order to get total number of parts to be scheduled; to multiply the allowed time for one part by the total of parts required for a certain batch release; and to add to its result the set-up time, in order to arrive at loading figures.

Some further typical steps allow:

Cards to be put into part-number sequence and, within part number, into initial processing sequence; segregation of detail parts, sub-assemblies, and major assemblies from each other; sorting of cards of different aircraft types into separate decks; removal of sub-contract items from the balance of parts; isolation of all cards representing operations done in a certain shop and on a specific machine from the rest of the cards; extraction of all parts and assemblies covering the construction of a given component from parts and assemblies which are required for another component; segregation of sub-contract items for which the sub-contractor supplies his own material from sub-contract items for which the required material is supplied to him, by the prime contractor, etc.

All of these steps have to be considered for the establishment of a coding system, that is, to decide what code numbers to use, how many digits to use, in which position to use them, and what the codes represent to cover all the required basic data. It must be decided what coded information will be located in each of the 80 available card columns, keeping in mind that a sufficient number of card columns have to be kept open for operational calculation purposes. It is important, too, that codes be sufficiently simple to be easily deciphered by all personnel using the documents.

The coded data is then fed through the I.B.M. equipment to produce the required document.

It is obvious that specific procedures are applied in order to produce the required information in the form of a final, usable document.

Master Schedule Listing

This contains every finished part number, within the required part-division. Each operation is listed in the initial processing sequence within the part number. The figure shown in the batch quantity column is the one-aircraft-off quantity multiplied by the coefficient applicable, corresponding to the aircraft type, for the batch release in question. The batch target time column will show unit target time multiplied by the one-aircraft-off quantity, and also multiplied by the coefficient applicable, corresponding to the aircraft type, for the batch release in question.

The scheduled week number column will show against each operation of each part number the week number in which the work has to be performed on the Friday of which it has to be completed. In the case of a part being manufactured in several subsequent shops, the week numbers shown must progress in the same sequence as the operations shown on the process.

Weekly Shop Programme Listing

This document will show separately, for each week number involved in the batch flow time, all part numbers in numerical and alphabetical sequence having operations scheduled in the given week for the particular shop. In other words, against any specific part number in the shop list, we will not necessarily find all operations as listed in the master list, but only the ones which are scheduled to be performed by a particular shop in a given week.

In order to facilitate the follow-up problem of the control personnel in a specific shop, each listed operation shows the previous shop, the next shop, where the work is coming from, or where the completed work must go.

By checking the total of the times loaded into a given shop, week by week, resulting from the totals of all set-up times and batch target times, we will find that they are equal to each other with respect to each of the weeks involved in the flow time for that batch.

Other Uses

The documents mentioned are only two of a series which are obtained.

A similar mechanised system has been installed and is operating efficiently for the establishment of Bill of Materials. Here again, it had to be decided what a bill of material should contain in its final form, namely:

(1) Complete definition of the material required.

(2) Total quantity which will cover the requirements.

Due to certain mechanical limitations, it was apparent from the beginning that the description or definition of a considerable number of materials would be too cumbersome to carry and would have to be coded for operational purposes, and then mechanically decoded at final listing time.

It also appeared necessary to indicate the quantities of raw materials required for the unit of a finished part in inches, square inches, ounces, etc., as basic data and to transform these initial measurement units at bulking time into final measurement units, i.e., feet, number of sheets, pounds, etc. Also, as a basic requirement, the system established had to be able to show all materials required against every finished part number or assembly number of the aircraft and flexible enough to list all finished part and assembly numbers which do use the same material, and in what quantity.

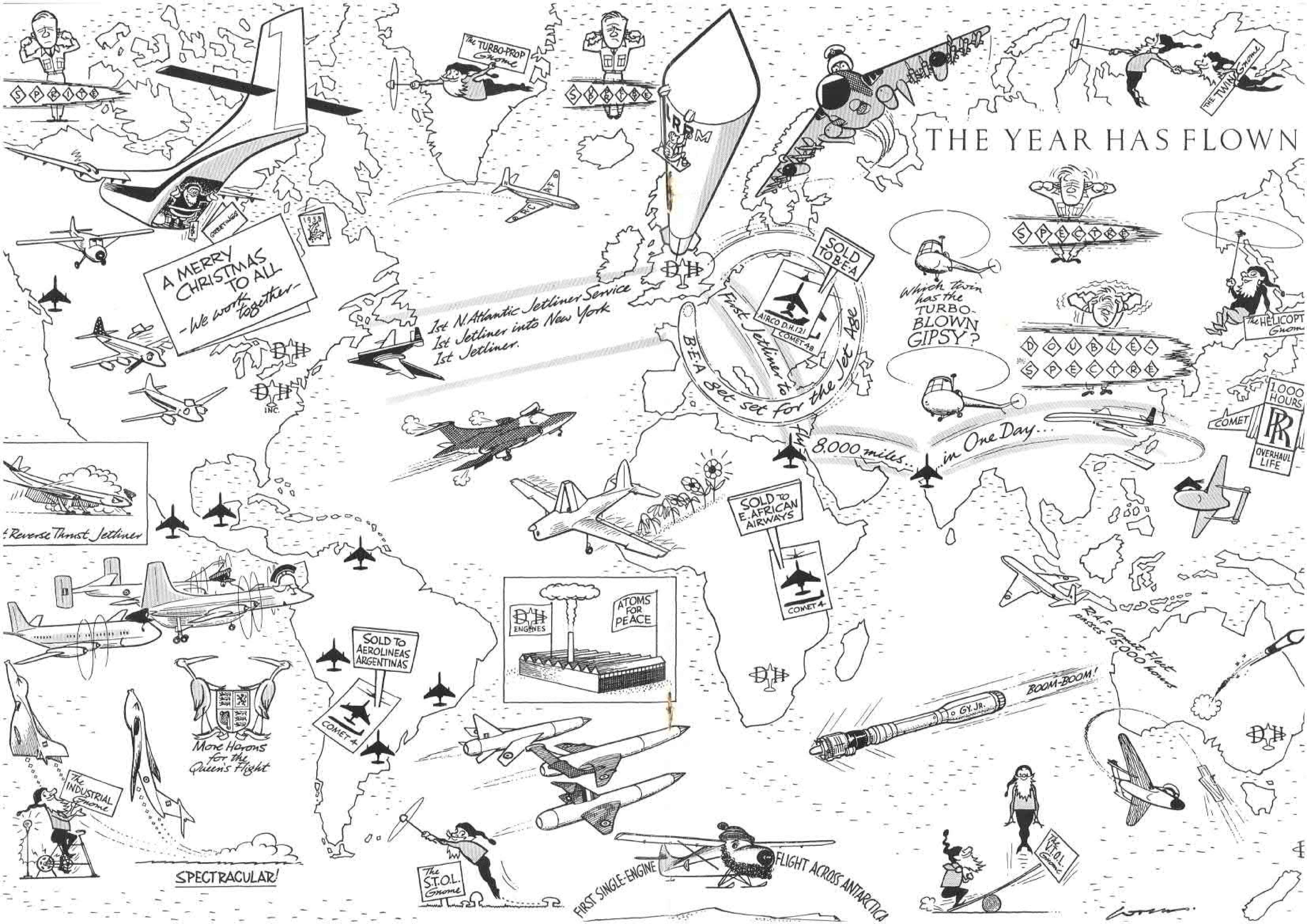
Conclusion

These systems are operating successfully and enable D.H. Canada to produce mechanically the major part of all information required in this field, in document form, using I.B.M. equipment grouped around the 407 Tabulating and Calculating machines.

They have shortened considerably the time required to establish schedules, loading, control documents, Bills of Materials, etc., as well as reducing greatly the different control and follow-up personnel required previously.

The above systems are considered as a major benefit to the organisation.

No problem is too great or too small for the I.B.M. Tabulator which lists, prints and adds reports data. Explaining some production control point is G. Blanchard (third from left), Production Control Manager, de Havilland Aircraft of Canada Ltd., author of this article.


THE YEAR HAS FLOWN
SPRITE
The TURBO-PROP Gnome
The TWIN Gnome
A MERRY CHRISTMAS TO ALL
- We work together -
1958
1st N. Atlantic Jetliner Service
1st Jetliner into New York
1st Jetliner.
D.H.
D.H. INC.
SOLD TO B.E.A
AIRCO D.H.121
COMET 4B
First Jetliner to
B.E.A set set for the Jet Age
SPECTRE
Which twin has the TURBO-BLOWN GIPSY?
DOUBLE-SPECTRE
The HELICOPTER Gnome
1,000 HOURS
COMET
OVERHAUL LIFE
8,000 miles...
...in One Day...
Reverse Thrust Jetliner
SOLD TO E. AFRICAN AIRWAYS
COMET 4
D.H. ENGINES
ATOMS FOR PEACE
SOLD TO AEROLINEAS ARGENTINAS
COMET 4
More Herons for the Queen's Flight
R.A.F. Comet Fleet passes 15,000 hours
BOOM-BOOM!
GY. JR.
The INDUSTRIAL Gnome
SPECTRACULAR!
The S.T.O.L. Gnome
FIRST SINGLE-ENGINE FLIGHT ACROSS ANTARCTICA
The V.T.O.L. Gnome

New York's Jetliner Restrictions

Comet's Take-off Weight, Range and Payload unaffected

At midnight B.S.T. on October 3 — a few hours before B.O.A.C. inaugurated regular trans-Atlantic Comet services—the Port of New York Authority publicly authorised jetliners to use the International Airport at Idlewild. The permission was subject to a number of restrictions, all of them designed to safeguard the amenities of the neighbourhood.

That the Comet can easily meet all the restrictions imposed by the Port of New York Authority (which represents one of the most noise-conscious communities in the world) and the fact that it does so without loss of range or payload are obvious sources of satisfaction to intending Comet operators throughout the world; most of them face similar problems to a greater or less extent.

The Port of New York Authority rulings are quoted verbatim at the end of this article. Briefly they amount to:

(a) A preferential runway system

(b) Take-off weight and technique to be such that a height of 1,200 feet is reached over the nearest residential area

(c) Power to be reduced before over-flying built-up areas.

What these regulations mean to the Comet can best be understood by discussing the aircraft's take-off and climb performance at maximum all-up weight (158,000 lb.) in relation to each of the runways available for jet airliner operations. The map below shows the layout of the runways and the proximity of dense urban areas.

Runways 22 and 25

With zero or light winds, or when the wind is in the south-west quarter, the Comet would use runway 25. Fig. 1 shows the line of this runway to be over the sea and there are thus no noise problems. Alternatively runway 22, which is in line with community "A," might be used and it is then a simple matter for the pilot to make a gentle turn of 30° to the right to clear the area.

Each of these runways is 8,000 feet long—more than enough for a maximum-weight take-off under any conditions likely to be encountered.

Runways 13R and 31L

If the cross-wind component on runways 25 and 22 exceeds 20 knots, then runways 13R or 31L are used, the choice being dependent on the direction of cross-wind.

If runway 13R is used then the line of flight is towards the communities marked "B." A steady 15° banked turn to the right, through 120°, however, enables the aircraft to avoid the area completely. In any event the nearest houses are some 3½ miles from the start of take-off and a straight-ahead climb on a hot day (80°F. — into wind component 20 knots) would by then have enabled the Comet to attain 1,800 feet, using the procedure laid down by the Port of New York Authority which calls for a reduction to climbing power before over-flying built-up areas. This altitude is half as high again as the Authority's minimum of 1,200 feet.

If runway 31L is used (when a right-hand circuit is in force) the aircraft must pass over the community marked "C"—approximately 2½ miles from the start of take-off. With a 20-knot headwind and maximum all-up weight of 158,000 lb. the Comet would, in theory, be at 1,100 feet at this position on a hot day (80°F.); on a standard day (60°F.) it would have reached 1,300 feet. However, practical operating experience at Idlewild shows that the combination of an 80°F. air temperature and a strong down- or cross-wind component on runway 25 are unlikely eventualities.

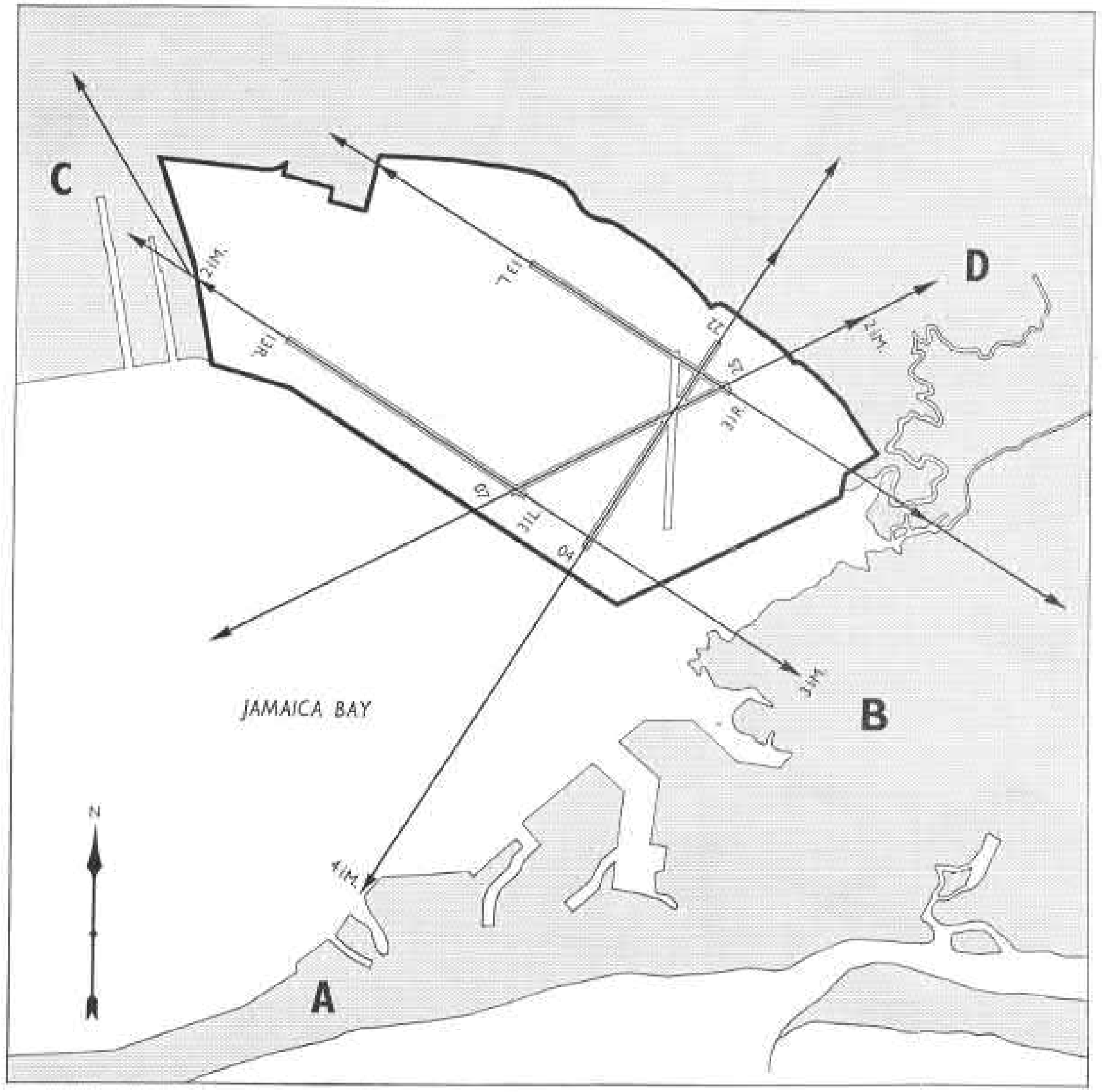
Runway 07

If the cross-wind component over runways 13R or 31L exceeds 20 knots and its direction is downwind on runway 25, then runway 07 must be used. Once again there is a community (marked "D") at a distance of approximately 2½ miles. The Comet would thus be at the altitude indicated in the previous paragraph for runway 31L. It is, however, entirely practicable to make a steady 15° banked turn to the right through 180° and this makes it possible to avoid over-flying the built-up area.

Conclusion

One remote contingency alone — a strong downwind component on runways 22 or 25, between the hours of 10 p.m. and 7 a.m. (P.N.Y.A. has ruled that jetliners must use runways 22 or 25 between these hours) can affect operators. B.O.A.C., however, schedule their New York–London Comet 4 flights outside this period. Cancellations or delays on this account are, therefore, most unlikely.

The Comet's good power/weight ratio and low wing loading confer a runway and climb performance unequalled among jet airliners and better than many contemporary piston-engined airliners. These qualities enable it easily to meet the Port of New York Authority's restrictions without loss of range or payload, a fact which is being proved in practice by daily Comet 4 operations.



Idlewild International Airport, New York. This sketch-map shows the proximity of the built-up areas which surround New York's International Airport on three sides. The Comet has no difficulty in meeting the P.N.Y.A.'s stringent noise regulations.

NEW YORK'S JETLINER RESTRICTIONS

1. The Comet will use Runway 25 as a mandatory preferential runway for take-offs in zero wind conditions and for all wind conditions which will produce a headwind component during take-offs on this runway, provided the crosswind component does not exceed 20 knots.

2. Runway 22 may be used for take-offs in lieu of Runway 25, in which case the pilot will make a right turn as soon as practicable after take-off sufficient to avoid flying directly over the communities which are in a direct line with the runway.

3. In the event that take-offs cannot be made on Runways 25 or 22 under the conditions set forth in (1) and (2), then, and only in that event, Runways 13R, 31L and O7 will be used under the following conditions:

(a) For take-offs on Runway 13R, the pilot will make a turn to the right as soon after take-off as practicable, such turn to be made with approximately 15° bank. In addition, taking into account wind and temperature conditions, take-offs from Runway 13R will be so planned and conducted that the aircraft will not fly over any community underlying the flight path at an altitude of less than 1,200 feet and the pilot will observe the piloting procedures set forth in (5) below.

(b) Take-offs on Runway 31L will be so planned and conducted, taking into account wind and temperature conditions, that the aircraft will not fly over any community underlying the flight path at an altitude of less than 1,200 feet and the pilot will observe the piloting procedures set forth in (5) below.

(c) For take-offs on Runway O7, the pilot will make a turn to the right as soon after take-offs as practicable, such turn to be made with approximately 15° bank. In addition, taking into account wind and temperature conditions, take-offs from Runway O7 will be so planned and conducted that the aircraft will not fly over any community underlying the flight path at an altitude of less than 1,200 feet and the pilot will observe the piloting procedures set forth in (5) below.

4. No take-offs will be made on any other runways without specific permission.

5. All take-offs in 3 (a), (b) and (c) above will be made using the following piloting procedures:

Initial take-off will be made with a power setting of 8,000 r.p.m. and 20° flap.

Aircraft will be allowed to accelerate to V_2+15 knots during climb, and the pilot will maintain this speed to the best of his ability until he has reached the communities adjoining the airport.

Just prior to or upon reaching the nearer boundaries of communities adjacent to the airport, as defined on Chart No. NYA-5967, the pilot will effect a power reduction to 7,350 r.p.m.

6. Take-offs during the hours between 10 p.m. and 7 a.m. will be made on Runways 25 or 22 only.

A Portable Cable Tester

The cable tester, together with 25-way coupler and termination units, extension cable and headset.

De HAVILLAND Propellers Limited have produced a cable test set which provides, in easily portable form, the facilities for checking the continuity and insulation of multi-core cable looms hitherto available only in fixed or cumbersome equipment. Although initially designed for checking electrical systems in aircraft, the unit is of particular value in any type of installation where cabling is already in place, or where the cable runs are in confined spaces: its applications thus extend to many types of industry, including shipping, railways, mining, communications systems and factory maintenance.

Either a continuity or an insulation check can be carried out from one end of a cable run, the far end being terminated by a small unit weighing less than ½ lb. (*225 gm.*) A test is initiated by a press button and the instrument automatically selects each wire in turn. The identification of the core undergoing test is indicated in a window which is illuminated by a red light if failure occurs, in which case the selector stops at the faulty core. Successful completion of a test sequence is indicated by the extinguishing of a separate indicator lamp.

A single outlet from the test set can be adapted for use with any cable by means of a suitable coupler supplied against the customer's requirements. In the case of a connector having a multi-position keyway (e.g., Plessey Mk. IV) the coding is checked by a clearly marked movable keyway on both the coupler and termination units.

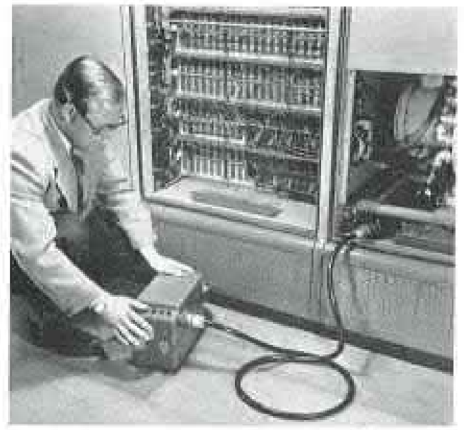
To enable long cable runs to be tested in conditions where the termination unit is more conveniently attached by a second operator, an intercommunication amplifier is incorporated in the instrument, connection being made via the cable under test. Standard service style headsets may be used.

When this system is in use the operators receive an additional audible signal as each test is made and can distinguish when a cable failure is detected.

In its portable form the cable tester is mounted on a strap which can conveniently be used either as a neck sling or a carrying handle. Power is supplied by a lightweight battery of a type having no free electrolyte, and of sufficient capacity for about sixteen hours of normal use. Couplers and termination units can be carried in pouch-belts. For difficult situations, where access to the cable to be tested is limited, an extension cable can be used.

A charging unit can be supplied with the test set. Internal regulation of the unit ensures that in four hours the battery will be fully charged, yet there is no risk of overcharging however long the equipment is left. State of charge is indicated by a meter.

An A.C. power unit is available as a replacement for the battery when the test set is in use on the bench or near a mains supply.



The test set, shown here being used to check an electronic computer, is of particular value in any installation where cabling is already in place.

Providing jet transport support to V-bomber movements is among the vital rôles played by the R.A.F.'s Comet 2 fleet. Air Chief Marshal Sir Harry Broadhurst piloted the Vulcan, seen here at Nairobi. Lady Broadhurst travelled by Comet. The combined force was en route for Rhodesia where Sir Harry was paying an official visit.

Seven Million Miles

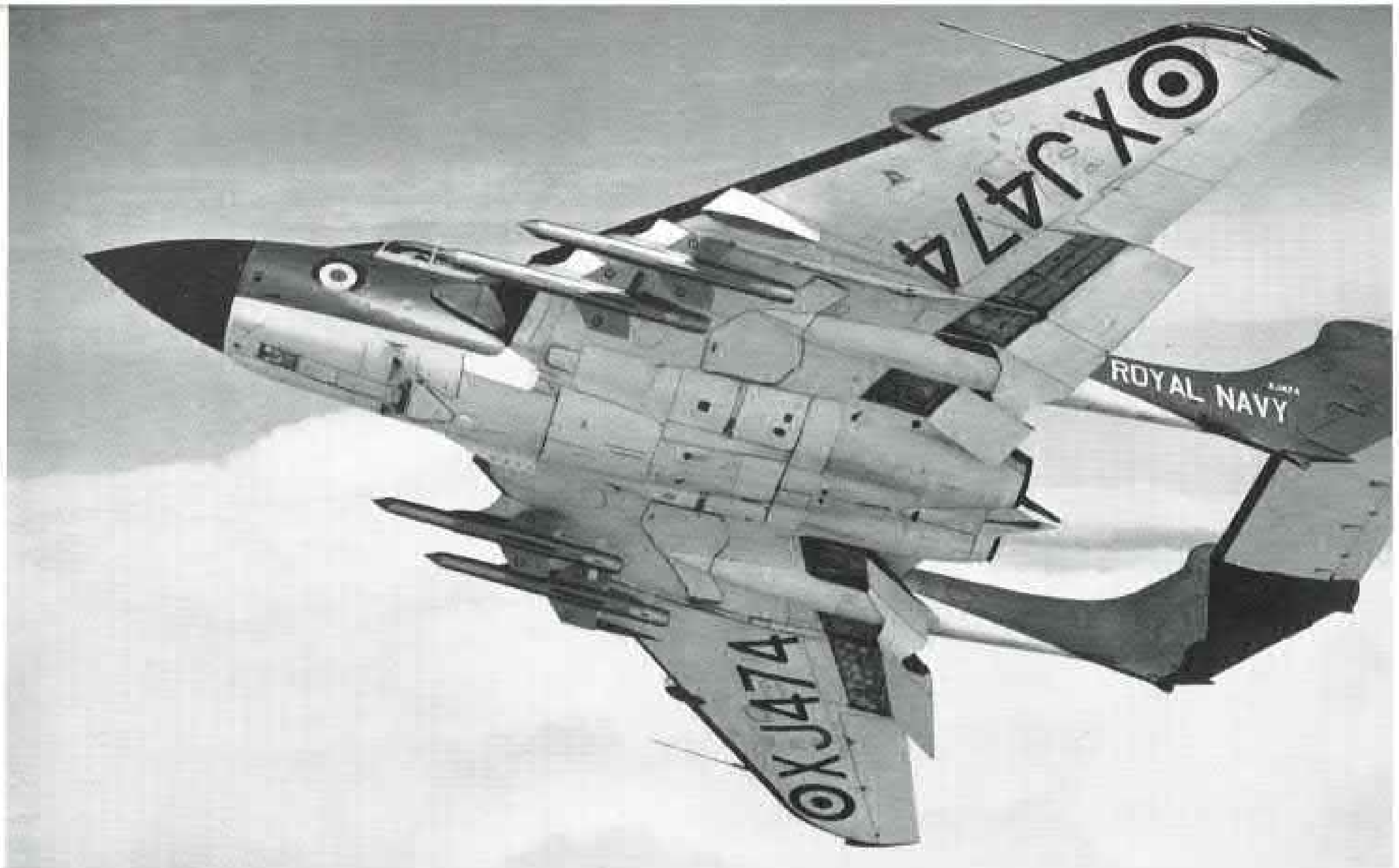
R.A.F. Comet 2 Experience

Marshal of the Royal Air Force Sir Dermot Boyle, Chief of Air Staff, inspects a Comet 4.

Katunayaka, Ceylon, has been a regular port of call for R.A.F. Comets. Latterly, however, the Comet fleet has tended to concentrate on providing troop movements to and from the Middle East. In recent operations one aircraft alone completed 93 flying hours in 10 return sorties, some 40,000 miles of valuable work.

Britain's defence needs are daily expedited by Transport Command's Comets. This Comet is flying over the Alps on its 11,000-mile journey to Salisbury, South Australia. R.A.F. Comets have made the Lyneham/South Australia flight in little more than 24 hours' flying time.

The Weapons Research Establishment at Woomera issued this Comet 2 photograph taken at Edinburgh Field, Salisbury, South Australia. The kangaroo in the Bristol Freighter roundel, however, provides the only clue to the location. This Comet, like each of its stablemates, has flown considerably more than 1,000 hours, as have the Comet 1A's (Ghost engine) of the Royal Canadian Air Force.



Sea Vixen with four D. H. Firestreaks.

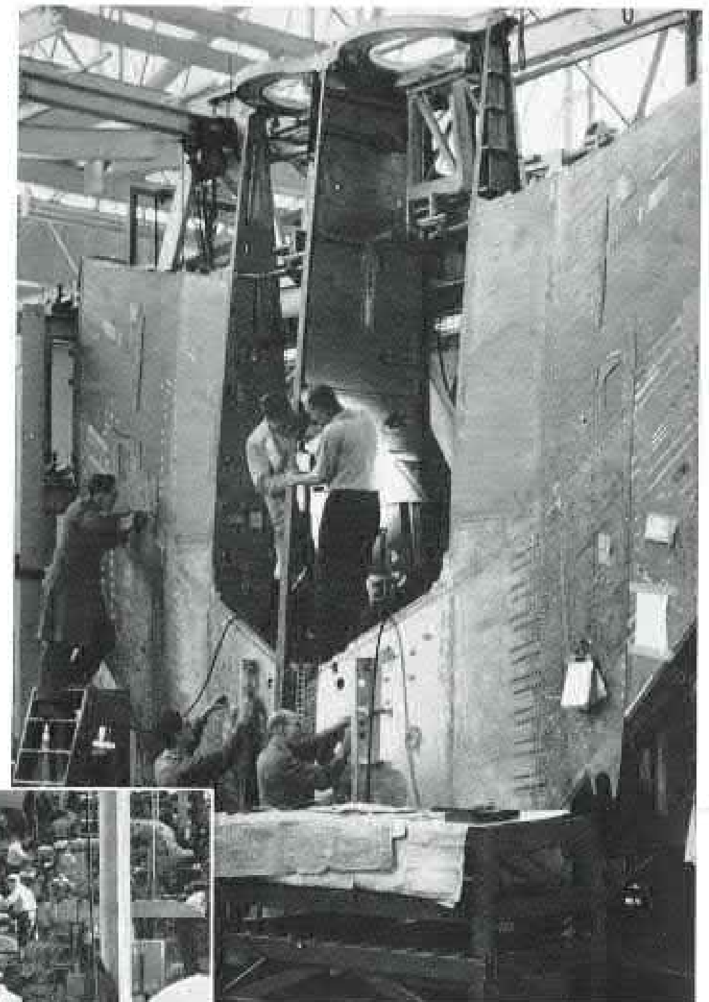
Sea Vixen, R.N.

Pompey's Contribution to Production

D.H. Portsmouth plays a vital part in the de Havilland Enterprise, serving the production needs of all the factories in the de Havilland Aircraft Company group; for example, many large Comet sub-assemblies are made at Portsmouth for delivery to Hatfield and Chester. In another part of the factory work is going ahead on the building of stub wings for the Sea Vixens now coming off the production line at Christchurch for service with the Royal Navy.

One of the production Sea Vixens is now in the hands of the Service Trials Unit at Yeovilton and its makers are confident that it will prove a worthy successor to the Sea Venom.

The Sea Vixen's performance and manœuvrability coupled with a highly-developed weapons system confers a high rate of interception. de Havilland Firestreak armament ensures that interceptions result in kills.



(Above) Building stub wings for the Sea Vixen.

(Left) D.H. Portsmouth — a section of the Machine Shop.

Passengers about to board an Avianca Aerotaxi Beaver on a scheduled flight from Bogota to a remote mountain-locked community in the Colombian interior.

They Fly Where You Want to Go

A Vigorous South American Taxi Service by Beaver

by JAMES E. GRIMSHAW

"FROM a tiny acorn the mighty oak did grow." That old saying aptly describes the story of Avianca (Aerovias Nacionales de Colombia). The "tiny acorn," an 800-pesos investment made by eight business men of Barranquilla, Colombia, in 1919, is to-day "a mighty oak" with capital assets of 20,000,000 pesos bearing an annual harvest of 20,000,000 dollars. In addition, the nation as a whole is benefiting from the swift, efficient movement of passenger and freight which it provides.

Avianca was the product of inspiration and imagination. The inspiration was spurred by the need in mountainous Colombia for a quick, safe, efficient means of transportation in an age when this kind of transportation was becoming more and more essential. With waterways in the main too swift for navigation and with mountainous and jungle-clad terrain presenting insurmountable road and railway building problems, the only practical solution was to fly. But in 1919, for many, the aeroplane as a means of transportation was considered highly impractical. It was regarded at best as a unique weapon of war or as a stunt man's plaything.

Aviation had its beginning in Colombia along the serpentine course of the Magdalena River. The aircraft flew between Barranquilla and Guandat, the chief Magdalena River port serving Bogota. The air journey, made with two intermediate stops, took from dawn to dusk — leaving the last stage of the journey to Bogota to be accomplished by train. During 1920, the first year of operations, two Junkers were used on the service, but only 20 travellers were intrepid enough to make the trip by air. Cargo, however — especially newspapers — was carried on every flight.

At the outset, financial losses and other problems beset the young company. Yet despite these, in 1922 the public responded favourably to a new stock offer and it was possible to expand the fleet to seven aircraft. The inauguration of one of the first airmail services further attracted public interest and when the nation's President, Señor Pedro Nel Ospina, made use of the airline, public confidence became widespread.

In 1948, with a well-established domestic service linking Colombia's sixty-odd major cities in operation and an international service connecting the nation with many of the World's leading centres of commerce and culture, Avianca embarked on a new venture. Aerotaxi, known affectionately as Avianca's little brother, came into being to serve those areas which were too sparsely populated to justify the use of airliners or lacked the facilities to handle them. The new service began operations with a fleet of eight four-seat aircraft. It proved popular and in 1954, Aerotaxi began replacing the four-seater aircraft with larger DHC–2 Beavers. To date Aerotaxi has built its Beaver fleet to 15, the latest aircraft being delivered in October, 1958.

"Don't ask us where we fly — tell us where you want to go." The Aerotaxi slogan aptly describes the company's operation. While the air service flies some regular schedules and is especially important to the ranchers of the "Llanos" or plain country, Aerotaxi Beavers are used extensively by oil and mining companies for exploration in the mountainous interior, and as flying ambulances they bring the sick and injured out from isolated areas. In 1956, when the Colombian Radio and T.V. authority began work on the establishment of T.V. booster stations across the nation, Aerotaxi Beavers were used extensively for survey and to transport ground parties, their equipment and supplies to construction sites. Another unique Aerotaxi application is a "purchase service" for the convenience of the ranchers of the plains and people living in remote hinterland areas. Its operation is both informal and efficient. A Beaver pilot on one of the scheduled routes observes a white sheet spread out on the ground below. He closes the throttle, lands beside the white patch and exchanges a few words with a waiting rancher or ranch hand. Perhaps a piece of paper is passed from hand to hand. Then the pilot revs his engine, takes off and continues on to his destination. On the return trip he will land again (or airdrop a parcel) at the point of contact. As aerial messenger-boy he may deliver a carton of cigarettes . . . a few yards of dress goods for the Señora . . . or possibly a new motor for the pump. Whatever the item, the charge for the service will only include the store price for the goods plus the usual freight or express charges.

Aerotaxi operates 150 airports in Colombia on scheduled service and the Beavers operate from every elevation including the Magdalena Valley, Bolivian Savannas on the north coast, the wide Eastern Llanos, and in the most mountainous regions of the interior. During 1956 the aircraft chalked up 21,310 flying hours, carried 86,542 passengers, 940,000 lb. of newspapers, 217,000 lb. of freight and 495,000 lb. of airmail.

For the business men and ranchers of Colombia the name "Aerotaxi" is synonymous with the word "Economy". In the Eastern Llanos a Beaver takes one hour to travel a distance that would take at least a month by mule or canoe — the only alternatives to air travel. Experience has shown that Aerotaxi transportation costs 40 per cent. of the ground transportation expenses, without counting the risks involved in the latter and the time lost.

There are many stories of air rescue in the off-beat regions of the world. One of these comes from the Western Cordillera of Colombia. A prospector lay injured on a high hill and a large helicopter was unable to effect a rescue. Then a Beaver was contacted. Guided by the Beaver, a ground rescue party had to hack its way through a dense jungle barrier to reach the scene. Since speed was essential if the man's life was to be saved, the rescue team travelled light and the Beaver, in addition to reconnoitring the easiest route and acting as guide, dropped liquid foods, bottled in tyres, to the ground party.

Aerotaxi Avianca has the largest fleet of Beavers in Colombia. The Colombian Air Force is second with eleven, then Aerotaxi de Santander (a mountain jungle operation) is third with seven Beavers and one Otter. In addition to these operators, the versatile Canadian designed and built utility plane is used by a number of Colombian civil government departments such as Civil Aviation, Colonisation and Agriculture.

The first Beaver to Colombia went to Aerotaxi de Santander in 1951. The aircraft was purchased by Señor Gonzolo Galvin, founder of the service, after it had been highly recommended to him by Dr. Octavia Andrade, an enthusiastic Beaver-owner of Brazil. Señor Galvin built his Beaver fleet up to seven and in 1956 he became the first Latin-American owner of an Otter.

Santander operates out of Bacaramanga, in Eastern Colombia. In this region of dense jungle and high mountains, surface travel is not only tedious and slow, it is extremely dangerous. The natives are often hostile and for this reason it is necessary for land travellers to move in pack mule convoys. Vehicle travel is impossible since in these regions jungle trails are the only links between many communities.

Operating out of Bacaramanga, Aerotaxi de Santander provides a popular service for prospectors, oilmen and traders. Expeditions that would normally consume weeks of plodding through jungles can be accomplished in hours in the comfort of a Beaver's cabin.

When Gonzolo Galvis undertook the establishment of his jungle airtaxi service he had to hack landing strips out of a very unco-operative jungle. In some areas the lush growth is so rapid that a landing strip two hundred by thirty yards may shrink in a couple of weeks to half that size. The aeroplane necessary for this type of jungle operation needed to have exceptional short landing and take-off ability, yet have cabin space large enough to accommodate a prospecting group of four or five plus supplies and equipment. The Beaver proved to be everything that Galvin's Brazilian friend had said it was.

Adios! — Passengers board an Aerotaxi Beaver at a small interior airport for the trip to Barranquilla. At the port city some will board Avianca airliners en route to New York and other foreign centres.

Hive of activity — A typical daily scene at one of the hundred-and-fifty Aerotaxi Airports that network Colombia. There are more than 1,200 Beavers in world service — many in South America.

Air service for prospectors, traders and others who travel in Eastern Colombia's wild jungle and mountain regions, is provided by the Aerotaxi Santander fleet of seven Beavers and one Otter.

Dessert coming up! Where surface transport takes days and often weeks, air service from Colombia's richly fertile mountain valleys brings fresh fruit and vegetables to the nation's cities.

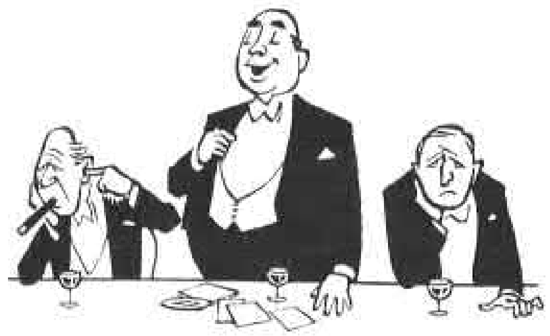
Avianca Aerotaxi Beavers on a busy morning.

Knuclear Knowhow

Some definitions from the U.K.A.E.A.'s "Glossary of Atomic Terms" Wrendered by The de Havilland Engine Company

Scintillation Counter

An instrument for detecting charged particles by the flashes of light they produce in certain materials known as phosphors, e.g., naphthalene, thallium chloride.



Self Absorption

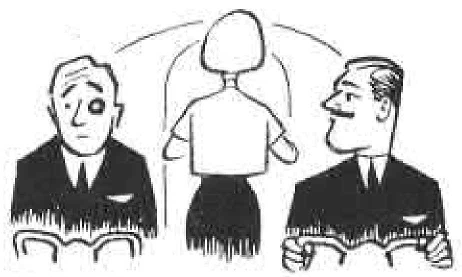
Some radiation from a source is absorbed by the material itself during its path from inside the source to the surface — this is termed self absorption and can be significantly important with thick beta emitters.

Decanning

Removal of the can from a fuel element after irradiation.

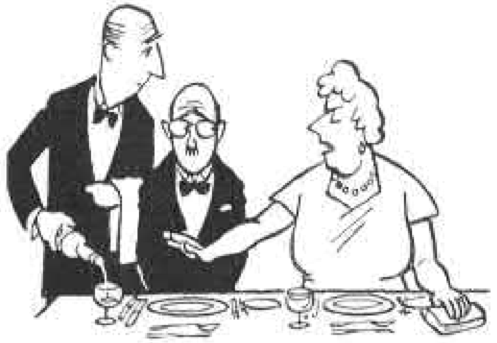
Fast Reactor

A nuclear reactor in which most fissions are caused by neutrons moving with the high speeds they possess at the time of their birth in fission. Such reactors contain little or no moderator.



Pinch Effect

The effect of the associated magnetic field in a gas conducting an electric current whereby the gas is constricted or pinched into a narrow central region if it was previously diffused. It occurs in discharge equipment such as Sceptre and Zeta.

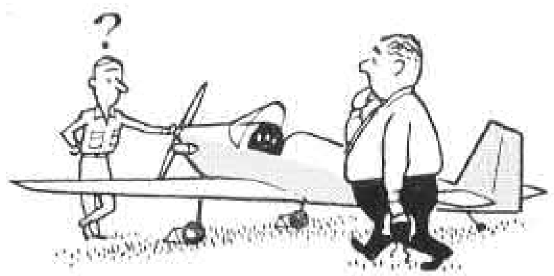


Maximum Permissible Level

The recommended upper limit for the dose which may be received during a specified period by a person exposed to ionising radiation over an indefinite period. So far as is known, a normal person so exposed will suffer no harmful effect.

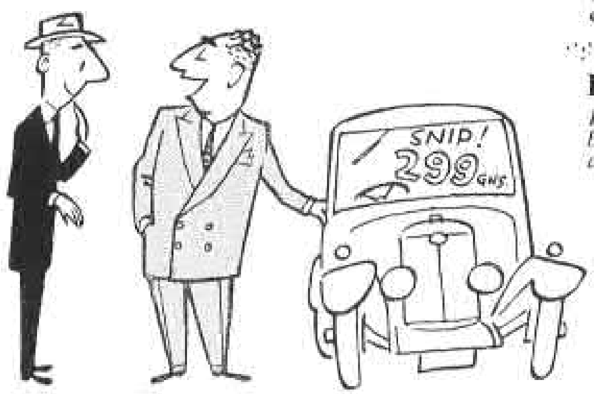
Natural Abundance

Refers to the relative fractions of each different isotope of an element normally found in nature. For example, H constitutes the fraction 0·99985 and D (or heavy hydrogen) constitutes the fraction 0·00015 of the hydrogen atoms found in nature.



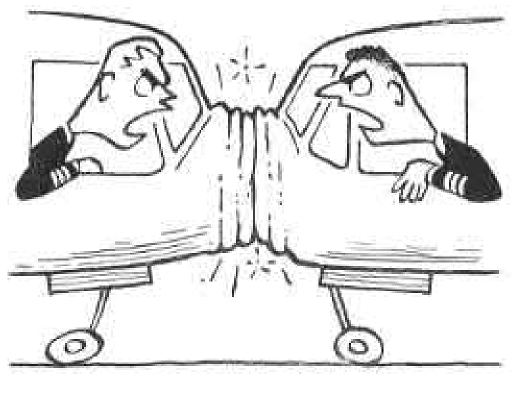
Body Burden

Radioactive material may be absorbed by the body and retained. The total amount present at any time is said to be the body burden.



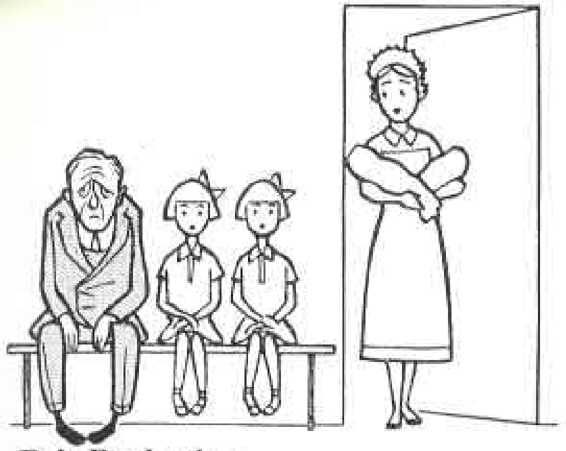
Fertile Material

Isotopes capable of being readily transformed into fissionable material by the absorption of neutrons, particularly uranium–238 and thorium–232; sometimes called source material.



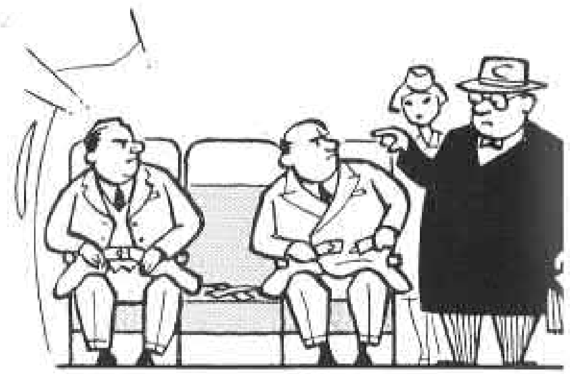
Inelastic Collission

One in which the struck nucleus is excited or broken up, or captures the incoming particle, i.e., a collision in which the particles do not bounce off each other.



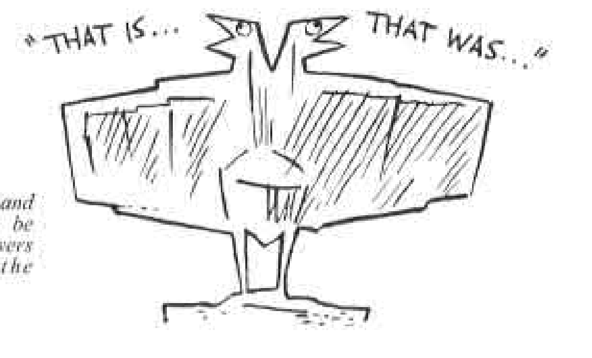
Pair Production

The conversion of a gamma ray into a pair of particles — an electron and a positron. This is an example of direct conversion of energy into matter according to Einstein's equation: $E = mc^2$. It only occurs when a gamma ray passes close to a nucleus which appears to act as a catalyst for the process.



Critical Mass

The minimum amount of fissile material required in a particular type of reactor to sustain the chain reaction. It will vary according to whether a moderator or reflector is present and could occur in a poorly-designed process in a chemical plant.



Shell Model

A concept that neutrons and protons in a nucleus may be arranged in shells or layers somewhat similar to the electron shells in an atom.

After Heat

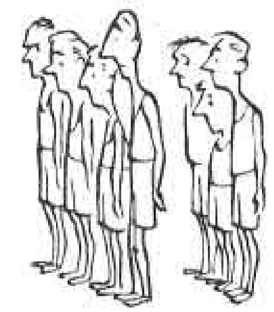
Heat generated in a reactor after it has been shut down, which comes from the radioactive substances formed in the fuel elements (i.e., fission products)

Monte Carlo Method

A method of solving complex physical problems, e.g., neutron diffusion problems, by a series of statistical experiments performed by applying mathematical operations to random numbers.

Binding Energy

The total mass of the protons and neutrons which form a nucleus is greater than the mass of the nucleus. The difference is a measure of the energy binding the nucleus together. It is the amount of energy which must be supplied to a nucleus to cause it to break up.



Back Scattering

The emergence of radiation from that surface of a material through which it entered, due to its collision with and reflection from atoms in the material. This principle is used in the design of some thickness gauges.

Fast Fission

Fission induced by "fast" neutrons. As the fission threshold in U–238 is 1·2 MeV., this energy value is usually considered the lower limit for fast fission.

The Spectre Rocket Engine

On November 4 Mr. W. N. Neat, B.A., A.F.R.Ae.S., Chief Engineer of the Rocket Division of the de Havilland Engine Company, presented a lecture, "The Spectre Rocket Engine," before the Royal Aeronautical Society at its Headquarters at 4, Hamilton Place. An abridged version of Mr. Neat's paper is given here by kind permission of the Society.

WORK on rocket propulsion was begun by the de Havilland Engine Company in 1946 almost exactly a year after the cessation of World War hostilities in Europe. For the first year or so activities were confined largely to a general appreciation of rocket problems and techniques and to an assessment of the experience which had been obtained elsewhere. At that time "elsewhere" meant almost exclusively Germany, from where many technical reports were then becoming available.

In 1946 the policy in this country regarding guided weapons was, to say the least, obscure and the part which the liquid-propellent rocket engine was to play in that field, even more obscure. It was not surprising therefore that my company, being already well established in the field of aircraft propulsion, should very soon tend to concentrate its rocket propulsion efforts to manned aircraft applications. They were encouraged in this policy by the successful German use of the Me.163 and of rocket take-off units fitted to the He.111, Ju.88 and other aircraft. In particular, it was foreseen that the defence requirements of the U.K. might necessitate at an early date the use of a fast-climbing rocket-propelled fighter.

In 1947 it was felt that the usefulness of the Comet 1 might be restricted by its marginal take-off capabilities from high altitude tropical aerodromes. Various schemes were considered to remove this restriction, one being the use of built-in rocket units, and on the basis of this requirement the Sprite assisted take-off unit was designed.

In order to convince possible users of the practicability of rocket units for such a purpose and to obtain some first-hand experience of handling them and their propellents, two Walter 109–500 units were temporarily fitted to a Lancastrian aircraft. Altogether eight take-offs were carried out and no features were revealed which appeared to rule out the entire practicability of rocket units for civil aircraft.

Because of this satisfactory experience and for various other reasons, concentrated hydrogen peroxide or H.T.P. was chosen as the propellent for the Sprite. There was an especial reason for its being used for this application since it permitted so-called "cold" operation with no combustion. Such a simple system seemed highly desirable for our first venture in rocketry, particularly as this was intended for use on a civil aircraft.

By mid-1951 most of the problems with the unit had been sufficiently overcome to permit take-off tests in the Comet to commence. However, although the feasibility of the Sprite was adequately proved by these trials, the units were never required operationally, since the take-off capabilities of later Comet variants were proved by the use of more powerful main engines.

Two of the Sprite units thus made redundant were modified to permit the combustion of fuel with the decomposed peroxide, and these units led logically to the Super Sprite which is at present in quantity production for assisted take-off on the Valiant. This engine in its nacelle, is illustrated in Figure 1.

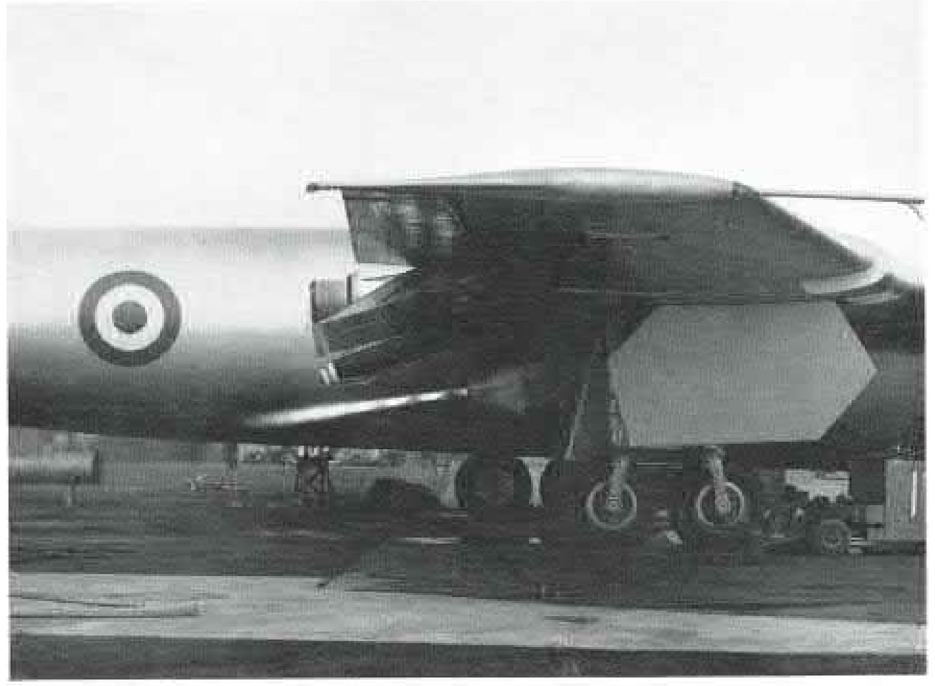


Fig. 1.—On the Vickers Valiant, the Super Sprite is contained in an external nacelle, one under each wing, situated between the main engine tail pipes.

All this is by way of introduction to the Spectre. It is, however, very relevant since a great deal learned on the Sprite and Super Sprite considerably influenced the design of the more advanced engine. For example, satisfactory experience on the earlier units helped to decide the propellents chosen for the Spectre. Both the Sprite and the Super Sprite provided invaluable experience on material compatibility and the development of suitable solid catalysts. Both units provided prior knowledge of test bed design and testing techniques, and in the case of the Super Sprite, information on the combustion of kerosene in decomposed peroxide and the establishment of ignition limits, etc.

Design Considerations

Even before work was begun on the Sprite and certainly concurrently with its development, thought was given to the use of a rocket engine to give super performance to a manned fighter. Ten years ago, it seemed that until the guided ground-to-air missile had attained sufficient reliability there might be a period during which a manned rocket fighter (if its development was begun soon enough) would be particularly suitable for the defence of the United Kingdom. Studies carried out indicated, as indeed one would expect, the attractiveness of the rocket fighter with its high rate of climb especially to high altitudes. These studies were extended to show, again as one would expect, how the range and duration limitations of the purely rocket-propelled fighter could be largely overcome by the use of both rocket and gas turbine power-plants in the same aircraft. Similar studies were simultaneously carried out by Saunders-Roe Ltd., later to be elaborated and extended to form the integrated weapon philosophy of the S-R.177 mixed powerplant interceptor.

Design studies were therefore begun on a suitable rocket for a manned fighter. The overriding principle for such an engine was that it should conform as nearly as possible to accepted proved aircraft engine standards. Above all, it should be robust and reliable, even if that meant, to begin with at any rate, some resulting weight penalty. It should be completely self-contained and capable of repeated operation during a flight and have a developed overhaul life, equivalent in number of sorties, to a gas turbine engine. It should be controllable over a wide thrust range, capable of straightforward installation, and demanding the minimum of attention between flights. Such then were the broad design requirements for the Spectre as originally conceived in 1947.

The first major decision to be made was that concerning the choice of propellents. A great

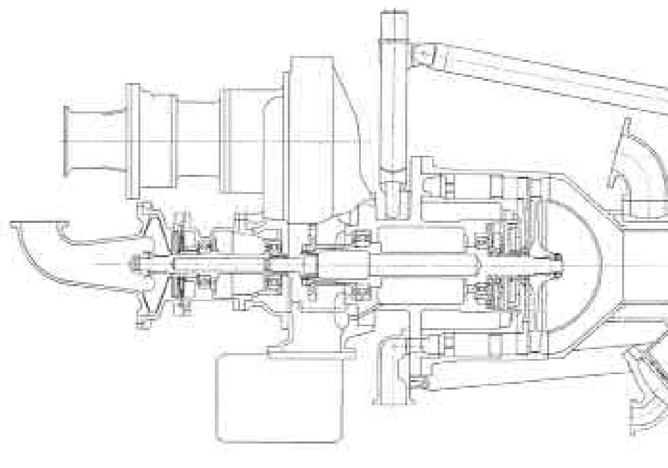


Fig 2.—Diagrammatic lay-out of the Spectre D.Spe.1 in the form in which it first ran as a complete unit.

number of possibilities were considered including the use of mono-propellents more powerful than H.T.P., but the final choice was soon narrowed down to kerosene as the fuel, since it was readily available, and in any case would have to be supplied to a mixed engine aircraft, and liquid oxygen, nitric acid, or H.T.P. as the oxidant. (For reasons which have been explained in a previous *Gazette* article, H.T.P. was eventually chosen as the preferred oxidant — a choice which has never been regretted.)

With regard to the size to which the engine should be designed, a survey was carried out through the aircraft industry. The recommendations obtained varied over a wide range from 2,000 lb. sea level thrust to 15,000 lb. Estimates at the lower end of the scale generally implied the use of a rocket in an adaptation of an existing aircraft or in a new aircraft designed to conventional standards, while the higher value usually coincided with the idea of a pure rocket interceptor with a very high climb rate and ultimate speed but with a very short endurance.

As a result of this survey and our own thoughts on the matter it was decided to design for a sea level thrust of 8,000 lb. with a possible later uprating of the engine to 10,000 lb. The amount of throttling required depended to a large extent on its application; it seemed that an engine for an all-rocket aircraft would require throttling over a wider range than if the rocket were to be used in partnership with a gas turbine. In order to cover all cases it was decided that initially the Spectre should be capable of throttling down to about 20 per cent. of its full thrust rating but with development to a lower limit at a later stage.

Having decided the most suitable propellents and thrust rating, a decision was then made as to whether the necessary thrust variation could be obtained with a single combustion chamber or whether multiple chambers, each operating over a more restricted thrust range, would be required. Propellent consumption at part performance would certainly be better with multiple chambers (though negligibly so at great altitudes) but design layouts showing the nest of pipes and complicated control system resulting from such an arrangement convinced us that a single chamber capable of operating over the complete thrust range would be simpler, lighter, more compact and reliable.

The question then arose as to whether this should be fed by a conventional, separate, turbo-pump arrangement or whether we should employ the quite radical low-loss or "topping" turbine scheme in which the turbine exhausts into the combustion chamber. This latter scheme had the potential advantage of higher overall specific thrust since the turbine exhaust was not ejected overboard with little

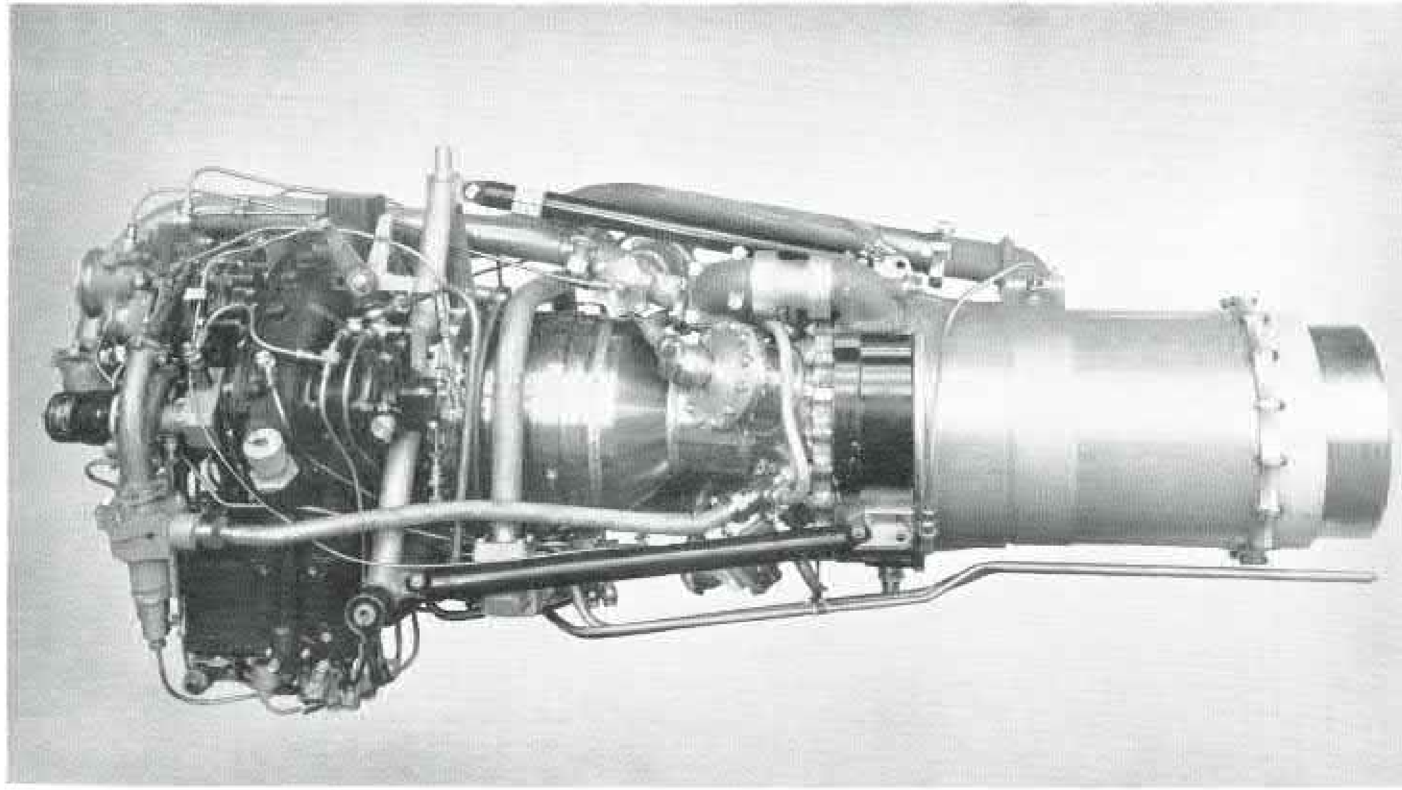


Fig. 3.—Port-side view of the Spectre D.Spe.1

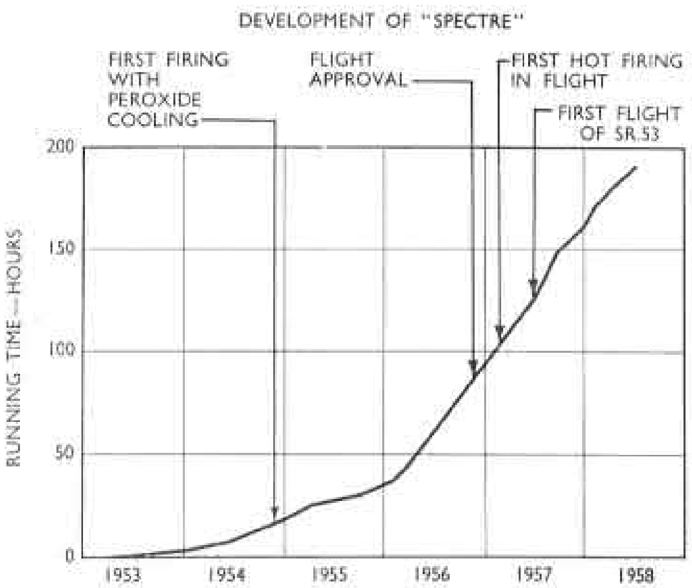


Fig. 4.—Graph of the running time accumulated on the Spectre between its first run and initial flight testing.

or no propulsive effect. It also led to a compact arrangement of engine without a separate turbine exhaust and with a solid backbone on which control valves and gear could be conveniently hung with the very minimum of framework. Fundamentally it led to an essentially safe ignition system since a steam flow from the turbine would constantly purge the combustion chamber of any fuel that might be left there unburnt.

On the other hand, it would result in a rather inflexible arrangement since the turbine and pumps could not be easily removed from the head of the combustion chamber and disposed elsewhere. Furthermore the turbine must inevitably work at a high pressure, greater than that in the combustion chamber, and this would necessitate a difficult seal adjacent to the turbine disc to prevent high pressure gas leaking down the pump drive shaft. On balance it was felt that the advantage of the low-loss system more than outweighed its disadvantages and the design of the Spectre proceeded therefore on these lines.

Considering the combustion chamber, at one stage in its design it was cooled with high-pressure H.T.P. delivered from a single pump, running at turbine speed. The chamber was anchored at its forward end, and in order to allow for thermal expansion the rear end was free to slide in the surrounding coolant jacket. With the coolant pressure higher than the combustion pressure this arrangement imposed an excessive combined buckling and tensile load on the nozzle throat section. To overcome this the engine was re-schemed so that the H.T.P. was pumped up to pressure in two stages, passing through the coolant jacket at a relatively low pressure before passing into the second stage pump. This resulted in very low combustion chamber wall stresses but of course complicated the design of the gearbox interposed between the turbine and the pumps.

A contract for the Spectre was received from the Ministry of Supply in mid-1951, although a great deal of preliminary work had been carried out before this. The rig testing of long-life catalyst elements began early in 1952 and of mechanical components about three months later. Fig. 2 illustrates the engine as it first ran as a complete unit.

A stainless steel chamber was used, located as already described, at its forward end. To permit easy inspection and replacement, the chamber was quite separate from the light alloy coolant jacket into which it fitted. Helical vanes were machined on the outer wall of the chamber to direct the H.T.P. flow, and a two-piece filler block was clamped over the vanes to form rectangular coolant passages. The H.T.P. flowed forward over the chamber and was taken out at a point just aft of the turbine. Fuel was injected through three banks of injectors arranged at 120° to each other. Each bank contained fifteen swirl nozzles, and by a suitable valve it was arranged that these would be brought into action progressively as thrust was increased. At full thrust about half the total H.T.P. flow was fed directly into the combustion chamber through three cylindrical silver catalyst decomposers interposed between the banks of injectors. The remainder of the H.T.P. was fed through the turbine which was of a single-stage impulse type, running at a maximum speed of 13,000 r.p.m. This was fed from an annular decomposer through a simple nozzle ring giving partial admission. From the turbine, a shaft passed through the annular catalyst pack to a gearbox on the front face of which were mounted the kerosene pump and the first and second stage peroxide pumps, running at 20,000, 7,500 and 13,000 r.p.m. respectively. The main drive, the gearbox and the pump shafts were all run on conventional ball and roller bearings, lubricated from an oil sump at the base of the gearbox. Forward of the turbine was a complicated gland preventing steam leaking into the gearbox. The pumps were of a very simple open-impellor type with twin tangential diffusers, and an arrangement of multiple seals to prevent kerosene or H.T.P. leaking into the gearbox. Also mounted on the front face of the gearbox was a centrifugal flyweight governor similar to a propeller constant speed unit. Fig. 3 shows a side view of the engine.

The engine was controlled by a single throttle lever which varied the governor datum setting. This passed oil into or away from a servo cylinder in which a piston varied the flow of H.T.P. to the turbine decomposer and hence the turbine speed. Linked with the governor control was a fuel control valve which staged the flow of fuel into the banked injectors, the ports on the control valve being designed to maintain a more or less constant overall mixture ratio over the whole thrust range.

The governor was intended to maintain a required turbine speed even in extreme conditions such as if the fuel ran out and a sudden loss of chamber pressure (and hence turbine back pressure) occurred. As an added precaution an overspeed valve was fitted, this being designed to shut down the flow of H.T.P. to the turbine on the advice of an excess pressure signal either from the coolant jacket or from the second stage H.T.P. Pump.

Bench Testing

Although the use of a low-loss turbine system produced an integral arrangement of engine, the Spectre was surprisingly amenable to step-by-step testing. Having individually rig tested the pumps, valves, turbine seal and starting system, the next stage was to take the turbine decomposer without the turbine or gearbox and to run it on H.T.P. from pressurised tanks.

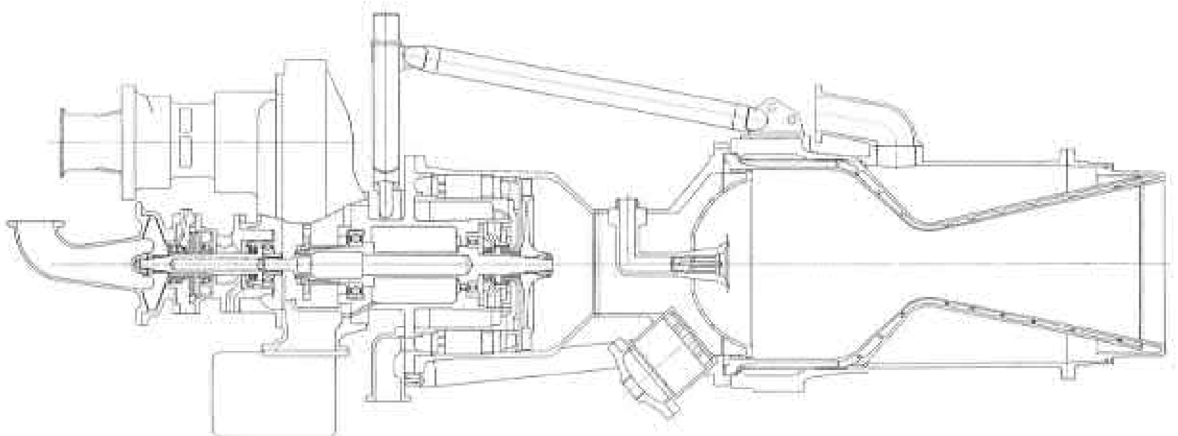


Fig. 5.—Sectional diagram of the Spectre D.Spe.1 in the form in which it was cleared for flight.

This was in order to check the distribution of peroxide into the decomposer and its decomposition efficiency. After this phase had been satisfactorily completed, the turbine gearbox and pumps were fitted and the turbine was run again from pressurised tanks with the H.T.P. pumps running on water, and the fuel pump on kerosene. To simulate different chamber conditions, throttle plates were bolted to the casing downstream of the turbine to give it varying back pressures.

After this had been done the turbine was then run from the engine's own pumps, and very soon afterwards the combustion chamber was fitted and the main decomposers brought into action. For this test the combustion chamber was cooled with water from a slave test-bed system, the first cold run of this nature being carried out by mid-1953. The first hot run was carried out in the autumn of 1953, the combustion temperature being initially kept down to about 1,700°C. by the use of a 16:1 mixture ratio. Stoichiometric and full thrust conditions were achieved about six months later and "hot" running with H.T.P. cooling, about six months after that. Very soon considerable running between thrusts of 1,000 lb. and 9,000 lb. was carried out and no really serious fundamental difficulties with H.T.P. cooling were encountered anywhere in this thrust range.

Fig. 6.—The specially modified Canberra with the Spectre mounted in the rear part of the bomb bay. A closed circuit television system in the aircraft is fitted with a camera in the engine bay so that the pilot can view the engine during flight.

Flight approval for the engine was obtained in the autumn of 1956 and a fair indication of the amount of development which had been carried out since the engine first ran will be apparent from an examination of Fig. 5, showing the engine as it was flight approved.

To begin with, the governor had been completely eliminated. This had been included in the original design because it was then not known whether a system involving a low-loss turbine, centrifugal pumps and catalyst packs, would have sufficient inherent stability. Although considerable running with the governor was carried out, tests showed that a system in which the H.T.P. was metered to the turbine by means of a valve directly linked to the throttle, was quite practicable. Any tendency to overspeed would be looked after by the pressure-operated overspeed valve which had always been a part of the propellent system.

It was found unnecessary to stage the fuel injectors in order to obtain low thrust performance. This was rather fortunate because frequent blow-backs in the injectors had necessitated non-return valves right at the point of injection. This was virtually impossible with the multiple injectors originally fitted but became feasible when each bank was replaced by a single poppet injector.

In the original design, H.T.P. was led from the coolant jacket through a complicated fabrication, around the cylindrical decomposers and fuel injectors, before it was piped away to the second stage pump. This arrangement involved a rather difficult liquid gas seal at the head of the chamber which very often failed, allowing either H.T.P. to leak into the chamber or combustion gases to leak into the coolant space. Furthermore, it was suspected that stagnant areas existed in the coolant space around the chamber head where H.T.P. decomposed and led to unstable running. The head of the combustion chamber was therefore redesigned so that the area around the decomposers and injectors was left uncooled, the H.T.P. being taken out of the coolant jacket at the forward end of the combustion chamber itself. A steam distributor was fitted into the head of the chamber, and the chamber head seal was generally simplified and gave no further trouble.

When attempting to carry out long runs at low thrust, persistent combustion chamber burning near the throat section was experienced. This was attributed to streaky combustion, due to the three-point injection system. Systematic experiments taking out one injector at a time proved this point. A single central injector was therefore fitted to replace the three previously used. Kerosene was led into the combustion chamber through a pipe just downstream of the turbine. From there it was led to a mushroom injector which protruded through a central hole in the steam distributor plate. The injector contained a large number of radial holes which sprayed kerosene on to a spun-over target plate. A non-return valve was built into the injector head to prevent any burning or explosion within the injector itself.

Quite apart from the effect of uneven combustion, it was found that burning of the combustion chamber wall often occurred under one of the coolant vanes, due to a local hot spot being formed. In order to prevent this, the vanes were removed from the combustion chamber and instead were cast on the inner wall of the associated filler block and small slots were cut in the vanes to allow a small flow of H.T.P. across them and thus prevent any local overheating.

After all these improvements had been well tested, and an attempt was to be made on a special category test with some confidence, an H.T.P. pump explosion occurred although over 50 hr. successful running had been carried out with the design. The explosion was attributed to H.T.P. overcoming the complicated seal arrangement and mixing with oil in the neighbouring bearing. It was decided that to overcome this trouble, completely vented open spaces between the H.T.P. and oil parts of the pumps were necessary. To find room for this redesign it was necessary to put the sealing arrangement between the two pump bearings and to lubricate the bearing nearest the pump impeller with H.T.P., an unplasticised P.V.C. rod bearing being developed for this purpose and giving practically no trouble afterwards. The new arrangement of pumps, together with most of the other changes described, are shown in Fig. 5, which indicates the form of engine which was first cleared for flight over a 2,000 to 7,000-lb. thrust range in November, 1956.

Flight Testing

Flight testing of the Spectre began in December, 1956, in a Canberra which had been specially modified as a flying test bed. However, before any flying took place, a number of cold ground runs, i.e., on H.T.P. alone, were carried out, the engine being fired into a pit over which the aircraft was wheeled. Very little aircraft trouble was experienced during this phase although there was some evidence that some trouble from noise and vibration might be met when full thrust hot running was attempted.

A series of six flights were carried out during which the engine was run cold up to a thrust of about 4,000 lb. During these flights experience was obtained on the general handling of the engine as well as its initial starting characteristics, its ability to change thrust and to restart during flight.

A series of hot ground runs were then carried out and at this stage our fears regarding the effect of the noise from the Spectre on the Canberra structure and equipment were justified. The effect of noise manifested itself in a number of ways. Fuselage rivets were loosened and some brackets attaching stringers to ribs were cracked. Cracks also appeared in the elevator skinning and a bracket supporting an electrical junction box in the rear part of the fuselage broke away. Even more seriously the tailplane actuator began to give trouble. Fortunately, all these failures were confined to the part of the fuselage to the rear of the rocket exhaust. As much electrical equipment as possible was therefore resited farther forward and the brackets holding the remainder were strengthened. Improved limit switches were fitted to the tailplane actuators, and since it had been shown that the effects were most serious under these conditions, ground running was kept to a minimum. When it was carried out, a protective sound-insulating muff was attached to the lower side of the rear fuselage.

Flight tests with the Spectre running " hot " were begun in February, 1957, and altogether 29 flights were carried out. As in the case of the previous tests with the engine running cold, an investigation into general engine handling was carried out, paying particular attention to thrust control and restarting. On the ground some trouble had been experienced due to the engine becoming overheated on shutdown as a result of the residual heat in the hot parts of the engine raising the temperature of the stagnant H.T.P. left in the coolant jacket. Because of this, the lower engine cowling was generally left off during ground runs. In the air, however, because of generally cooler ambient conditions, no similar trouble was experienced.

Following the completion of a satisfactory flight programme in the Canberra, a Spectre was installed in a Saunders-Roe S-R.53 aircraft early in 1957 and a series of ground runs carried out. These at once brought us back to the heat soak problem when the engine was shut down.

To investigate this problem, a further series of test bed firings were carried out. These were augmented by a number of firings in a fuselage rear-end specimen which was exactly similar to the S-R.53 and installed on our test site at Hatfield. The problem of heat soak was eventually overcome by improving the ventilation of the engine bay to produce cooler conditions, and in addition by changes which were made to the propellent system to permit a convective flow of H.T.P. on shutdown, thus reducing the effect of stagnant pockets. The most effective change, however, was to use main tank pressure to maintain a small flow of H.T.P. through the engine on shutdown, this flow being discharged through an overboard vent.

The first S-R.53 flight took place in May, 1957, and was quite successful except for the inability of the engine to restart during the flight. This was eventually traced to some valve malfunctioning which was subsequently put right by modification. A considerable number of S-R.53 flights have been carried out to date and except for some minor troubles the Spectre has behaved quite well.

Fig. 7.—The Saunders-Roe S-R.53 mixed powerplant interceptor research aircraft powered by a Spectre rocket and an Armstrong Siddeley Viper turbojet.

During the period in which S-R.53 flying has been carried out, some minor changes have been made to the engine. For example the injector system has been improved and the oil-to-H.T.P. heat exchanger eliminated. Main tank pressure has been used for starting, the separate starting system on the engine being deleted with resultant weight saving.

Future Developments

Development of the Spectre D.Spe.1 has now reached a stage where only minor matters demand attention. Experience with this first mark of engine has, however, shown how the design can be improved in a number of ways and many such modifications are being built into later engines.

By a general rearrangement of components it has been found possible to reduce the weight and complexity. As an example, it has been possible by locating the combustion chamber in a different way and at the same time changing its material, to revert to high-pressure cooling as was originally intended on the Spectre 1. This eliminates one of the H.T.P. pumps and greatly simplifies the gearbox. A number of parts originally made in steel are now made in light alloy, and some of the more difficult seals in the D.Spe.1 have been eliminated by redesign. These modifications together with many others are incorporated in the Spectre 4 and 5, the latter being shown in Fig. 8.

This engine is very much lighter than the Spectre 1, but there are still further improvements which could be included which would reduce the weight and size even more. For example, the pumps with only a very small loss in efficiency could be mounted on the same shaft as the turbine. This would eliminate the gearbox completely and with it the need for any oil lubrication, since all the bearings could then be propellent-lubricated following the practice already employed on the Spectre 1. The separate combustion chamber and coolant jacket could be replaced by a fabricated one-piece multi-channel chamber, the durability of which has already been demonstrated with H.T.P. cooling over a wide thrust range. All these changes could be made using no new principles but by employing a logical development of techniques which have already been proved by extensive running on existing engines.

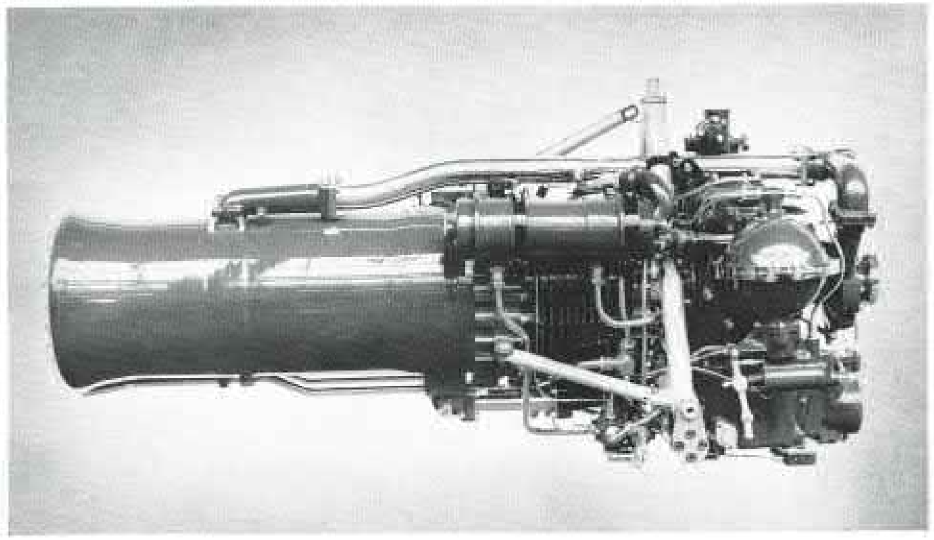


Fig. 8.—Starboard view of the Spectre D.Spe.5

A NATO Demonstration

MYSELF, I know it's the H-bomb . . . the arguments of prosaic meteorologists leave me unconvinced, as the heavens open and the evidence streams down.

Thus it was in the late summer on the sunny south coast of this Spectred isle that I could view, more with resignation than surprise, a water-spout advancing like a black pillar up the Solent. It boded well for the morrow when the Army had arranged to stage a little aerial demonstration for some Very Important NATO visitors.

At least it started as a " little " demonstration — but it grew and grew as the impoverished industry, flushed with Farnborough excesses, jostled for position to show their wares. Tents sprang up and cohorts of carpet-baggers arrived with their brochures until this modest private occasion had swollen into a minor S.B.A.C.

The day dawned bright and fair and into the gaily decked field dropped the contenders, ready to joust for custom in the afternoon. The helicopters large and small unscrewed themselves with precision into their allotted plots. The motorised umbrellas came STOLling in with their slips and everything else showing. The salesmen with their gay buttonholes and curly-brimmed hats straightened their ties and their literature — the scene was set.

But already the sun had gone and before the first charabanc of important soldiers had arrived, mellowed by lunch for the afternoon's amusement, a light rain was falling and a freshening wind carried it in soft curtains across the field. The guests were ushered into a large marquee and sat in serried steaming ranks facing the runway, a section of which was just visible through the raised flap in front. The spectacle began — if spectacle is the right word for a diversion consisting entirely of inspired commentary and startling " noises off." Unless by chance one of the performers happened to pass in front of the slot, their size and shape and purpose remained a fascinating enigma to the audience. To one uninitiated in the mysteries of soldiery the proceedings may have seemed a little confined, but this was indeed a tank's-eye view of aviation.

Back at the display area British weather was beginning to take its toll. The wind now gusting strongly was shaking the tents and imperturbable salesmen had begun to fray under the influence of flapping canvas and driving rain. The STOL and VTOL aeroplanes which by nature are designed to brave the elements in an up-and-down sense, or at least to butt the wind head on, are no match for sideways draughts. Alarming things were happening to their copious sails.

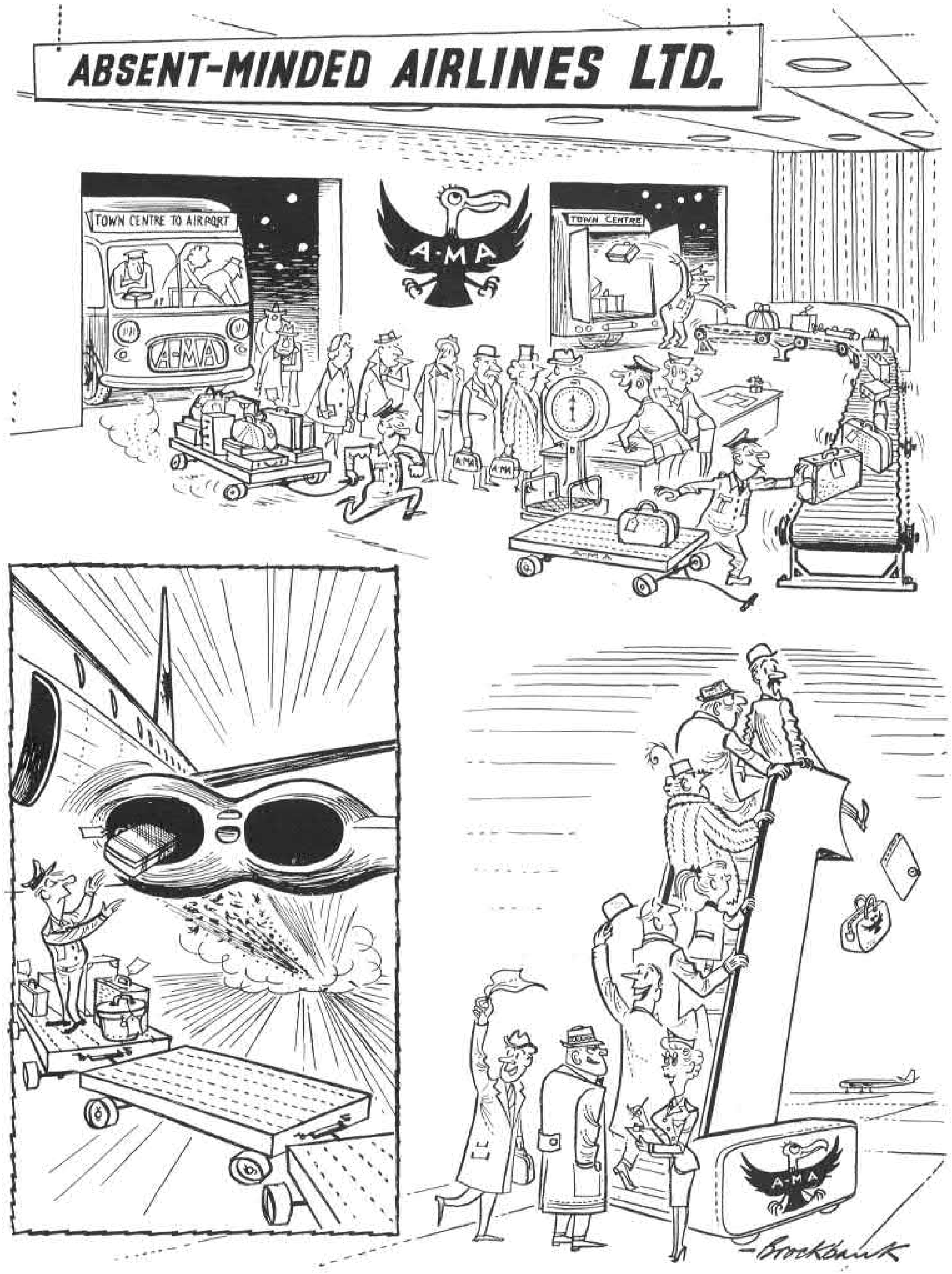
But it required one more devilish ingredient to render the swiftly degenerating afternoon into total catastrophe, and this arrived in the form of a large twin-rotor helicopter. Returning from its praiseworthy, if invisible, battle with the elements this monstrous contraption came winding hoarsely along the line of tents, seeking a roost beside its sheltering supporters. As it lowered itself it carved a trail of growing havoc. The tents of competitors bowed before the storm, guy-ropes snapped and rain poured through the sundered canvas. Full-grown Otters leapt into the air and bore down on lesser craft — debouching meanwhile the frightened occupants. Braver men fought with locked controls as the cyclone passed.

But these disasters paled beside the culminating *tour de force* as the monster hovered over its own premises before unwinding itself to the floor. It is difficult to imagine the moment of horror within that tent as the howling of the wind was drowned by the roar of their returning offspring but to the frozen gaze of one outside a quite extraordinary spectacle ensued. The draught from those great rotors seemed somehow to get under the tent flaps and blow the fabric up like a pompous frog. It grew and grew until it could grow no more and, inevitably it burst, erupting brochures until the sky seemed thick with literature, and propaganda fell like snowflakes across the field. Some leaflets danced high across Hampshire and were lost to view, spiralling up into the grey, rain-sodden clouds. Such a distribution could not have been planned by the most inspired P.R.O. and has since been the envy of all.

I am left with the vivid memory of bedraggled salesmen crawling from the wet folds of that stricken tent, of the struggles of buried shapes under a deflated mountain of sodden canvas and the sad salvage of shattered models.

Dry in a car I found my colleague, another witness of the disaster — red in the face and with tears coursing down his whiskered cheeks he summed up the occasion " My dear, the joy . . . the joy of it!"

There are lessons to be learned from this unhappy history — tents and helicopters should never, never be allowed to come into conjunction. It took the Army to remind us as we floated off the battlefield that the first real break-through in VTOL technology was that devised by Noah, with Celestial guidance—and thirdly that we must ban the H-bomb if we are ever to get our steaming British-warms dry again. — J.S.



A Business Man's Heron

There is a Christmassy touch about this obviously unpremeditated snapshot of a Heron executive aircraft owned by the Banco Nacional of Mexico. Perhaps a contract had just been signed—but where is the second glass? And those gloves! This is a specially furnished Heron with two main cabins, and the picture shows the forward compartment, provided with a sleeping-berth and ample accommodation for personal or business papers, clothing, etc., as well as cupboards for refreshment. Through the doorway one gets a glimpse of a travelling compartment with four large armchairs. A small cabin is located forward for radio navigation or galley purposes. A toilet compartment, wardrobe, and luggage bay, are located aft.

"A chap like that may be all right for the old bags of tricks, but he'd be out of work on the Comets."

"His trim, military figure moved briskly with no more than a trace of limp from his first war wound through Whitehall."

Famous London newspaper.

* * *

"I understand that if the child leaves school before the date I have given and family allowances are in payment, I should tell my Local Pensions and National Insurance Office immediately . . .".

Ministry of Pensions form.

* * *

"Comet 4C: different fuse, different wing, otherwise it's the same aircraft."

* * *

"Dear Carol, Excuse me for addressing you by your Christian name but I have just heard the news of your baby girl and cannot refrain from writing paternally . . .".

(*Thinks: something odd about that somehow*).

* * *

"It's all made plain in that clever brochure What World Air Transport Means to the Comet."

* * *

"Regret no spares despatched because no order received. Regards."

Regards! They madden me.

* * *

"I'll get this damned press release typed out within an hour of landing at Hong Kong even if I have to seek out Suzie Wong."

* * *

"Better tell the taxi Queens Road Central because maybe the Chinese driver don't speak English, eh?"

* * *

Dripping with perspiration on the Kowloon ferry, "Let's go and stand in the rain where it's drier."

* * *

Guest at Hong Kong cocktail in honour of Comet pilots, as they arrive (late) loaded down with suitcases: "Is this the band?"

* * *

Peering into a Wanchai taxi-dance establishment in search of Suzie Wong: "Not quite the right atmosphere. Too clean. Flies all dead."

"He says 'Misrair' at me at 43,000 feet through a mouthful of smoked salmon sandwich and expects me to understand."

* * *

Hiscocks at the Caribou press conference, Toronto, September 17:

". . . this rather unglamorous bush type of airplane."

"What do you mean, unglamorous?"

"Thank you."

* * *

"You say you did the Caribou in 13 months to the first flight. Would that be normal pace or would you call it a crash programme?"

"Normal, I should say. . . . Is there any difference?"

* * *

"Seasoned with years and years of experience."

"Yers, seasoned with thyme."

* * *

News broadcast:

In East London today bandits using a stolen taxi robbed two bank employees of £16,000.

Oh! Poor fellows! They couldn't have had a happy home environment.

* * *

"I will answer that in a perfectly straightforward way."

Top politician at Party conference.

My dear Jack:

I enclose the letter of my wife. She thought that even in such a foreign language you could feel how deeply she resented your so kind attention. The flowers . . .

* * *

It has taken all the energy, brilliance and brains of de Havillands and BOAC—assisted in some measure by the Daily Sketch—to get the Comet into service ahead of the Americans.

* * *

Genuine right through:

"The Rank Organisation announced last night that they will make a film on the Notting Hill colour riots. It will be filmed in the Notting Hill area, where shooting will begin on November 10 and will go on for about two months. The film, to be called "Sapphire," will be made in colour . . ."

The Times.

* * *

"Yes, we did Pisa. But such a rush! No time to lean against the tower."

* * *

"But it has been a most remarkable tour. What, to you, made the most outstanding impression?"

"Me poor feet."

* * *

"We went to Majorca for our holiday."

"Where is that?"

"Oh! I don't know where it is. We went by air."

* * *

"Rome! How wonderful! What did you see?"

"We saw the fountain, and St. Peters, and all the bits and pieces."

* * *

DANGER! NE JETTEZ RIEN DANS LA TOILETTE!

(*Comment faire alors?*)

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