AN ACCOUNT OF B.O.A.C.'s INTRODUCTION OF THE COMET 4: CREW-TRAINING AND FLIGHT PROCEDURES

ILLUSTRATED WITH "FLIGHT" PHOTOGRAPHS

BACKGROUND TO COMETS

THOUGH the early Comets were so suddenly eliminated from B.O.A.C.'s operations the Corporation's jet *savoire faire* survived. In the course of nearly two years—from May 1952 to April 1954—B.O.A.C. had flown nearly 30,000 Comet hours. As the intervening years have gone by, people have tended to look back on B.O.A.C.'s Comet 1 experience as a sort of brief experiment that ended in failure. But failure of the aircraft could not alter the historical fact of two years' highly successful pioneering in a new and revolutionary mode of air transport—two years which left a deep imprint of experience in the minds of all who flew and operated the Comet. Day and night throughout these two years the new operating techniques which the new form of propulsion demanded were developed, improved and refined; and though the corporate experience which resulted had to be put aside when the unit was disbanded, the experience of the men concerned—though dormant for three long years—ensured the continuity which permitted the B.O.A.C. Comet Flight to be re-established, in March 1957, smoothly and straightforwardly.

Continuity was also preserved by the appointment of a Comet 1 pilot to preserve the technical and operational link between the manufacturers and the Corporation. This was Capt. A. P. W. Cane, who had been flight superintendent of the Comet 1 fleet. Though keeping his hand in down the routes like the rest of the ex-Comet crews (he went on to Argonauts, while most others were transferred to Constellations), he was the Corporation's Comet-liaison man. His influence can be seen, for example, in the flight-deck layout, which is probably the best in any airliner to date. A practical flying man's influence is obvious here. Pilots' instrumentation, cockpit lighting, navigation equipment, engineer's station—these were typical of the technical problems which Capt. Cane advised upon from the earliest stages of the design.

When the contract for 19 Comet 4s was signed with de Havilland in February 1955, it was decided to take delivery—about a year before the Comet 4—of two specially modified and adapted Comet 2s. Known as 2Es, each had the extensive pressure-cabin modifications applied to R.A.F. Transport Command's ten aircraft, but were in addition revised to take two Comet 4-type Rolls-Royce Avon 524 (RA.29) engines in place of the outboard Avon 117s. The idea behind the two Comet 2Es was twofold: to amass flying hours on the Avon 524—which, though derived from the military Avon, was virtually a new design of commercial turbojet—and to rebuild B.O.A.C.'s Comet organization. These two essential objectives could obviously be neatly combined; and, though both aircraft were to be operated by B.O.A.C., one was owned by the Ministry of Supply.

The Comet Unit (now known as Comet Flight) was reformed in March 1957. Its original manager was Capt. Cane, with Capt. T. B. Stoney as his deputy. In October 1957 the unit was raised to Flight status when Capts. Cane and Field were appointed to special duties under the Corporation's technical manager (to do 707 and VC.10 as well as Comet liaison). Capt. Stoney was then appointed Comet Flight manager.

The first 2E was ready in August 1957, the second in September 1957. The plan was to operate eleven flights a week to Beirut, and the programme was launched on September 16, 1957. The Lebanese airport was chosen because flying to Beirut and back in the day gave just the necessary eleven hours per flight required to meet the target of 3,500 aircraft hours (i.e., 7,000 Avon 524 hours) by the end of May 1958. The aim was to clear the engines for a 500-hr overhaul life. In the event they were cleared for 1,000 hr.

The Comet 2E Unit was formed with 19 pilots. This was a sufficient nucleus for the 2E programme, and all the pilots were ex-Comet 1—a requirement for entry into the 2E Unit. However, the more recent Comet 4 personnel requirements have never been that everyone must be ex-Comet 1: obviously, B.O.A.C. could not crew 19 Comet 4s with the personnel from ten Comet 1s, even assuming that they were all available. In any case, since the demise of the early type there had been a change in the pilots' salary system—i.e., there were now varying salary-scales for different aircraft types. As a result pilots could bid, according to seniority, for transfer to new equipment. Such a bidding system, based on seniority, was the method by which names were chosen for the Comet 4 Flight; its obvious fairness avoids any awkwardness and suggestions of favouritism.

According to present plans B.O.A.C. will train rather more than 100 crews for the 19 Comet 4s—in accordance with the rough-and-ready rule of about five crews per aircraft. The Comet Flight has settled for a four-man flight-crew of two pilots, a navigating officer, and a flight engineer. Notwithstanding the present controversy, it looks as though B.O.A.C. have no intention of dispensing with full-time flight engineers on their jet airliners. Indeed, the flight engineer's station in the Corporation's Comet 4s is probably one of the most comprehensive of its kind.

Generally speaking, there are three types of pilot to be converted to the Comet 4: (1) those—19 in all—who were ex-Comet 1 and who are right up to date on the 2E; (2) the ex-Comet 1 pilots who have not been on the 2E; and (3) pilots who have had no jet experience. Initially, of course, the training programme has concentrated on the conversion of the 2E pilots; and here it is appropriate to retrace the programme which, on Saturday, October 4, 1958, culminated in the inauguration of passenger services across the Atlantic.

It was last January that B.O.A.C. first began to look seriously at the possibility of operating Comet 4s across the North Atlantic. They did not know at that time when Pan American would introduce jets on this route, but it seemed more than likely that PanAm might first put their early J57-powered Boeing 707-120s on the Atlantic rather than on to their Caribbean and South American routes. B.O.A.C. had to be prepared for this challenge, not simply for reasons of prestige, but because any airline exclusively offering jets across the Atlantic in the thin-traffic winter months—or in any season—is obviously going to get most of the business. So the Corporation had another look at the Comet 3 Atlantic "paper-jet" studies done four years before, applying the improved capabilities of the 4. Could such an operation be commercially and economically feasible? It looked like it. Between

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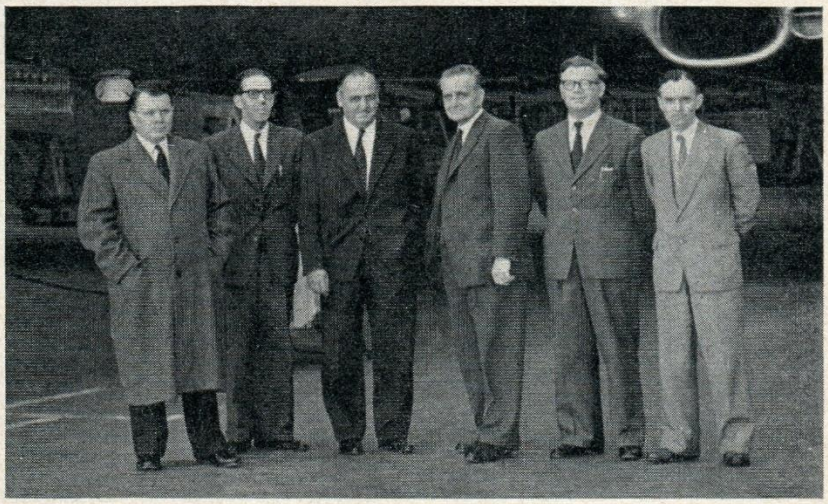
MEN IN CHARGE

COMET FLYING STAFF

(Left to right) Capt. T. B. Stoney, Flight manager; Capt. R. E. Millichap, deputy flight manager; Capt. J. N. Weir, chief of flight operations; Capt. B. G. Wallace, officer i/c training; Capt. A. P. W. Cane, special duties (technical manager).

COMET ENGINEERING STAFF

(Left to right, below) Mr. F. W. Jokiel, senior technical officer; Mr. F. E. Hart, base engineer; Mr. C. Abell, chief engineer; Mr. G. Halliday, superintendent of projects; Mr. R. J. McNaughton, maintenance survey engineer; Mr. T. Campbell, base foreman.



London and New York it was reckoned that the 4 might be able to lift 10,000-lb payloads in the winter and 12,000-lb payloads in the summer, with one stop on a high percentage of occasions westbound, and non-stop on a high percentage of occasions eastbound. In recent weeks, however, it has become clear that the 4 is, to quote B.O.A.C., "better than the book"; and there are hopes that considerably better payloads can in fact be carried.

Meanwhile, until last April plans were that inaugural services would start with daily flights to Australia. Target date was set for February 1959, assuming that four or five aircraft would be delivered by de Havilland by the end of 1958. But some time during April it appeared certain that PanAm were in fact going to put their 707s on to the Atlantic, and furthermore that they were going to do so in the autumn of 1958. It was decided to modify the Comet 2E programme—which by then was nearing completion—so that it could provide transatlantic jet experience. Instead of flying to Beirut and back, why not to Keflavik, Gander, the Maritimes, and the New York area? Because all but two of the 2E pilots were ex-Constellation—the Eastern-route aircraft to which the majority of ex-Comet 1 pilots had been transferred in 1954—the Flight's transatlantic route-experience was limited.

So towards the end of April 1958, Capt. Stoney got the go-ahead to switch 2E flying westwards across the Atlantic. There was only a limited number of 2E hours left to do, so the Ministry-owned 2E G-AMXD was withdrawn, and the revised programme concentrated on B.O.A.C.'s own 2E G-AMXK.

It was reckoned that eleven captains would be needed for initial Comet 4 services to New York. These eleven were dubbed the "Atlantic spearhead"; they were the first to be trained and they were given priority on all flights. The 2E programme was arranged in three phases, as follows:—

Phase 1: Eleven daily return flights to Gander, routed via Keflavik westbound. Each of the eleven "spearhead" pilots took part in four of these flights. Crewing was mixed so that everyone got experience of let-downs at Keflavik and Gander. After that exercise, which lasted for about 12 days, the aircraft went into the hangar for four days for the installation of Dectra. When this was completed the programme entered Phase 2, the idea of which was familiarization with the Maritime alternate airports, with the aircraft based on Gander.

Phase 2: Eight three-day trips, the first day of each consisting of a flight to Gander; the second being devoted to sorties from Gander to the Maritime airports of Goose and Stephensville, Sydney and Moncton, and return to Gander; and the return flight to London being made on the third. Then, having thoroughly cleared themselves at each of these Maritime airports, the crews were ready to branch further afield.

Phase 3: The plan here was to get to know the airports in the New York area. Eight further trips were made, as above to Gander on the first day, the second day being spent practising approach and let-down procedures at New York, Baltimore, Montreal and Boston.

No actual landings were made at New York—just the odd

touch-and-go, which was sufficient for the purposes of the exercise. All the pilots concerned were most impressed with the helpfulness of the American A.T.C. people. At first, because of the growing resistance to jet noise, there were certain reservations about procedures. For example, no approaches below 1,000ft were permitted. But after the New York authorities had been given data on Comet noise tests at Hatfield, these restrictions were relaxed, and the 2E was accepted as part of the normal traffic pattern. Not only did the 2E crews learn a great deal, but the American airport authorities in turn learned a lot about jet procedures and requirements in general. In particular, Baltimore were most friendly and co-operative: as one senior pilot said, "It has always struck me as appropriate that the name of that airport is Friendship." Crews always made a point of thanking everybody at all airports for their help before departing, and generally back came remarks like: "A great experience working with you." On one trip officials of the American C.A.A. and the Airways Modernization Board were given a ride to inspect the Decca/Dectra system; they saw how the 2E crews were able to employ the Flight Log not only for the Atlantic crossing but also in the Maritimes and New York areas, using the existing Decca chains.

The Comet Flight had trained eleven captains and six co-pilots by the time Comet 4 services began. For the record, and because B.O.A.C. have probably been too modest about the jet route-flying experience of their Comet 4 crews, it is appropriate to sum up this experience. When Comet 4 services began the Comet Flight had eleven captains all of whom had between 500 and 1,000 Comet 1 operational-service hours. Each had around 700 Comet 2E hours under route conditions, all of those hours having been accomplished during the previous 12 months. And each pilot had flown a minimum of 120 Comet 2E hours on the Atlantic route, and was familiar with all the alternates, A.T.C. procedures (including the language, which on the other side of the Atlantic is not always the same). Finally, each pilot had done routine Comet 4 conversion-flying, averaging six hours, at Hatfield and at London and Bedford. Conversion of 2E pilots to the 4 was, incidentally, perfectly simple; the two types have at least some of the same engine-type and handling qualities; the main dissimilarity —which in this case makes little difference from the pilot's point of view—is the greater length of the 4's fuselage. Transition was merely the mechanical business of take-off and landing.

It is true to say that when the 2E programme was completed last July, the Comet Flight felt in a very strong position indeed. If someone had said at that time, "Go ahead and operate," and had Comet 4s been available, services could have been started immediately. B.O.A.C. had in fact based their plans for an inaugural transatlantic service on a December 1 start; but, as is now well known, de Havilland produced the goods—delivering two aircraft on the contract date instead of one. This meant that B.O.A.C. were at once in business, and, as things turned out, they were able and ready to start services on October 4, nearly two months ahead of the original target date.

The training programme goes on and, indeed, will not be completed until December 1959. Ex-Comet 1 pilots with no 2E experience will have a ten-hour Comet 4 conversion course and check-flight and a minimum of three flights over the Atlantic route, including local flying and visits to all the alternates. Pilots with no previous jet experience will have a 12-hour conversion course, a check-flight and two or three route flights, according to the service.

The Flight has been hampered by the lack of a Comet 4 flight simulator, which is expected next April; but they have improvised very well with a converted Stratocruiser simulator. This now incorporates the Comet 4's Smiths flight system, which because of its newness could have been a bottleneck in the flying training programme. Most pilots will agree that there is nothing more disconcerting than sitting in a new type of aircraft in front of unfamiliar instruments. The Stratocruiser simulator was so controlled by the instructors that it could perform like the Comet in speed, rate of climb and—the most important operational feature of the jet—rate of descent. In addition, all the New York procedures were incorporated. Everyone spent between six and 12 hours on this simulator. There was also an arrangement with B.E.A. whereby Comet crews spent time on one of their Link trainers fitted with the Smiths flight system.

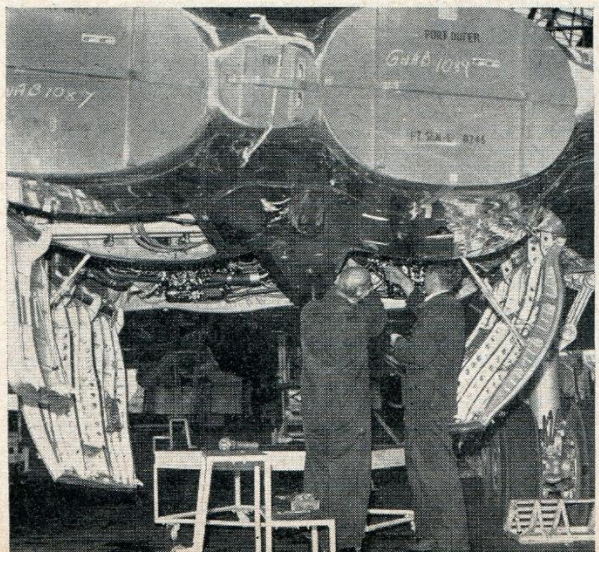
The Comet 4 flight-planning technique remains flexible, and will be improved as experience is gained. To start with, all flight-plans will be on the basis of a cruise-climb, as opposed to the stepped-climb, technique. On the 2E exercises pilots always asked A.T.C. for cruise-climb clearances, for as yet there is no commercial traffic at Comet cruising altitudes; but such clearances were by no means always granted. Often, because of military traffic, the pilots had to do 2,000ft or 4,000ft stepped-climb cruises —and sometimes even constant-height cruises—with considerable penalties in fuel as a result. For example, a 2,000ft stepped-cruise between London and Gander could cost 1,000 lb of fuel, which means five fewer passengers between London and New York. This is the crux of the jet's problem, and the reason why clearances to cruise-climb are always sought. The neatest answer is, of course, workable lateral-separation instead of vertical separation. Dectra, as fitted in one of the 2Es, showed pretty convincingly how this can be achieved; and B.O.A.C. can only hope that, in time, all airlines will adopt the system; obviously, lateral separation can work only if all carriers install the necessary equipment.

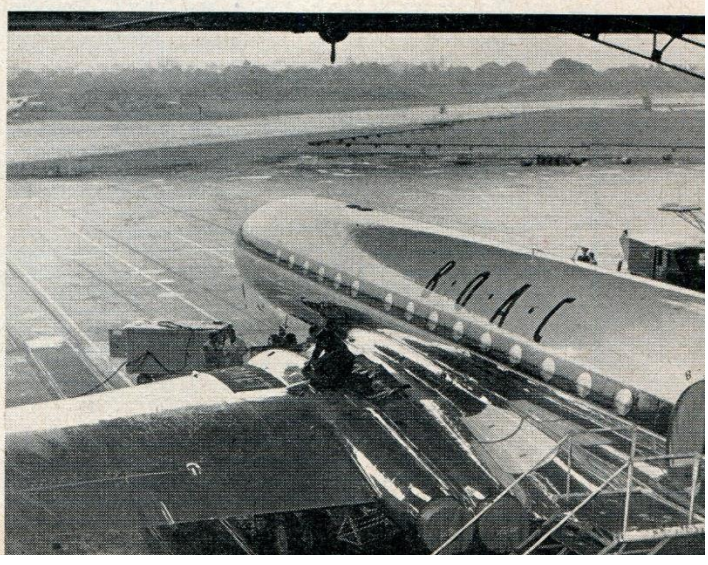
An entirely new flight-planning system has been devised for the Comet 4. Based on a cruise-climb, it provides for a cruise-climb to overhead destination, a continued cruise-climb and a descent to 1,000ft over the alternate. At this point sufficient fuel is reserved for holding at 20,000ft for $1\frac{1}{4}$ hr to $1\frac{3}{4}$ hr, depending on the sector. For example, on the sector to Keflavik the alternate is Prestwick; the flight plan is to arrive overhead Keflavik with fuel to permit a return to 1,000ft over Prestwick, where fuel for $1\frac{1}{2}$ hr holding at 20,000ft will still be available.

In practice, assuming that the destination and the alternate are open, there need be no worries about using some of the reserve—if, for example, a stepped-climb cruise has to be made or if headwinds are stronger than forecast. If in any particular circumstances the captain feels that the reserve is being run down too far he can decide to land *en route*. This, of course, he can do in the Maritimes between Keflavik and New York, though for obvious reasons not between London and Gander. If the captain flying this critical sector is not happy with the weather at Gander and all its alternates he can divert *en route* to Keflavik, or return to Shannon. In the last resort, and assuming the crossing has been made out of H.F. contact with Gander, he can get to within V.H.F. range of Gander and *still* return to Shannon with 15 min fuel for holding.

Westbound, it is likely that there will be one stop on around 85 per cent of occasions, and two stops on the remainder, though

(Left) Wide underwing access-doors allow much Comet 4 maintenance to be performed at shoulder height. Here two B.O.A.C. engineers, working in the forward outer access door of the four under each pair of Rolls-Royce Avon RA.29s, are attending to services on the inter-engine fire-wall. (Right) Taken in B.O.A.C.'s No. 5 hangar at London Airport last week, this photograph gives an indication of what is now the daily round of the Corporation's maintenance. Overwing maintenance is limited to a single engine services access panel above each powerplant. White wing-root panels enclosing passenger dinghies are a feature of B.O.A.C.'s Comet 4s.





Study session in the Comet 4 cockpit. The First Officer is indicating the flying-control hydraulic system change-over levers.

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in the event this may well be bettered. Eastbound, the procedure will be to flight-plan from New York to Shannon, with London as the alternate—a slightly different concept than flight-planning non-stop to London. Whether or not this plan is adopted will depend on winds and payload. Probably the only factor which will prevent the direct New York - London flight will be the weather conditions at London. On training flights full tanks (70,600 lb) will be carried, but on commercial services the operation will be gradually refined until the optimum figure for the season and the sector concerned can be determined. Flight-planning has been deliberately biased towards fuel, for the good commercial reason that, as experience is gained, it is always better to be able to say to the commercial department that you can carry more, rather than less, payload.

Plans for the expansion of Comet operations are now fairly firm. As is well known, B.O.A.C. intend to work the Comet Flight hard—up to an annual utilization per aircraft of nearly 4,000 hr within two years. About the middle of next month, probably, services to New York will be stepped up to once-daily frequency. Next May a four-times-weekly service to Tokyo will begin. By September, Hong Kong and Singapore will be served and by December five services a week to Sydney may be started. Early in 1960 services—possibly daily—to South Africa are envisaged, followed by others across the South Atlantic to South America.

In their Comet Flight B.O.A.C. appear to have built up a team of exceptional calibre and spirit. Each member is a devotee of the Comet, an aeroplane that always seems to extract superlatives from the people who work with it. In the coming years a great deal is expected of the aircraft and the team behind it: evidence for this is the planned utilization-rate—higher than any previous B.O.A.C. aircraft, and indeed as high as is achieved by the equipment of any long-haul operation—and in the world-wide route-network which B.O.A.C.'s Comets will open.

KOLIBRIE COMPLICATIONS

TWO members of the Board of the Nederlandse Helicopter Industrie, G. F. Verhage and J. Meyer Drees, recently offered their resignations. The reason (writes a Dutch correspondent) seems to be that lack of orders for the H-3 Kolibrie helicopter, which they designed, has involved the company in financial difficulties. Up to now 14 Kolibries have been built but only four sold (to the Israeli Air Force), and the Royal Netherlands Air Force have decided not to buy the Kolibrie as it is too small for their purposes. Resignation of the two directors, says our correspondent, "could mean the end of this very promising aircraft, as well as of the company who build it." There is, however, some hope (he adds) that things may be settled; and there is a chance of additional orders for spraying operations next spring.

AGARD MEETINGS

CONVENING in Copenhagen on October 23, the 13th AGARD aeromedical panel meeting is to hold a two-day symposium on *Escape and Survival*. About 15 papers will be presented.

At the eighth general assembly of AGARD (Advisory Group for Aeronautical Research and Development), which is also being held in Copenhagen (October 28-29), there is to be a round-table discussion on *The Impact of Space Technology on NATO Research and Development*.

Among papers to be presented will be *Biomedical Aspects of Space Flight*, by Brig-Gen. Don Flickinger, Director of Life Sciences, Air Research and Development Command, U.S.A.F.; and *Structure and Material Problems*, by Richard V. Rhode, Assistant Director for Research, NACA, and John C. Houbolt, Langley Aeronautical Laboratory, Langley A.F.B., Va.

I.G.Y. DATA CENTRE

A THIRD World Data Centre for Rockets and Satellites is now operating at the D.S.I.R. radio research station at Ditton Park, Slough, Bucks. Previously there were only two such centres, in Moscow and Washington, and it was agreed at the recent Moscow meeting of the I.G.Y. special committee to accept the British offer of another one.

As many of the I.G.Y. experiments are concerned with investigations of the ionosphere, and studying the travel of radio waves from satellite transmitters is one way of gaining information about it, Ditton Park forms an appropriate location for a data centre. Its workers and those at its Singapore sub-station are engaged in such studies, together with scientists at the Post Office Radio Station, Banbury, the Cavendish Laboratory at Cambridge University, the Great Baddon laboratories of Marconi's Wireless Telegraph Co., the R.A.E. Farnborough, the R.R.E. Malvern and the Admiralty Signals Research Establishment, Portsdown.

C.A.I.-I.A.S. MEETING

AT the 1958 joint meeting of the Canadian Aeronautical Institute and the Institute of the Aeronautical Sciences, held in Ottawa on October 7-8, technical sessions were devoted to aero-medicine, aeroelasticity, propulsion, environmental testing, aircraft actuating systems, materials and test flying. Principal speaker at the banquet on October 7 was Mr. Elwood R. Quesada, chairman of the U.S. Airways Modernization Board. The following papers were presented:—

Aeromedicine: *The Design of Training Equipment*, C. P. Seitz, Grumman Aircraft Engineering Corp; *Functional Mockups for Aircrew*, M. G. Whillans, Biosciences Research, Defence Research Board; *Recent Studies of Human Requirements in Hypersonic Escape*, A. W. Hetherington, Directorate of Life Sciences, A.R.D.C.

Aeroelasticity: *The Use of Models in Aeroelastic Analysis*, J. McKillop, Engineering Div., Avro Aircraft, Ltd.; *The Flutter of Low Aspect Ratio Wings*, W. P. Targoff and R. P. White, Jr., Cornell Aeronautical Laboratory; *The Aeroelastics of Tall Stacks*, R. A. Boorne, Mount Allison University.

Propulsion: *Design and Applications of Mach 4 Turbine Engines*, M. A. Zipkin and R. E. Neitzel, Flight Propulsion Lab. Dept., General Electric Co.; *Rocket Propulsion in Canada*, R. F. Wilkinson, Explosives Wing, C.A.R.D.E.; *Powerplant Design Considerations for VTOL Jet Transports*, Martin J. Saari, Lewis Flight Propulsion Laboratory, N.A.C.A.

Environmental Testing: *Environmental Simulation, Its Meaning and Value in System Testing*, C. A. Mills, Electronics Div., Canadian Westinghouse Co., Ltd.; *The Ordnance Corps Envanal System*, H. M. Bunch, Environmental Research Sect., Southwest Research Institute; *Operational Value of Test Specifications*, E. B. Moss, Canadian Applied Research, Ltd.

Aircraft Actuating Systems: *Pneumatic Actuating System for 1,000° F. Operations*, John A. Osterman, Advanced Systems Research, Georgia Division, Lockheed Aircraft Corp; *Design of Hydraulic Systems for High Speed Aircraft*, D. Royston, Engineering Div., Avro Aircraft, Ltd.; *The Rôle of Electrical Actuating Systems in Supplementing Sea Master Flight Controls*, H. C. Zachmann, Electronics and Electrical Dept., The Martin Co.

Materials: *Close-tolerance and Other Special Forgings*, W. Morgan, Research and Metallurgy, Canadian Steel Improvement, Ltd.; *Thermal Insulation Ceramic Coatings*, A. V. Levy, Material and Process Section, Marquardt Aircraft Co.; *Ultra High Strength Steels*, W. B. F. Mackay, Atlas Steels, Ltd.

Test Flying: *Broad Outline of Aircraft Feel: Pilot's Appreciation*, W. J. Potocki, Avro Aircraft, Ltd.; *Piloting Research Aircraft*, J. Walker, High Speed Flight Station, N.A.C.A.

On the day following the joint meeting, the first meeting of the Astronautics Section of the C.A.I. was also held in Ottawa. Papers read and discussed were: *The Clock Paradox*, W. F. Campbell, National Research Council; *Propulsion Systems for Space Travel*, Dr. H. S. Ribner, Institute of Aerophysics, University of Toronto; and *Guidance and Control*, R. D. Richmond and D. Bogdanoff, Canadair, Ltd.