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The Outlook is Black Boxes

ELECTRONICS have traditionally been regarded as an annoying and troublesome mystery. Formerly nobody could tell when a black box would contract some alarming sickness and go dead, or even emit wisps of smoke. The only cure seemed to be to carry the thing off to some electronic witch-doctor's den for the performance of protracted rites with complex equipment and experienced cunning. There was no question of relying on a black box to perform a vital control function.

But this stage is passing. Automatic pre-flight check-out, self-monitoring and fault-tracing, built-in redundancy and, most important of all, vastly improved basic reliability, promise to make black boxes predictable and trustworthy—and the very innovations which bring these benefits greatly reduce the size and power consumption, and even, in some cases, the cost of the equipment.

The capability of black boxes has also expanded. The first failure-surviving systems, though still based largely on elaborate multiplication and redundancy, are being entrusted with the entire responsibility for safety in brief, but critical, periods of flight. Electrical signalling may well soon replace mechanical flying controls on certain production aircraft. At least one receiver incorporating microelectronics offers a mean time between failure better than 30,000 hours. Engineers are cautiously alluding to "fit and forget" procedures. Who knows how far such developments will take us in 20 years' time? *Flight International* has for years recognized the trend by devoting to such developments special annual reviews such as that which we now present.

NASA is Five

THE first day of this month was the fifth birthday of America's National Aeronautics and Space Administration. NASA was born with a mouthful of silver spoons, represented by five space-probe projects, three satellite programmes, Project Vanguard, and all of what had been the National Advisory Committee for Aeronautics (including four major research laboratories). In 1960 the Administration acquired the whole of the Army Ballistics Missile Agency, together with its redoubtable director, Dr Wernher von Braun.

Within twenty-four hours of its formal establishment NASA had a staff of 8,400 people—the nucleus from which its present payroll of 30,000 has grown. Instead of four major research centres there are now ten. The budget in fiscal year 1959 was 339 million dollars, and for the year 1964 Congress has authorized 5,350 million.

Mr Karl G. Harr Jr, president of America's Aerospace Industries Association, remarks that NASA was established to achieve the toughest technological task America has ever attempted, namely the exploration of space. He says: "Whatever 20/20 hindsight may prove in the years ahead, NASA's incredible successes in its brief existence, in terms of solving scientific, technological and managerial problems, earn a front rank position in twentieth-century accomplishments. In simplest terms, man has discovered more about the universe around him during the half decade of the space agency's existence than in all previous recorded history."

All of which is true; and we convey congratulations not only from ourselves but from the growing readership of this journal, who week by week turn with mounting enthusiasm to the pages which record the greatest of all man's adventures.

WORLD NEWS

HSA-Dornier Co-operation

Negotiations are in progress between the MoA and the German Ministry of Defence, and between Hawker Siddeley and Dornier, concerning possible collaboration in developing a VTOL aircraft. News of this collaboration—referred to in *Flight International* for September 26—was given officially in reports from the German MoD on Tuesday of last week and in a Hawker Siddeley statement the following day, which said that its object "would be to pool the experience available in the two countries. On the German side Dornier are already developing the Do31, a light V/STOL aircraft for the German Ministry of Defence." The statement continued:

"Hawker Siddeley have also carried out extensive light VTOL transport aircraft studies in the de Havilland Division. Both companies have basically the same concept of powerplant configuration for such an aircraft. This is a combined installation of two wing-mounted jet engines for level flight and pure-lift engines in lift pods on the wings—the thrust of the wing engines being deflected downwards during take-off and landing.

"The first stage of the planned collaboration would consist of a combined feasibility study which would clarify the possibility of co-ordinating German and English research requirements. As a result of this study, a combined development would be proposed, which would serve as a basis for further discussion between the two governments.

"From the present state of discussions it can be expected that the two countries will reach a successful and mutually beneficial agreement on close collaboration in the VTOL transport field."

Transall Rejected

On October 11 the Federal German Defence Committee in Bonn voted against ratification of the Franco-German agreement for joint production of the Transall C.160 military transport aircraft. The Committee called instead for a technical evaluation of the Lockheed C-130 Hercules.

The latter is an excellent aircraft, and in many respects the C.160 resembles a twin-engined version of it (the engines are 6,000 h.p. Rolls-Royce Tynes built by a European consortium). Nevertheless, the European aircraft has been specially designed by France and Germany to meet their own needs, and its flight-test and manufacturing programme is well advanced.

Potez Buy the PT6

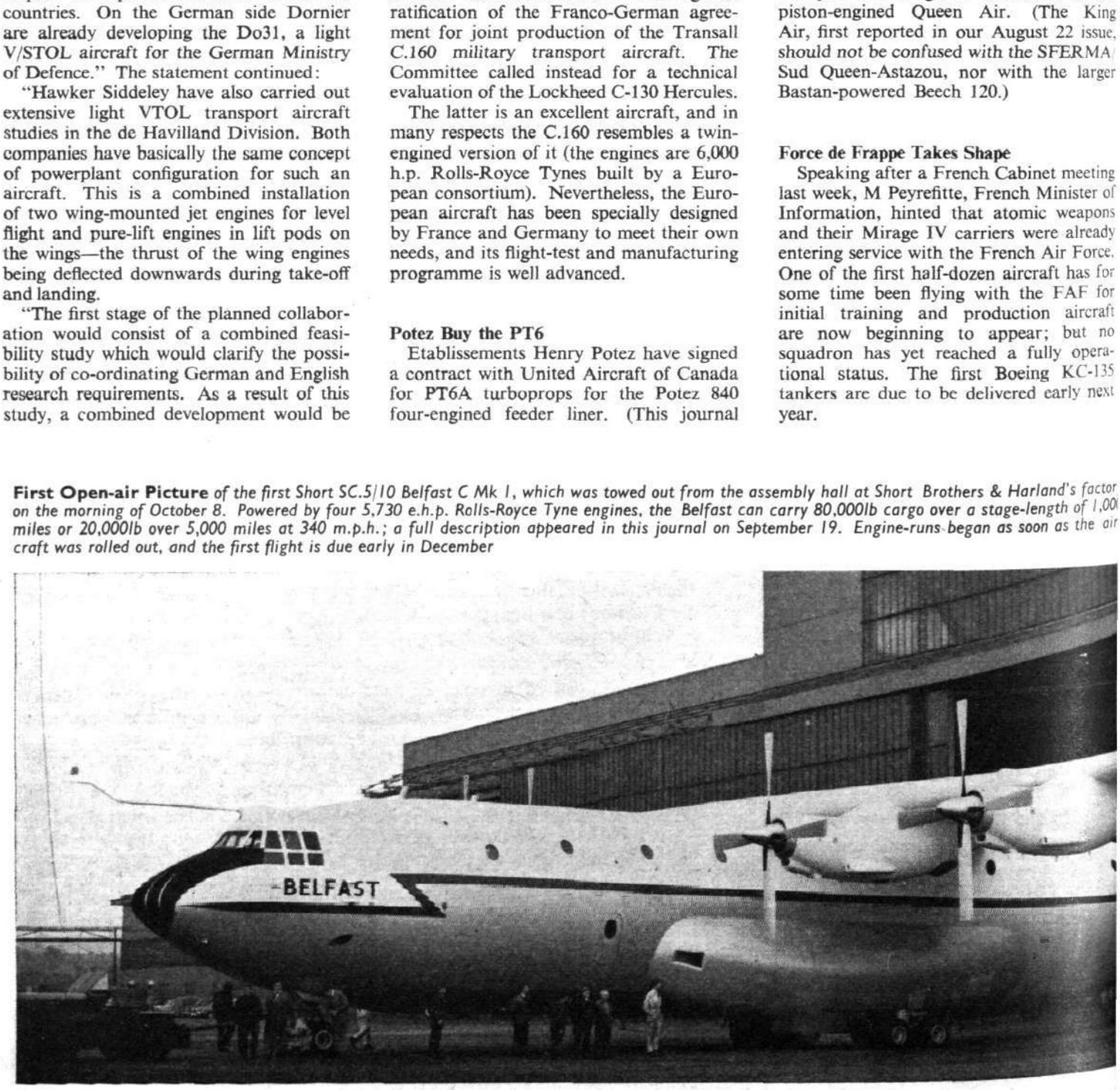
Etablissements Henry Potez have signed a contract with United Aircraft of Canada for PT6A turboprops for the Potez 840 four-engined feeder liner. (This journal first reported the possibility of a PT6-engined Potez 840 on November 1, 1962.) The initial order involves one set of powerplants to be used for conversion and certification of one aircraft.

United Aircraft of Canada have developed the 550/600 h.p. PT6 primarily for low-cost propulsion of light aircraft and helicopters, and have also achieved sales in surface applications. Earlier this month Beech Aircraft announced an initial production batch of 200 of the new PT6-powered King Air derivatives of the piston-engined Queen Air. (The King Air, first reported in our August 22 issue, should not be confused with the SFERMA/Sud Queen-Astazou, nor with the larger Bastan-powered Beech 120.)

Force de Frappe Takes Shape

Speaking after a French Cabinet meeting last week, M Peyrefitte, French Minister of Information, hinted that atomic weapons and their Mirage IV carriers were already entering service with the French Air Force. One of the first half-dozen aircraft has for some time been flying with the FAF for initial training and production aircraft are now beginning to appear; but no squadron has yet reached a fully operational status. The first Boeing KC-135 tankers are due to be delivered early next year.

First Open-air Picture *of the first Short SC.5/10 Belfast C Mk 1, which was towed out from the assembly hall at Short Brothers & Harland's factor on the morning of October 8. Powered by four 5,730 e.h.p. Rolls-Royce Tyne engines, the Belfast can carry 80,000lb cargo over a stage-length of 1,00 miles or 20,000lb over 5,000 miles at 340 m.p.h.; a full description appeared in this journal on September 19. Engine-runs began as soon as the air craft was rolled out, and the first flight is due early in December*



First Air-to-Air Portrait *of the BAC One-Eleven short-haul jetliner. On Monday, October 14, this first example had flown 42 times and logged a total of 70hr 10min, with very satisfactory results. Powered by two Rolls-Royce Spey turbofans, the One-Eleven has been purchased by eight airlines and negotiations are in progress with many other customers*

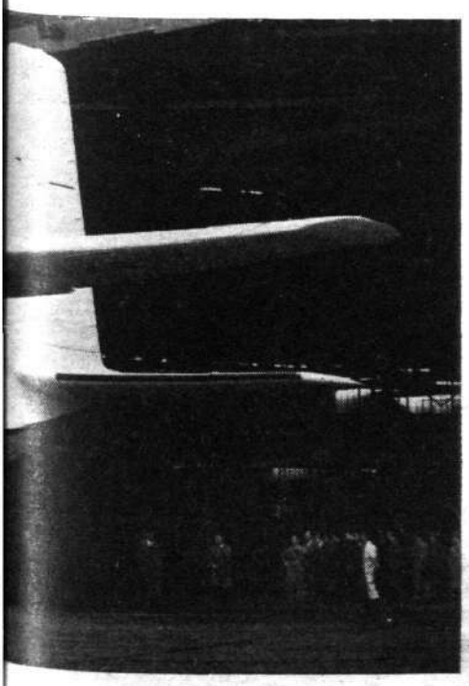
"Divisionalising" BAC

British Aircraft Corporation have formed a new wholly owned subsidiary, British Aircraft Corporation (Operating) Ltd, which will take over the whole of the business at present carried out by four BAC subsidiaries, Bristol Aircraft, English Electric Aviation, Hunting Aircraft and Vickers-Armstrongs (Aircraft). From January 1 next year these companies and their facilities will become divisions of the new operating company, and be known respectively as British Aircraft Corporation (Filton Division), BAC (Preston Division), BAC (Luton Division) and BAC (Weybridge Division). The existing Guided Weapons Division of BAC also becomes part of British Aircraft Corporation (Operating) Ltd. [In each reference in the foregoing passages we use the initials BAC for the sake of brevity.]

BAC chairman Lord Portal of Hungerford says in a message to employees that the change will result in the disappearance from the aviation industry of four well-known and honoured company names, but that it is "an inevitable step towards the declared object we have always had in view, namely to integrate all our resources as fully as possible in the interests of efficiency, flexibility and stability."

The directors of British Aircraft Corporation (Operating) will be Sir George Edwards, chairman and managing director; Mr J. E. Armitage, Viscount Caldecote, Mr A. H. C. Greenwood, Mr J. Harper, Mr A. W. E. Houghton, Mr G. E. Knight, Mr W. Masterton, Mr F. W. Page and Mr W. A. Summers, with Mr J. O. Charlton as secretary.

Respective chairmen and managing directors of the four new divisional companies are: BAC (Filton), Mr J. Harper; BAC (Preston) and BAC (Weybridge), Mr A. W. E. Houghton; BAC (Luton), Mr. W. A. Summers. Lord Caldecote is chairman and managing director of BAC (Guided Weapons).



Garrett-AiResearch T76

The Garrett Corporation, for many years a leading producer of small gas turbines, has announced its intention to enter the field of aircraft propulsion with a 600 h.p. turboprop. Designated T76 by the US Navy Bureau of Weapons, the engine is a fixed-wing derivative of the AiResearch 331, which since 1961 has been flying as the powerplant of a Republic Lark (Alouette) helicopter. A free-turbine version of the 331 was projected, but the T76 is a single-shaft engine with a three-stage turbine, each stage being produced from an identical casting complete with blades and machined to one of three different overall diameters.

Specific fuel consumption of the T76 (presumably at maximum power at sea level) is given as 0.614 lb/hr/s.h.p., and the shaft speed at maximum power is 41,730 r.p.m. Dry weight is approximately 260lb, giving a power: weight ratio of 2.31. Engines are being tested with a Hartzell three-blade 8ft propeller and also with a Hamilton Standard 7ft 6in propeller. The 50hr preliminary flight rating test is due next month, by which time the power section of the engine will have run some 9,500hr.

Ryan Flap-blowing Contract

A stored-energy system of boundary-layer control which could improve aerodynamic characteristics of aircraft during landing and take-off will be studied by Ryan Aeronautical Co under a $200,000 research contract awarded by the US Army's Transportation Research Command. Air will be drawn in through slits ahead of the flaps, boosted by jet-pump action and ejected through blowing slits over the flaps and ailerons. A similar arrangement is provided for the tail surfaces.

The system is to be powered by stored compressed air. Fuel will be injected with the air and ignited, and the resultant expansion will provide the required energy for the jet-pump operation, permitting the system to function without extracting power from the engines. Engine-driven pumps will recharge the compressed-air tanks during cruise.

Ryan state that the stored-energy system "appears to have many advantages, including the ability to extract energy from the aircraft's engine in small amounts over an extended time during cruise flight and store it, and the ability to provide full BLC power independent of the engines, even during a total power failure emergency." The system is being investigated for possible application to Army aircraft. Modification of a YCV-2B Caribou is envisaged in follow-on phases of the programme.

Business Flying Centre at Tollerton

Tollerton Airfield, Nottingham, is to be developed as a centre for private and executive flying by Truman (Aviation) Ltd, who have been granted a 75-year lease on the airfield by Nottingham City Council. Improved aircraft and radio maintenance facilities will be provided, in addition to new catering services including restaurants, bars and a motel.

The company already acts as agent for Piper aircraft in Britain, and has carried out a large amount of charter flying for local business men and industrialists. It is hoped eventually to establish at Tollerton what the company describes as the first British "Fly-in Mecca" for the executive and private owner, on the lines of the American general-aviation centres.

AIR COMMERCE

IATA Holds Court in Rome

By the Air Transport Editor

Scene in the Palazzo dei Congressi, Rome, at the public opening session of the IATA annual meeting

AS last year, when fare-cheating was the theme of IATA's Dublin meeting, history will give a tag to this year's IATA a.g.m.—the nineteenth—in Rome. It was the first time that racial politics had contaminated the Association's discussions—but more of this in a moment.

Count Nicolo Carandini of Alitalia, the host airline, laid on a five-day party for some 250 delegates and wives that awesomely rivalled the nationalistic quality-competition of previous years. The social side *has* to be good to attract the top people of the world's airlines, because they do not really come to these meetings to work. There are working sessions, certainly, and these are taken seriously enough for a NO ENTRY TO THE PRESS notice to be pinned to the doors. But the working papers are all circulated to airlines in advance, and the a.g.m. usually approves without dissent the reports of IATA's committees and—though not this year—the nomination of committee members.

The highly civilized and expensive social arrangements could be dismissed with a sneer as a smashing junket, but the cynics know nothing of the knots that get untied and the ideas that are fertilized over a quiet drink between presidents in a hotel suite or at some social function. It is good for the industry and its chiefs that they can have this relaxed summit meeting each year. Though these a.g.m.s are called IATA's parliament the atmosphere is more that of a court than of a debating chamber.

This year there was intrigue in the court: the African airlines, supported by some Asians and for some inexplicable reason by the Communist-country carriers, demanded that the South African and Portuguese airlines should be excluded from any policy-making positions in IATA. The demand took the form of a proposal to remove the South African Airways names from the list of nominees for the legal and medical committees. When the time came to vote (by secret ballot in view of the circumstances) the African *bloc* and its supporters marched importantly out of the chamber to discuss their position. There were 19 of them—Air Afrique, Air Algèrie, Nigeria Airways, Ghana Airways, Air Mali, Air Ceylon, PIA, MEAL, Iraqi Airways, Ethiopian (though not, it is believed, the whole delegation), Suday Airways, Air Guinée, UAA, LOT, JAT, CSA, Cubana, Kuwait Airways, and Garuda. The two grown-up Asian members, Air-India and JAL, did not support the motion—to their great credit. There were said to be 55 votes (out of 93 members) for the South Africans, who were elected.

As Sir William said afterwards. "We have to mind our own business. We aren't entitled to look at a man's politics or his race or his religion. If a body such as ours goes outside its own business it is the kiss of death. It cannot be our business, it cannot be, it cannot." He cited the remarkable record of the non-political Universal Postal Union, which for 100 years had minded its own business.

Chief Dafi, of Nigeria Airways, said afterwards that this was not a matter of politics; it was "a matter of human rights." He wanted IATA to succeed, but it could not "blind itself to what is going on in South Africa, Angola and Mozambique today, This cannot be separated from commerce." In his view it was "a challenge to all those who believe in the rights of man and all those high-falutin' phrases." The initiative had come from the airlines, not from their governments, and they took full responsibility. In answer to a question he said that BOAC could do business with SAA—or the Moon—that was *their* business, so long as it didn't affect Nigeria.

The South Africans and the Portuguese said nothing, though one delegate was heard to remark later "Some of these people have only been in IATA for five minutes and have no professional or technical knowledge of the business. All they can think about is politics. If I could speak better English I would have got up and said that IATA must be free from politics because air transport, of all things, can do so much to improve political relations. The UN is the place to deal with these problems. You do not have to be for apartheid to stay in that hall and make IATA work."

Inasmuch as this silly digression enabled IATA to re-affirm its non-political principles it probaby did more good than harm. Otherwise the meeting passed off harmoniously enough (and with the best-ever public relations arrangements). There was more candour, more critical self-scrutiny. Handing over the presidency to Count Carandini, Mr J. F. Dempsey of Aer Lingus outsparkled all other speakers during the week. Like all Irishmen he talks well; unlike some Irishmen he means what he says. Quoting Plesman's "The air ocean unites all peoples," he said IATA would first have to reconcile the "one world" concept with the "jarring influence of many diverse aviation policies." If aviation policy was to have "a more worthy basis than that of mere power" governments must realize that individual interests were best served by "a generous spirit of co-operation." He did not say that IATA should protect the inefficient, "but we must be wary of equating efficiency with size."

Mr Dempsey was bound to say something strong about the SST, and he did: "I assert that those who advocate the SST and at the same time talk about lower fares are offering us conflicting propositions." In the past, he said, "we have been guilty of some extravagance in discarding perfectly adequate aircraft and plunging

prematurely into re-equipment programmes without exercising sufficient care in counting the cost. We ought to have learned our lesson by now." There was "a very real danger" of diverting money and resources into supersonics, to the deprivation of developments in the economy of existing jets. Would it not be more rational to concentrate on "a short-haul aircraft with low seat-mile cost which would really open up air travel to the peoples of the world?"

Count Carandini, the new president, in a reference obviously aimed at the CAB, said that IATA should not be "opposed or hindered" in its resolutions by interventions of government agencies, though he warned that if the Association did not do something about excess capacity "we must expect governments to take action over our heads." He spoke with frankness about IATA's own failings here: "Over-capacity has caused an enormous drain on our resources, and it continues to do so after four full years of jet operations. To be realistic, we must admit that persistent over-capacity can no longer be attributed to the introduction of new types of aircraft, but primarily to the incorrect planning of the capacity to be offered. . . ."

If substantial fare-reductions were divorced from control of capacity, the industry would revert to public subsidy in one form or another, and would "bid farewell to any hope of health or independence." As for supersonics, these ought to "inspire us to cure the disorders that at present weaken us," so that the airlines might face supersonics "purged of the errors that attended our reception of subsonic jets"—and with a subsonic/supersonic differential fare structure.

Sir Matthew Slattery of BOAC, this year's chairman of IATA's executive committee (the Association's basic authority) made a good impression during the week. At a press conference—one of the few given by delegates—he said he was not so worried as some about the SST, which unlike the subsonic jets would come in a relatively small way and would not replace subsonic jets. There would be a demand, but a limited demand, for the SST, and he was not worried about writing-off subsonic jets by the end of the decade. In answer to questions from the Italian Press he gave the VC10 a big plug (quietness, and take-off and landing speeds), and revealed plans for a VC10 development with Rolls-Royce Medway engines having a 10 per cent improved fuel consumption.

Asked about the South African situation, and whether BOAC would re-route its services there if banned *en route* by African States, Sir Matthew said "yes, we would, probably." BOAC would continue to serve South Africa, and in a way that did not cause offence—"we do business with anybody regardless of race, creed or colour."

Answering a question on ticket swindles, he said that the first episode, a few months ago, had cost BOAC, PAA and TWA a lot of money, BOAC least of all—about $15m. Altogether it might have cost BOAC £10m to £15m at the final reckoning. This was "a big criminal job," related to currency manipulation and gold smuggling; BOAC's security service had discovered a "bunch of international crooks" who went to a small agency with the promise of big group business—all bogus—got one of their men into the agency, and in due course absconded with the money and the tickets. One agency in Milan had lost £30,000, and "if we're not careful we're all going to be robbed."

Left to right: Mr J. F. Dempsey of Air Lingus, who handed over the IATA presidency for 1963-64 to (right) Count Nicolo Carandini of Alitalia, the host airline. In the centre is the Italian Minister responsible for civil aviation, Sr J. Andreotti

Asked about BOAC and Peking, Sir Matthew said that no negotiations were in hand, though the corporation would go anywhere they were asked if it were an economic proposition. They were always being asked to service new places (though the Chinese had not actually asked them) because, like Alitalia, BOAC was the best airline in the world.

News-points from the Meeting

- TAA foresee a requirement for six BAC One-Elevens initially, and 12 eventually, notwithstanding Mr Ansett's proposal to buy four more 727s.
- UAA have a requirement for three One-Elevens, rising to five, from 1966.
- BOAC, Qantas and TCA are working informally together to standardize operational and commercial requirements for the Concorde. The group does not include Air France.
- Some Qantas engineers are not worried so much about supersonic radiation problems, which they feel can be solved, as about upper-air weather and turbulence, on which they feel more knowledge is required.
- Asked which airport authorities had, according to the IATA technical committee's report, imposed noise limitations "arbitrarily and without consultation," Dr Piero Venturini of Alitalia, chairman of the committee, said "New York, Athens, London and others."
- Mr A. H. Milward, chief executive of BEA, said that as a result of increased UK domestic charges BEA's costs would rise by about £⅔m, and he thought it was almost inevitable that domestic fares would have to go up on April 1 by perhaps six per cent.
- Air Cdre Nur Khan of PIA announced plans for a service, probably next April, to London from Karachi via Moscow. These are the first beyond-Moscow rights granted to a non-Communist airline.

BRITISH EAGLE'S UK TRUNK APPLICATIONS REFUSED

AS this issue closed for press it was learned that the Air Transport Licensing Board has refused every one of the British Eagle applications for additional United Kingdom trunk services. At the hearing in August (before the company changed its name from Cunard Eagle) the Board rejected BEA's plea that the applications were *res judicata* and accepted British Eagle's contention that although the general arguments for the applications were substantially unchanged from those employed in July 1961—when the Board first heard domestic-trunk applications from the airline—the possibility of changed circumstances with the passage of time justified re-examination of the situation.

In making its decisions on the key routes of the applications, the Board said: "In 1961 we decided the amount of capacity which, having regard to the many conflicting arguments, a second operator might reasonably be allowed to mount on the London - Glasgow, Edinburgh and Belfast routes and refused to grant a licence for a service between London and Manchester. We have reconsidered the reasons for these decisions and are satisfied that our fundamental approach was sound and need not be modified. In particular, we think that the interests of British civil aviation would not be served by adopting a course which would be detrimental to the financial interests of BEA at a time when these routes are not, and are not likely to be, profitable for some time. We are satisfied that the capacity provided by BEA is reasonably adequate to meet the needs of the public. While it will probably remain the case that at peak times not every intending passenger will be able to obtain a seat this is a common feature of public transport everywhere."

The application for additional capacity on the London - Dublin route was refused because it involves a traffic-rights issue which has not yet been resolved in respect of the services already licensed. Not surprisingly, the Board turned down British Eagle's bid for limitation to be imposed on BEA's services.

One of the main pillars of the British Eagle case was the company's need of the applications for operating an economic viability. The Board emphasized that considerable attention had been paid to this point, but concluded that no weight could be attached to it, noting that the position of British Eagle was "the result of its own acts." Concerning the routes for which the company already had licences, but did not operate, the Board observed that at the 1961 hearing it was told that for the first two years the airline intended to operate the domestic trunk routes with daily Viscount services, and that on this basis it granted the limited-frequency licence. The

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fact that the airline now sought increased frequencies with Britannias was a development for which they were themselves responsible. Regarding the £1.5m commitment for the lease purchase of five Britannias, the Board felt that the granting of traffic licences could have been made a condition of the contract, which in any case had a break clause.

Perhaps the hardest and most surprising of all the decisions is the refusal to grant British Eagle a London - Manchester licence. In view of the traffic density and the high load factor on the BEA services, it is even more surprising viewed against the decision to licence two operators on the London - Liverpool route. The Board granted Starways' application for increased frequency and allowed Cambrian Airways on to the route by making Liverpool an intermediate stop on their unlimited-frequency licence to the Isle of Man. This, it is hoped, will impose its own limitation on Cambrian's London - Liverpool frequency.

THE BATTLE OVER MALTA

LAST week the Malta Air Transport Licensing Authority heard an application by Malta Metropolitan Airlines to operate daily scheduled services from the island to London, to Palermo and to Catania in Sicily. Objecting to the application were Eagle Aviation (British Eagle), BEA, Malta Airways and Skyways.

Owned by a consortium of businessmen with interests in Malta, Malta Metropolitan Airlines operate a DC-4 on charter flights from London Gatwick to various Continental destinations, including Malta. If the application is granted, say MMA, they will operate the services with Britannias purchased from BOAC.

Representing British Eagle, Mr Norman Ashton Hill put forward the objection that since June 1959 the company had held a permit from the Maltese authority to operate a service between London and the island at a return fare of £19. Because the British Government did not grant its approval, the service was never implemented. BEA and Malta Airways also objected to the application because, they said, it would divert traffic from their joint operation, which had been carefully built up to the stage where it now offered an excellent service at very low rates. Mr Maurice Finer, representing MMA, said that the service would be timed to meet the peak demand, which already exceeded BEA's capacity. The return fare would be £33 13s.

IN THE CASE OF FOG

THE Ministry of Aviation has published its report* on the accident involving G-AMJU, a British United (CI) Airways DC-3 at Blackpool Airport on January 25 this year. The aircraft was on a flight from Newcastle with a crew of three—two pilots and a stewardess—and six passengers. During the night landing at Blackpool the DC-3 swung off the runway and its port outer wing was torn off in a collision with a brick hut. There was ground fog at the time, and delay occurred before the emergency services arrived at the scene. None of the passengers or crew was injured.

About ten minutes from the Blackpool circuit, the commander, Capt P. R. Dunt, was told that visibility was 80yd in thick freezing fog about 30ft deep. From the circuit the crew were able to see all the runway lights; the visibility was queried with the air traffic controller, who reported that he had just sent a vehicle to the threshold to check, and that it was still less than 100yd. After completing two more circuits the captain decided that the visibility on the first part of the runway was sufficient for an approach and landing.

The approach was made with half flap and 5kt in excess of the recommended speed in case an overshoot was necessary. At 700ft and two miles from touchdown, all the runway lights were visible, and at 400ft at least half of them could be seen. After the aircraft crossed the threshold lights it entered a layer of shallow fog; according to the co-pilot, the number of lights visible was reduced to four. During the flare-out there was more float than anticipated and the captain switched on the landing lights, thinking there was no longer any risk of mistaking the fog layer for the runway surface; but both pilots were dazzled by the reflection of the light in the fog and lost visual reference.

Under the observations heading, it is remarked that the airline's operations manual included no specific minima for landing at Blackpool. It was assumed that, instead, the circling minima would apply, and if necessary provide an effective approach ban. The report continues: "Since circling minima as defined in paragraph 8.2.4 of the operations manual appear to apply a visibility limitation only in the case of a break-cloud procedure, they would seem *ipso facto* not to apply in this case."

Recommendations of the report are that steps should be taken to ensure that when circling minima are included in operations manuals provision is made for the conditions associated with radiation fog; and that operators of airfields at which transport operations take place in low visibility should be encouraged to take measurement of runway visual range.

* *C.A.P. 196, Her Majesty's Stationery Office, price 1s 9d.*

UNION DE TRANSPORTS AERIENS

AFTER a commercial relationship dating back to the early fifties, and following a decision to merge taken two years ago, the privately owned French airlines TAI and UAT finally became one company on October 1 under the name Union de Transports Aeriens. The formation of UTA with a capital of £2.6m completes the process of integration which began with the decision in September 1961.

The combined fleet consists of six DC-8s, two DC-7Cs, 15 DC-6s, six DC-4s, and six Herons, and the aircraft are being progressively repainted in the company's new colour-scheme, made up from TAI green and UAT blue.

UTA's lengthy network of routes extends to the five continents. The heaviest concentration connects Europe with West and Southern Africa; and, from November 1, Lagos, Accra, Robertsfield and Freetown will be served by DC-8 flights from Paris. Following a government decision, Air France has withdrawn from these areas, leaving UTA as the only French carrier.

The African network will continue to be operated in association with Air Afrique, and the new airline will continue to give technical and commercial assistance to Air Afrique in the manner established by UAT.

4,500hr BETWEEN OVERHAULS

A ROLLS-ROYCE DART 510 has been removed from a BEA Viscount after more than 4,500hr of continuous service since its last overhaul. This is believed to be the longest operating time for which any engine has been left installed in the same aircraft, undisturbed for over two years except for routine maintenance. The 510's currently approved time between overhauls is 4,250hr. A preliminary investigation of the engine has shown it to be in good condition, but other engines will have to be run to the new figure before the new time can be approved for regular operations.

Melbourne got its first look at the Boeing 727 on October 1 when the aircraft called at Essendon Airport during its world demonstration and proving flight. So far eight 727s are on order for Australian airlines—six for Ansett-ANA and two for TAA. Both airlines will simultaneously introduce the type late in 1964

AIR COMMERCE...

An Il-18 of Interflug, showing the airline's new insignia

EAST GERMANY'S INTERFLUG

FROM September of this year the Deutsche Demokratische Republic (DDR) has one civil air transport operator —Interflug. Previously there were two organizations: Deutsche Lufthansa, a national corporation using (as does the West German organization) the old pre-war title; and the Interflug company started in 1958 and which was jointly owned by the Reisebüro, the national travel agency, Deutrans, freight agents, and Deutsche Lufthansa, of the DDR. The new company has the same three shareholders as the original Interflug, plus the Ministerium für Verkehrswesen, the Ministry of Transport.

The General Director of Interflug is Herr Karl Heiland and for all operational matters the company enjoys much the same independence as do those West European national operators which look to their respective Treasuries for finance.

DDR civil aviation policy generally, and Interflug shareholding control in particular, is exercised through the Chief Administrator of Civil Aviation in the Ministry of Transport. Chief Administrator is Herr Artur Pieck, son of the republic's first president.

Under Herr Pieck, who claims to be neither a politician nor an aviator but an administrator, there are four principal departments dealing respectively with Interflug; airports and air traffic control; technical inspection of aircraft; and sport flying and gliding.

The Interflug transport fleet consists of five four-engined turboprop Il-18s, constructed in and bought from the Soviet Union, and 25 twin-engined Il-14s, which are "produced in the DDR."

In addition, for agricultural work—mostly crop spraying—and communications, there are 23 Soviet single-engine An-2 biplanes, and 55 Czech L60s. A number of Mi-4 helicopters are available for contract work, and are principally employed on construction sites, building and repairing chimneys, surveying, or occasional emergency transport of sick persons for the health authorities. The total employment roll of Interflug is given as 2,000. Airport employees and air traffic controllers number another 800.

The civil aviation effort in this part of post-war Germany has been built up virtually from scratch in the last decade. Almost all the aircrew are young men trained with Soviet assistance, partly in the Soviet Union and partly in the DDR under the supervision of, or helped by, Soviet instructors.

The first steps in pilot training are taken in the aero clubs or gliding centres. All young Germans in the Republic, at 17 and after completing the 12-year educational course, can apply to join one of the flying or gliding clubs. No fees or flying charges are payable. The number of gliding club members is currently estimated as 6,000 and another 300 are at the seven powered-flying clubs.

The most promising of the pilots go on for further training in the National People's Army with the possibility open to them of transferring to civil flying. A few selected members of the flying clubs have gone direct to the Interflug training establishment, but it is stated that pilot requirements are met for the time being and there will be no further training next year.

Operations base and headquarters of Interflug are at the central airport Berlin-Schönefeld, which has recently refurbished passenger handling buildings and is some thirty minutes' drive from the city. It has a 3,600m (11,800ft) runway and plans are agreed for a second runway of 3,000m (9,800ft) in a parallel direction. It is intended to use one runway for take-off and the other for landing.

The present Interflug route network of scheduled services connect socialist countries only. Principal services are Berlin - Moscow; Berlin - Warsaw; Berlin - Prague - Budapest; Berlin - Sofia; Berlin - Bucharest; and Berlin - Belgrade - Tirana. There are also internal services which radiate from Schönefeld to Erfurt, Leipzig, Dresden, and to Barth on the Baltic. In the summer season there are also services from Dresden and Leipzig to the Baltic coast.

One intriguing aspect of Interflug operations, as with the air services in the Soviet Union, is the economic result. Do they pay or are they subsidized? No balance sheets are available for inspection but the answer given to the direct question is that Interflug is "self-supporting." Surpluses made have been invested in the company. But of course it depends upon the definition of terms. Capital for the purchase of equipment is loaned by the State, and the British corporations may care to know that no interest is payable on these loans. Amortization is over an eight-year period.

The fare structure is estimated to be based on rates somewhere between IATA's tourist and first-class fares, with a 10 per cent group fare reduction, and a further reduction on inclusive tours. There is also an agreement between the socialist airlines of Eastern Europe which provides for a 50 per cent reduction on standard fares for, as far as can be ascertained, all nationals travelling between these countries. This agreement may well be the reason for the high load-factor which is claimed to be an average of 80 per cent.

The DDR earnestly want more connections with the Western countries—and not just for economic or narrowly political reasons. They want contacts with other people. Interflug emphasize that they have 22 general agreements with other operators and 28 interline agreements, but they seek more. Only six foreign companies fly scheduled services into Schönefeld and they include Aeroflot, Lot, CSA and Malev. But with pleasure they tell of non-scheduled flights by Transair, Flying Enterprise, Nortair, Finnair, Kar-air, AUA, KLM, Sabena, and SAS. They are deeply disappointed that this list does not include BEA. Although the then Minister of Aviation made a somewhat ambiguous remark to the Commons in March 1960 about there being no "prohibition" on flights to Leipzig, the fact is that political and not commercial judgment has been the deciding consideration. The potential traffic of course is not large. An estimated 1,000 people travelled to Leipzig from the United Kingdom for the 1963 spring fair.

On the point of British trade, DDR civil aviation authorities say they will be interested in certain airport equipment and explain that their landing system at Schönefeld is British.

AIR COMMERCE...

JAL REORGANIZATION

FROM the beginning of October, Japan Air Lines have become effectively merged with Japan Aircraft Maintenance Company (JAMCO). The merger has been made in the interests of more efficient and economic maintenance of JAL's fleet in Tokyo. At the same time there has been a general reorganization of the airline's administration, operations, and maintenance departments in Tokyo. As a result of the merger, JAL's capital has increased from £12.5m to £13.5m, and the number of employees from 5,300 to 8,000.

LONDON LIGHTS

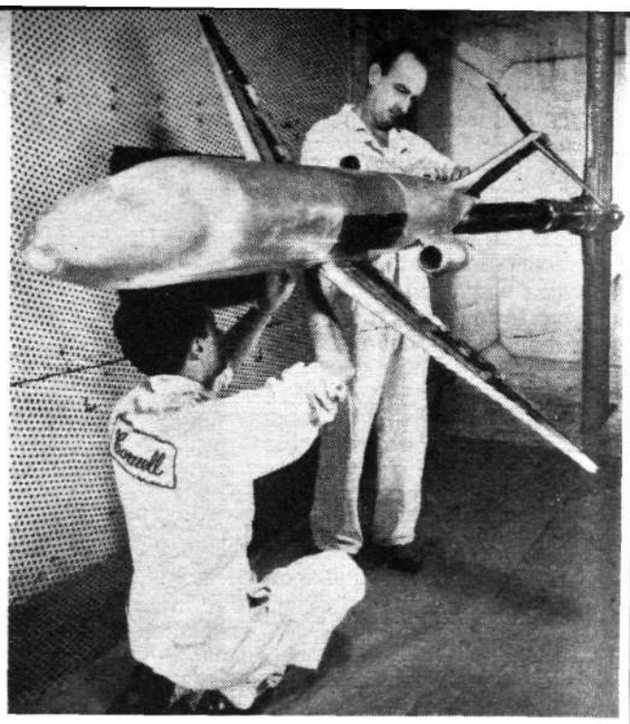
THREE new systems designed mainly to improve taxiway conditions are to be experimented with shortly at London Heathrow. The first of these is the fitting of the existing green taxiway lighting with a flashing system which should greatly enhance its value in poor visibility conditions. Up to now this invaluable centre-line lighting has only been clearly visible at night, but the new installation, with a xenon tube flashing at about one-second intervals, will assist the safe taxying of aircraft both in the brightest sunlight and the murkiest gloom.

A new type of light for taxiway indication is the subject of a second experiment. Originally known as "button lighting," it consists of a shallow aluminium fitting $\frac{7}{8}$in high, strong enough to allow aircraft to pass over it, and bonded to the surface of the taxiway instead of being connected to the usual deep lighting pit. Apart from the obvious saving in time and manpower, it is estimated that the cost is only about one-fifth that of the conventional system. This makes it especially suitable in areas where no lighting has previously been fitted and where the cost of excavation for normal installation would be prohibitive.

Thirdly, new directional signs in the form of illuminated arrows at taxiway intersections, operated from the control tower, will simplify direction-finding for pilots of taxying aircraft by day, particularly where foreign-speaking aircrew are concerned. This is a modern development of daylight route-indication, a system which has been in use at Heathrow since 1954.

EMERGENCY EVACUATION

UNITED AIR LINES have challenged the validity of recent FAA tests aimed at determining whether 189 passengers can be evacuated from a PAA thrift-class Boeing 707 in an emergency. A test was conducted by Pan American in New York recently for the FAA and the CAB, as anticipated in a note in these pages on October 3. United, in objecting (mainly on economic grounds) to PAA's proposed California - Hawaii thrift-class fare, asked the CAB to consider the emergency evacuation problem, which has always been uppermost in the mind of their president, Mr W. A. Patterson. In a letter to Mr Najeeb Halaby of the FAA, Mr Patterson said that the experiment had ignored five major criteria, according to UAL observers present at the experiment. They said that no effort had been made to comply with UAL's request that the test include: (1) performance of evacuation duties by crew members; (2) selection of a respresentative, normal passenger "mix" which would have old people and children as well as able-bodied adults performing the evacuation; (3) clearing of the aircraft without assistance from anyone other than crew members, and only using equipment normally employed in actual evacuations; (4) utilization of life vests and launching of life rafts to simulate a water ditching; (5) establishment of a minimum 90sec for complete evacuation. Mr Patterson also told Mr Halaby that Pan American staff participating in the evacuation were all vigorous, able-bodied individuals.



A six per cent scale model of the DC-9 being tested in the Cornell Aeronautical Laboratory's transonic wind tunnel at Buffalo, NY, at speeds up to Mach 0.9

Bilateral News Ghana and Algeria have signed a civil aviation agreement. At the other end of the Mediterranian, the Lebanese Government has said that it is in an advanced stage of negotiations for bilateral agreements with Cyprus, India, Iran and Kuwait, and that discussions have started with Afganistan, France, Iraq, Ivory Coast, Nigeria, Pakistan, Sudan, and Tunisia.

NEA Viscounts Auctioned At the auction of ex-Northeast Airlines Viscount 798s at Logan Airport, Boston, on October 5, Aloha Airlines, Hawaiian Airways and Mr John Mecum, a Texan, each bought one aircraft. The remaining six were retained by the Irving Trust Co of New York, who have acted as trustees under an equipment trust agreement between NEA and Vickers. The nine realized a total of £1.15m, and it is reported that Mr Mecum paid £103,000. Nine spare Rolls-Royce Darts brought in £25,000, and £1,000 was paid for a quantity of spares.

The fifth Hawker Siddeley Trident, seen at Cairo during recent hot-weather trials. The aircraft is in the Far East until the end of the month and, although the trip is primarily part of the route-proving programme, the opportunity will be taken to give a number of demonstrations to interested airlines

Auctioneer Aaron Krock, arm raised, calls for bids as the nine ex-Northeast Airlines Viscount 798s were put up for sale in Boston. (See news item, p. 638)

FAA SCEPTICISM ON THE SST

THE United States Senate Aviation Committee was yesterday (October 16) due to begin a review of progress on the US supersonic airliner programme. Witnesses are being called from airframe and engine manufacturers and the Federal Aviation Agency. Unrefuted speculation circulating among delegates to the IATA meeting in Rome suggested that other major US airlines, including American Airlines and TWA, are about to place orders for Concordes. Obviously there is a growing feeling amongst operators that the United States SST programme is going much too slowly, and that the Concorde is going to enter service with a clear lead.

Recent statements by the FAA's Administrator, Mr Najeeb Halaby, show a hardening of the Agency's attitude to SSTs in general, and scepticism about certain important technical features of the Concorde. On the subject of supersonic bangs and possible US restriction, Mr Halaby predicted that a future administrator of the FAA might say: "Congress has told me they will not permit sonic booms of greater than 1.6lb of over-pressure, and, Mr Concorde, you are creating 2lb of over-pressure. So we will ban the Concorde or any like noisy aeroplane from US skies."

Apart from the question of choosing the most promising design and manufacturing organization for the United States SST—a decision not scheduled to be made before May 1, 1964—there remains almost a deadlock on arrangements for financing the programme. Mr Halaby has said that the Government should not contribute more than 75 per cent of the cost, the rest coming from private industry. Industry has already said that the £25m investment represented by a 25 per cent share is more than it can afford.

Turning to a technical feature of the Concorde already widely criticized by people in the American industry, Mr Halaby said the FAA were not sure that the heat and creep resistant properties of the aluminium structure would allow of three transatlantic trips a day at Mach 2.2 with a life of 30,000hr. In an article in *The Times*, Dr A. E. Russell, head of the BAC team on the Concorde, replied to Mr Halaby's criticism in the following terms: "The remarks might be true of the aluminium alloy used in current subsonic airliners, but this was not the alloy being used in the Concorde. We have selected a type of aluminium alloy used in aero-engines for many years. It has lower ultimate strength properties under cold conditions, but it has very good resistance to prolonged high temperature and shows no deterioriation of properties, including creep, for an indefinite period at 120°C and hardly any sign of creep up to 150°C." Dr Russell said that in the areas where skin temperatures would exceed 120°C, such as near the engines, titanium would be used. "We have actually tested about 10,000 samples of different materials, and we are still going on collecting more and more information. At Bristol Aircraft alone we have 24 testing machines continuously in operation, and some of the materials have so far been tested for over 20,000hr without signs of any serious deterioration."

BOAC Appoint "Commercial Ambassador" Mr John Combe, formerly executive assistant to the BOAC general manager for western routes, has been appointed the special task of developing contracts with the higher management of British business houses and industry.

QANTAS IN 1962

QANTAS results for the year ending March 31, 1963 show a record profit and revenue for a trading year. Net profit was £A1,406,246 after provision for taxation of £A492,776, compared with a profit of £A408,817 in the previous year. The net profit was after paying £A1,301,569 in interest on loans and overdraft mainly to finance purchase of new jet aircraft. Revenue exceeded £A40m.

The airline's chief executive and general manager, Mr C. O. Turner, has said the basic reason for this successful year was the original choice of the Boeing 707-138 aircraft for the mainline fleet and subsequent conversion to the turbofan powered model—the 707-138B "V-Jet." Another most important reason for the profit success was the company's careful cost control, a tribute to capable staff at all levels. A reason for considerable satisfaction was the growth of Qantas traffic. It increased 27 per cent on the previous year, far exceeding the general growth rate of the worldwide industry rise of 16.6 per cent. If Qantas' costs had been on a level with the airline industry average in the generally unprofitable year 1961, it would have shown a loss as so many airlines did, but the aircraft—specially designed to provide just the right-sized vehicle for Australia's world air network—can be operated at a cheaper cost per aircraft mile and therefore requires fewer passengers per service to cover costs. Both the Boeing and Electra fleets gave excellent performance and technical delays at Sydney and other points were reduced from 12 to eight delays for each 100 take-offs.

Two additional Boeing 707s have been ordered for delivery in August and September 1964. The aircraft on order are identical with the present V-Jets, and one by-product of the efficiency and operating economy of these aircraft has been the creation of eight surplus spare engines. The life between overhauls of the turbofan has been progressively increased to the extent that the eight engines can be installed in the two new aircraft from available reserves and thus effect a saving of £863,000 on the capital outlay.

Qantas carried 240,000 passengers during the year, and passenger mileage rose 30 per cent to 978m. Air cargo traffic increased 18 per cent to 32m ton miles.

Mr Turner concluded his statement by saying: "Overall the company's cost structure and financial position is sound and with freedom from international disturbances and the other influences to which the airline industry is so vulnerable, the board and management believes the company is in a good position to obtain an increasing portion of a market that should grow with the lowering of fares and cargo rates."

Pan American Order More 320Cs An order for three more Boeing 707-321C cargo aircraft brings to 11 the total number on order by Pan American. When the order is completed in May 1964, PAA will have the world's largest fleet of jet freighters in the airline industry. The line at present has three jet-freighters in service providing six weekly trips across the Atlantic and three across the Pacific. The total number of Boeing jets delivered or on order now stands at 521, and the total number of 320Cs at 26.

Bomb Detector An experimental device is under development for the FAA for the purpose of detecting bombs which might be stowed away on aircraft.

Scone airfield, the home of Airwork Services Training, is situated in some of the most beautiful countryside in the British Isles

TRAINED IN SCOTLAND

JUST as "trained in Scotland" has become a distinction widely respected in the worlds of medicine, science, and engineering, so also is it gaining significance in the world of civil aviation when applied to the graduates of Airwork Services Training at Perth.

With the recommendations of the Duke of Hamilton's committee on pilot training and the questions of seniority and redundancy now troubling the ranks of professional airmen very much in mind, I recently journeyed north in the *Flight International* Beagle Airedale to meet the staff and students of the school and see how AST is working now that its acquisition of modern aircraft is complete.

AST is divided into the School of Aviation (piloting) and the School of Aeronautical Engineering (maintenance engineering). *Ab initio* entry to either school is possible, and the courses are open to anyone, provided only that he can speak English and (in the case of the pilot courses) medically fit to fly. There are standard courses to meet the requirements for every United Kingdom pilot's licence from the private through commercial to the twin conversion and instrument rating. The scale of fees represents good value for money, because all the flying courses are MoA-approved and so qualify for a reduction in required flying time.

The curricula are arranged to give the most effective instruction in the subjects directly relevant to a particular licence rather than to include a lot of extra-curricula subjects that might be intended to give students a general education. The list of special courses is aimed to fit in with the diversity of experience among potential commercial pilots and the wide range of special duties in civil aviation. It includes: special six/eight weeks' conversion courses for experienced pilots requiring concentrated ground instruction before sitting the technical examinations for the commercial pilot's licence/instrument rating; flying instructor's courses; navigation courses to the standard of the flight navigator's licence; air traffic control courses; and, recently, helicopter training courses.

The numerous courses of aircraft maintenance and overhaul of the School of Aeronautical Engineering are intended to provide training for the Air Registration Board examinations leading to the maintenance engineer's licences.

AST is one of the Air Holdings group of companies and, not surprisingly, many of the United Kingdom students are sent by British United Airways and its associates, or are private individuals hoping eventually to work for one of these airlines. Although obviously well in touch with operators' requirements, AST cannot guarantee to find employment for its graduates. An increasing number of students are sponsored by airlines and air forces outside the United Kingdom. Since Airwork began training ground engineers and flying crews some 28 years ago, the courses have always been popular with students from abroad, and many a fair maid of Perth has lost her heart to the son of an eastern potentate (less romantically a Highland crofter is alleged to have found that one of his sheep had been run over by a Latin gentleman driving an MG).

Any impression that AST is a sausage machine producing licensed nondescripts was soon dispelled during a tour of the schools under the guidance of the principal, Wg Cdr F. D. Nugent, AFC, whilst lecturing was taking place. The students are obliged to live in the airfield accommodation, but there are plenty of sporting and rec-

Left, Wg Cdr F. D. Nugent, principal of AST, talking with two students of the engineering school. Right, Bob Critchley, chief flying instructor, in action

TRAINED IN SCOTLAND . . .

Two students typical of many sent to Perth by overseas airlines: left, Powis Spencer from Ghana Airways and, right, Inderjeet Singh Sekhon from Malayan Airways

reational facilities. The combination of just the right amount of discipline, working and living together as a community of young people, and some of the most beautiful countryside in the British Isles undoubtedly does much to make up for the absence of compulsory extra-curricula studies.

Flying training is now given almost exclusively on Cessnas. Basic dual and initial solo flying are performed on either the Chipmunk or the Cessna 150. The latter aircraft are also equipped with shoulder harnesses and may be spun; and, unlike some comparable American machines, the 150 has plenty of elevator for demonstrating the stall, as well as powerful flaps. Before making the conversion to twin-engined flying, students carry out interim flying on the larger Cessna 175. The venerable Consul and Rapide have at last been retired, and all twin flying is now performed on the Cessna 310. Although the 310 is not the most docile of twins, it is considered a very good training machine by Bob Critchley, the CFI, mainly because of its high performance, but also because the awkward trim-changes do teach a student awareness of such things at an early stage.

Everyone—pupils and instructors—seemed agreed that Perth was a good area for learning to fly. One Malayan remarked that the monsoon will be easy after some of the weather his course had experienced. In general the weather seems to be either very clear or very bad, and the hilly countryside makes a pilot terrain-clearance conscious right from his first solo. Two Hiller UH-12Cs have recently been added to the school fleet, and the first course of students, three pilot officers of the Ghana Air Force, began their helicopter training on September 30.

Articles (e.g., in *Flight*, October 14, 1960) have already described the facilities of AST, and the school publishes a very excellent brochure and prospectus which they send to anyone requiring detailed information on courses and fees. In order to gain an overall picture of the school's character I spoke to a number of the students to find out how they came to be there and what they now felt of their chosen careers. Although I picked them quite at random it is significant that five of the six I spoke to came from outside the United Kingdom. (In fact, it is not unusual for there to be students from over 30 countries under training at Perth at the same time.) Language difficulties, frequently a serious problem in the past, have been largely overcome now that a "language laboratory" has been commissioned. From a knowledge of basic English, a student can be quickly taught an adequate working knowledge of the technical English that will enable him to make a start on a particular course. The laboratory consists of sound-proof cubicles, each with a tape recorder. One tutor then monitors the progress of a number of students who are kept constantly occupied recording answers to questions.

Typical of many overseas students to whom I spoke was Powis Spencer, from Accra. He left school at 17 with passes in the West African School Certificate and joined Ghana Airways as a clerk. Two years ago the airline sent him to Perth to study for the maintenance engineer's licences; he made good progress, and completed the course before reaching the age of 21, which is the minimum for holding this licence. Ghana Airways then decided he should undergo a flying course, and he recently went solo in a Chipmunk after six hours' dual; now he hopes to have the commercial licence and instrument rating by August 1964. Such a preliminary engineering background to a commercial licence is not common amongst students, but it should open up good opportunities in Ghana Airways for Powis Spencer and is a further example of the value in having maintenance and flying schools under the same roof.

Another student who had also made very good progress was Inderjeet Singh Sekhon from Kuala Lumpur, who is being sponsored in his training for a CPL and IR by Malayan Airways. Sekhon first began flying privately with a flying club while working for the Malayan railways, where he became station master at Kuala Lumpur. Sekhon is one of a group of five trainee captains that Malayan Airways have sent to Perth; and, weather permitting, he hopes to complete the course in November. After two years or so flying as a second officer on scheduled services, Sekhon hopes to come back to Perth for the technical examinations leading to an airline transport pilots' licence.

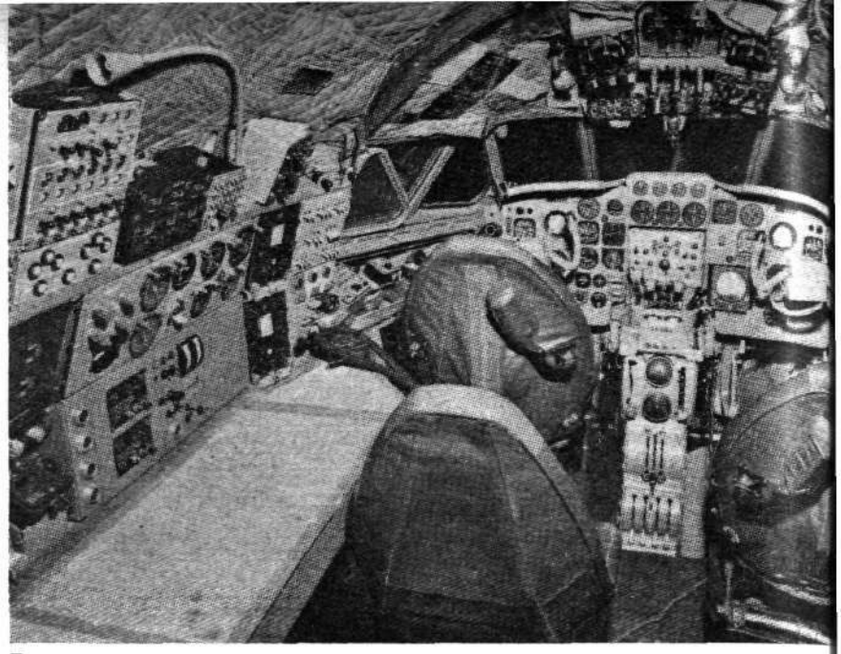
In spite of the present world-wide surplus of commercial pilots, the high quality training services of AST will undoubtedly remain in big demand for a very long time. At the moment, AST and the College of Air Training at Hamble are the only establishments with full MoA approval for commercial pilot training, and between them will be well able and qualified to handle the majority of the 200 new pilots per year which the Hamilton Committee has estimated will be needed in the future.

N. F. G. H.

A hundred and ninety-one students from 35 countries

Aviation Electronics

A "FLIGHT INTERNATIONAL" SURVEY



The BLEU Comet fitted for blind landing development with Smiths multiplex auto-pilot and instrumentation

AS Autumn draws on, the display season comes to a close, this year without the SBAC show at Farnborough, but with two major symposia in the electronics equipment field, namely, the FAA meeting on all-weather operation at Atlantic City and the RAE/EEA symposium on electronics development for civil aviation at Farnborough and Malvern. Both these meetings are extensively reported in this special feature, together with additional information on some US industry projects.

The FAA and All-weather Landing

IT seems that one has only to arrange a meeting to examine the problems of all-weather operations to ensure weather conditions appropriate to the subject. On the opening day of the FAA Symposium on all-weather landing at Atlantic City last month, the weather in the Atlantic City area was so bad that Mr N. Halaby, the Federal Administrator, was unable to arrive in time to make the opening address. When he did arrive, several hours late, his speech was undoubtedly coloured by the fact that his journey from California by Jet-Star had involved five instrument approaches in fourteen hours, including missed approaches at Atlantic City.

Mr Halaby made the plea that, while pursuing the goal of all-weather capability for fully equipped air transport aircraft at major traffic terminals, the requirements of other aircraft at other airfields should not be overlooked. He suggested that progress toward the airlines' objective should also provide benefits in economy and increased safety for all of aviation. The FAA has already made some progress in this direction by designing low-cost ILS installations capable of operation to Phase I weather minima of 200ft and ½ mile. The cost of these installations is $80,000, compared with $260,000 for the previous equipment, so that it should be possible to provide ILS at more airports. It is hoped that this cost break-through will improve instrument approach facilities at many of the world's airports where more sophisticated equipment cannot be economically justified.

The pioneering work of BLEU and the Smiths Autoland conversion of the FAA's DC-7 received a sincere tribute of praise from Mr. Halaby. He indicated that similar systems based on ILS-coupled autopilot, with "glide-slope extension" where necessary, and autoflare using radio altimeters were the first systems likely to enter service on US-registered aircraft, in 1966. The attention of the meeting was directed throughout to the problems of operation at the ICAO and IATA Phase II weather minima of 100ft cloud-base and visibility, or runway visual range, of ¼ mile. There were three major sessions, each followed by panel discussions. The first was devoted to the airborne components of all-weather systems.

Airborne Systems

A tidy international balance was maintained in this field by presenting six papers on airborne systems, three from British and three from United States manufacturers. The first speaker was Mr R. W. Howard of Elliott Brothers (London) Ltd, who concentrated on the design and testing of monitoring systems. Three possible categories of automatic monitoring were discussed, with examples of each type. These were absolute measurement, comparison monitoring and performance monitoring. Mr Howard suggested that each category had its application. The VC10 requirement was explained as automatic failure detection, with failure survival, using only a minimum of redundancy. On the subject of nuisance disconnects, Mr Howard stated that the VC10 system calls for a minimum nuisance-disengagement level of one per 1,000 hours for each cross-monitored section of each half of the complete installation, which should give a considerable safety and confidence level. The conclusion reached in the paper was that it may be possible to increase the reliance placed on automatic monitoring systems, even to the extent of allowing them partial responsibility for overall aircraft safety.

Mr Zeffert, of BAC, in a paper entitled *The BAC One-Eleven and All-Weather Landing*, described the dilemma of the manufacturer of short-haul aircraft. Because of the widely differing requirements of airlines, large and small, a difficult balance has to be achieved between producing an aircraft which is inexpensive and simple to operate and maintain, and one which is capable of matching the weather minima capabilities of the long-haul aircraft when necessary. Mr Zeffert pointed out that the cost of equipping the short-haul aircraft may be as high as nine or ten per cent of the total price, and that this must have a significant effect on seat-mile costs. BAC believe that the systems designed for the One-Eleven should be flexible, ranging perhaps from a straightforward single-channel autopilot to full automatics. There is little doubt within BAC that there will be a customer demand for something which will allow a lowering of minima without going all the way to full blind landing. The interest of Aer Lingus in automatic landing for the BAC One-Eleven was announced and a firm BAC project now exists. Mr Zeffert suggested that the basic design of the One-Eleven lends itself to all-weather equipment by virtue of the duplicated systems of the aircraft. The basic Bendix PB-20D for the One-Eleven differs from the standard equipment in the stabilizer trim-motor and the inclusion of a torque-limiter adaptor unit in the pitch axis designed to limit the accelerating forces due to a "hard-over" while leaving the autopilot with adequate authority. Starting with this basic equip-

BAC ONE-ELEVEN SYSTEM AND LOWER MINIMA

	Barriers to lower minima partially or completely removed by system											Remarks
	1	2	3	4	5	6	7	8	9	10	11	
	a b	a b c d		a b	a b			a b c	a b	a b c d e		
Basic Bendix PB2OD autopilot, with soft pitch hardover characteristic	×									× × ? × ×		Reduced certification break-off height should be possible, relative to current systems.
Split-axis computer Elliott/Bendix autopilot with pitch monitor	×									× × ? × ×		Ditto
Fully fail soft autopilot with autothrottle	× ×	×								× × ? × ×		Further reduction may be possible.
Fully fail soft single-channel autoflare system	× ×	×		× ×					×	× × ? × ×		
Full failure survival auto-flare system	× ×	× × ×		× ×		×	×	× ×	×	× × × × ×		Significant reduction in minima. Phase II system.
All-weather system with duplicate pitch automatics and pilot participation in azimuth	× ×	× × ? ×	?	× ×		?	×	? ?	×	× × × × ×	?	
Full automatic landing	× ×	× × × ×	×	× ×		×	×	× ? ×	×	× × × × ×	?	Phase III system

Barriers to the Achievement of Lower Minima

(1) Flight path disturbances due to autopilot hard-over. 1a, loss of height due to nose-down runaway; 1b, bank angle and heading deviations.

(2) Sudden loss of automatic control and unpremeditated transition from auto to manual control. 2a, complete loss of automatic control in pitch, azimuth and airspeed; 2b, loss of pitch and azimuth auto control; 2c, loss of azimuth only; 2d, loss of pitch only.

(3) Height losses following decision to overshoot.

(4) Limitations due to glide-slope characteristics. 4a, poor low-altitude glide-slope beam characteristics; 4b, vulnerability to loss of glide-slope signal due to ground station failure.

(5) Limitations due to localizer characteristics. 5a, poor low-altitude localizer beam characteristics including susceptibility to overflying aircraft effects; 5b, vulnerability to loss of localizer signal due to ground station failure.

(6) Excessive pilot work-load causing deterioration in safety.

(7) Inadequate instrument aids for safe pilot management of the system.

(8) Lack of aircrew confidence in the system. 8a, due to demanding nature of the task imposed on the system; 8a, due to lack of adequate educational and training programmes; 8c, due to inability to demonstrate system safety.

(9) Inadequacy of height information. 9a, barometric altimeters—inaccuracies due to lag, position error variation with incidence and ground proximity, vulnerability to incorrect barometric setting, instrument errors, inherent lack of sensitivity; 9b, radio altimeters—dependent on reasonable terrain characteristics under last phases of approach path.

(10) Aircraft characteristics unfavourable to lower minima. 10a, high approach speed; 10b, poor cockpit view; 10c, bad ground-effect; 10d, marginal lateral stability on approach; 10e, unsuitable control circuits.

(11) Lack of roll-out guidance or control.

AVIATION ELECTRONICS . . .

ment as Stage I, five possible further steps or stages can take the One-Eleven through to full autoflare, with autothrottle, failure survival on pitch-axis automatics and suitable situation displays.

This "package" would relieve the pilot of two of his main tasks, control of pitch and of speed, and leave him only with the task of making a manual transition in azimuth at about the point where flare-out is initiated. The flare-out system will be based on the BLEU exponential-flare law, preceded by an "attitude-hold" phase, though the latter should be of short duration.

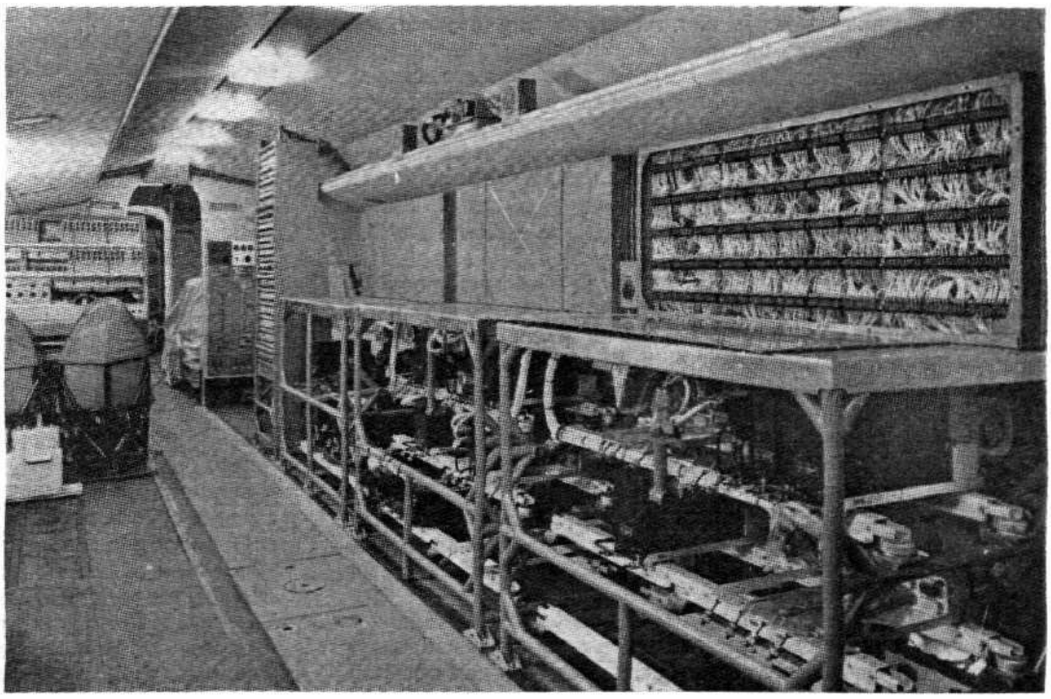
Fully automatic landing would require an additional monitored azimuth channel, two azimuth computers, monitored localizer receivers and an improved instrument display. As described by Mr Zeffert the One-Eleven programme at various levels should meet the needs of many operators in an economic and practical way.

Mr McKinlay of Smiths Aviation Division outlined the history of Smiths all-weather operations from the mid-1950s through to the present BEA Trident programme and with the Comet 2E trials, which are aimed at establishing the validity of the conclusions reached in work with the Varsity—a much simpler aircraft. The work involved in retro-fitting the system in the Comet was described. Special mention was made of the operational requirement that the flight director system should duplicate all the facilities available from the autopilot, and that they should be selected simultaneously on a common flight controller.

The autothrottle system uses airspeed signals in conjunction with pitch-rate. As became evident later, there are many choices of input for an autothrottle system and the protagonists of angle of attack, "raw" or processed, had a great deal to say on the subject in subsequent sessions. Mr McKinlay made the point that each sub-channel of the automatic control system is capable of flying the aircraft unaided, and that this can be a valuable asset after failures. In this single-channel, reversionary mode conventional protection is provided against hard-overs.

The "proof of the pudding" for multiplex autolanding autopilots will be when they have been shown to perform within a defined range of operational conditions. This will entail a working-up phase of about two years if 25 to 50 aircraft are involved. It is hoped to record photographically as many landings as possible and to supplement this with pilot questionnaires and airborne flight recorders when available. A Smiths film which showed equipment check-out techniques using SADIE was clearly of great interest.

Mr Utterstrom of Boeing described the 707-720-727 lower weather minima programmes, which of course introduced the problem of retro-fitting as well as of introduction of new equipment on an



Equipment racking, junction boxes and recording equipment in the main cabin of the BLEU Comet

existing production line. Being the first US paper, it also highlighted the difference of opinion between the UK and US manufacturers. The UK is convinced of the need for eventual operation to Phase III (zero-zero) standards and of the requirement to rely for the purpose on multi-channel automatics. Many people in the US see the programme stopping short of Phase III capability and, for this reason, feel they will be able to avoid multiple-channel equipment. The role of failure- and performance-monitor in this concept stays firmly with the pilot rather than with the automatics.

Boeing believe that the ability to operate to Phase II standards can be economically achieved now, and firmly plan to introduce certain equipment into production 707/720 and 727 aircraft. Flight tests in fog conditions at Arcata and elsewhere lead Boeing to the conclusion that visibilities of 750ft would form the practical lower limit, so long as cross-winds did not exceed 10-15kt and the aircraft was accurately aligned at a height of about 70ft. From this height the pilot would have enough visual references adequately to monitor or conduct the flare. The Boeing philosophy required automatic touch-down capability for Phase II minima and "go-around capability from any height including after touch-down." It is hoped that manual approaches can give the same results as automatics, and further study of split-axis operation and improved pilot displays is planned. The economic cost of survivable electronics was discussed, and a parallel was drawn with the Boeing 707 electrical system in which all four independent generating systems had been put out of action by a statistically remote "common event." There is, however, a good deal of common ground among designers on the use of ILS glide-path extension schemes, passive failure autopilots, centralized and improved failure-warning devices and ground-proximity indication—radio altimeters. Progress in windshield rain removal was stated to be necessary, and a film of the Boeing system showed that considerable improvements in visibility are obtainable by the use of such equipment. Speed control, or autothrottle, is regarded by Boeing as being a customer option.

Experience with the Caravelle

The Lear-Siegler presentation by Mr K. C. Kramer included some interesting reports of problems encountered during the Caravelle programme for Sud-Aviation. Vertical wind-shear of the order of 30kt per 100ft, and lateral wind-shear of 15kt per 100ft were encountered at Toulouse. As the "standard" maximum wind-shear is only 4-6kt per 100ft it is understandable that lateral deviations and "firm" touch-downs were experienced. Although some people expressed surprise at Mr Kramer's figures, they were substantiated by flight recorder traces showing speed- and throttle-variations and excessive elevator activity which are difficult to explain with any other theory. Lear have now devised a new concept of glide-path control to counter the vertical wind-shear problem; and their new lateral coupler dispenses with runway-heading reference, and has been "optimized" for directional localizers. Mr Kramer stated that when the all-weather landing computers are engaged, all major autopilot signals are switched out of the existing autopilot and into the all-weather landing system. The only parts of the autopilot used during final approach are the servos and servo amplifiers. Other features of the Lear system include radio altimeters, hard-over failure protection, and "path monitoring." Autothrottle control and manual or automatic de-crabbing are also probably included in the system.

Tests of an automatic "go-around" mode have been completed and the feature will be incorporated in the production system. A separate output will be provided for an instrument display if manual "go-around" is desired. The instantaneous vertical velocity signal (barometric vertical rate plus vertical accelerometer) is used to command a rate of climb which can be achieved with one engine inoperative. It is expected that when this lower rate of climb has been firmly established the pilot will continue the climb with some other mode of operation. Lear consider that it is possible for an aircraft to descend 30-40ft below the minimum altitude before establishing a positive climb, this height being lost during the two seconds pilot-decision time at 10ft/sec, plus a continued descent for 1.5sec after "go-around" has been initiated.

Lear propose to make available to the pilot the same computer outputs as are being used by the autopilot, and to display these on flight-director instruments. Some success has been achieved in a preliminary examination of the use of localizer beam-error and runway heading for controlling the ground roll through the rudder. That Lear's philosophies are acceptable has been demonstrated by Alitalia's decision to retro-fit the equipment to their Caravelles. Certification of this system for Phase II operations is expected in early 1964.

The Douglas proposals as outlined by Mr Wilson described the DC-9 equipment, but added that the system would be suitable for any turbojet aircraft. Mr Wilson suggested that the basic DC-9 package called only for the addition of autothrottle, flight-instrument monitor, autopilot monitor, dual radar altimeters, dual "go-around" computers and dual vertical speed references to give the aircraft Phase II (100ft and ¼ mile) capability. The only items not duplicated would be the autopilot and the autothrottle system. Douglas propose to programme a linear decrease of ILS signal gains in the later stages of an approach to achieve autopilot stability. Glide-path beam-distortion at low altitudes is handled by glide-path extension techniques based on memorized vertical speed. This phase is initiated manually by the pilot or by passage over the middle marker. The glide-slope signal is linearly programmed to zero during this stage, thus retaining maximum stability.

The instrument monitor activates the pilot's and co-pilot's master warning lights on the glareshield and illuminates an associated light on an annunciator panel. Inputs to this monitor system include those from compass system, pitch attitude, bank attitude, localizer and glide-slope receiver.

The "go-around" computer uses angle of attack and horizontal accelerations to compute a safe pitch-attitude command for the pilots' display; and the same inputs can be used to compute speed-command during an approach. The speed-control system can also act as a monitor of autothrottle and can command the airspeed necessary to maintain a given stall-speed ratio for any aircraft weight, flap configuration or "g" manœuvre. The same signals will serve the autothrottle system operating through individual clutches for each engine. Manual over-ride capability is provided by friction slip clutches.

It was stated that the DC-9 systems lend themselves to operation in Phase II weather minima. The aircraft has no pitch changes with changing thrust, and has good performance, stability, and handling characteristics.

During the subsequent panel discussion a number of pertinent comments were made. Mr McKinlay thought that it was extremely difficult to make monitoring systems as reliable as the automatic controls. Douglas are looking at the present division of tasks and responsibilities between the two pilots, and anticipate increased demands on pilot skills, with an attendant requirement for better training. The FAA stated that they are examining the potentialities of DME co-located with ILS, and its value in the monitoring role. Flight simulators have been used to measure the performance of "go-around" computers, some of which used SCAT (Speed Command, Attitude Target) instrumentation. SCAT, made by Safe Flight Instrument Corp, uses angle of attack together with forward acceleration sensed by a pendulum referenced to the pitch gimbal of a vertical gyro.

Sub-system Development

This session of the symposium was opened with a Sperry presentation on autothrottle systems. The paper pointed out the limitations of an autothrottle based on plain airspeed and "raw" angle of attack, or processed angle of attack. Problems encountered included excessive throttle activity, poor speed-holding and excessive persistent errors caused by gusts and wind-shear. Very good performance has been obtained by using airspeed *and* accelerometer signals to provide tight airspeed control in wind-shear conditions with minimum throttle activity, while retaining angle of attack as a long-term reference to cope with flap configuration changes. An incidental benefit of such a system would be to provide a fail-safe sensor feature.

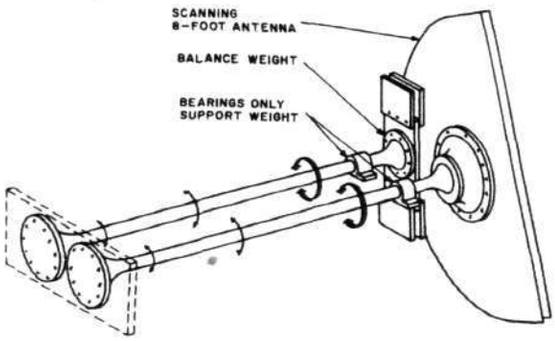
The Bell company suggested the use of their ground-based precision radar landing system as an independent monitor for airborne systems based on ILS. It was suggested that by keeping the monitor ground-based, the weight and cost penalties of equipping a fleet of aircraft for all-weather operations would be considerably reduced. The proposed system is based on the AN/GSN-5A produced primarily for a naval carrier-landing requirement.

Information on the position of an aircraft relative to the required flight-path within two miles of touch-down would be acquired

by precision radar, and be then digitally encoded and transmitted to both the pilot and the air traffic controller so that each could monitor the progress of the approach.

The next system to be described was the "second generation" guidance system proposed by Airborne Instruments Laboratory who have received an FAA development contract. Major difficulties encountered in the use of conventional ILS for approach and landing include the gap in elevation guidance from 100ft to the runway, the most vital stage in the procedure and the one during which the flare-out and landing are performed. The frequencies used for ILS glide-slope (330Mc/s) make improvement of the guidance in this critical area impossible. By extending the techniques developed for the Flarescan glide-slope, which has been successfully used for actual landings, AIL have been able to plan a system which offers substantial advantages over all current ILS installations.

The new system provides complete landing guidance information, both in the aircraft and on the ground. Narrow scanning pulse-coded micro-wave beams are transmitted from two ground sites to provide azimuth and elevation guidance. These same ground stations receive radar reflections from the approaching aircraft, which can be displayed for ground monitoring or for back-up PAR capability. An additional facility, precision DME, is integrated into the system, using an airborne interrogator-decoder and a ground-based transponder. The DME system-delay is adjusted to



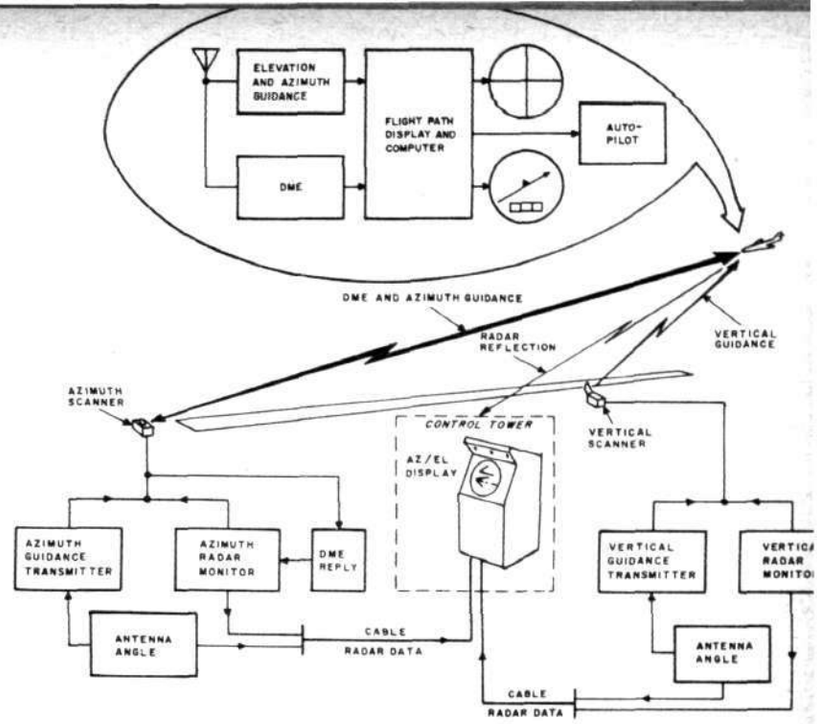
The resonant torsion bar mechanism employed in the oscillating elevation aerial of Flarescan

show zero range at a point on the runway opposite the vertical scanner.

The use of scan "inter-lace" whereby radar and beam guidance are transmitted on succeeding scans enables the parameters of each function to be individually optimized. A scan rate of five cycles per second is achieved by a newly developed resonant torsion-bar scanner. The time required for a complete aerial-scan cycle is divided into six time periods. Two are used for azimuth and elevation beam-guidance, two for radar azimuth and elevation, and one for DME, leaving one spare for the possible addition of a second elevation beam from a second site. The entire system operates on a single radio frequency in the Ku-band between 5.41 and 15.7Gc/s. On these frequencies beam-guidance requirements can be met at 15 miles range with a transmitter peak power of 2kW. For radar tracking a transmitter peak power of 100kW is used, scan interlace allowing the use of two different transmitters.

The system was described in greater detail than the above brief summary, and appears to meet the probable future requirements by making available more complete information, both to the pilot and the air traffic controllers, than any other system.

Mr Proferes of the FAA described progress to date in the Federal programme to provide improved ILS at various airports. Eighteen directional wave-guide localizers are already in service and 14 more scheduled for installation. The aerial systems have received a great deal of attention in the effort to reduce unwanted reflections from overflying aircraft. A new clearance array under development should provide a continuously available stand-by localizer to cover failure of the primary wave-guide array in Category III installations. A mean time between failure of 5,000hr is expected for a new



Guidance elements of A.I.L. Flarescan, showing its proposed triple functions of beam guidance, PAR-type presentation and DME

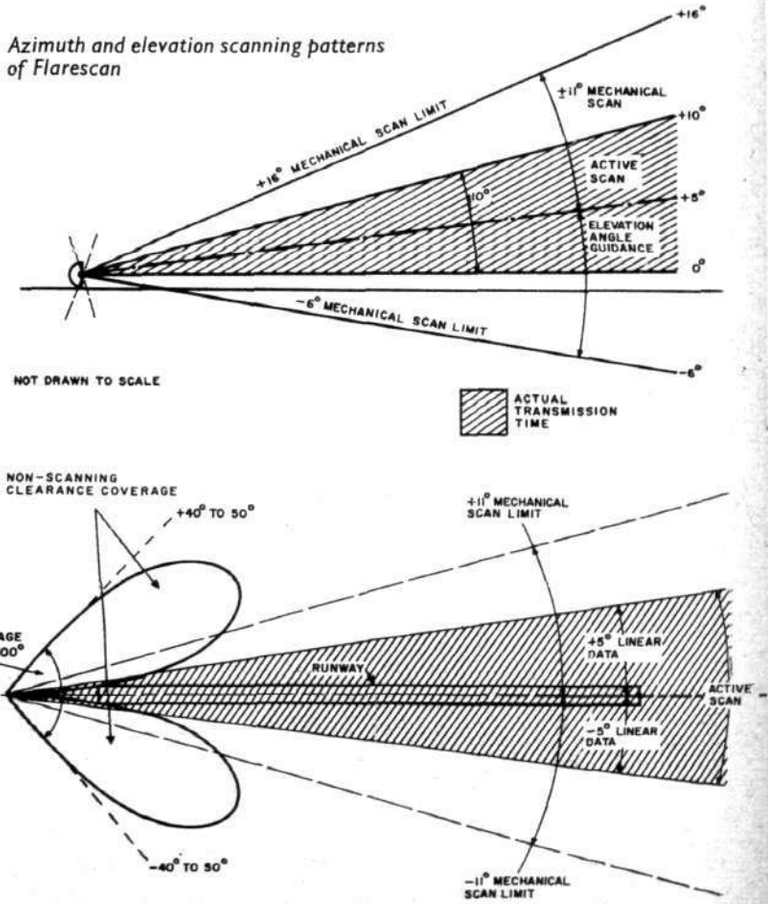
localizer transmitter employing solid-state techniques wherever possible. Similar improvements are in hand for the glide-scope.

A development project for precision DME has the objective of providing accuracies of ± 350ft. Possible applications include provision of position information during the capture of localizer and glide-slope, definition of the touch-down point and of the length of runway remaining. The DME might eventually replace middle and outer markers.

Collins Radio Company described their latest ILS receivers and the contribution they can make to the performance and reliability of the airborne component of the all-weather system. New standards of reliability are being achieved by their solid-state equipment. VOR, localizer and glide-slope receivers are contained within a single ½-ATR package, weighing only 18½lb, and this has encouraged some airlines to specify three receivers for each of their new generation of aircraft.

Power requirements are so low (50W for ILS) that the equipment can operate comfortably from the aircraft batteries in case of electric

Azimuth and elevation scanning patterns of Flarescan



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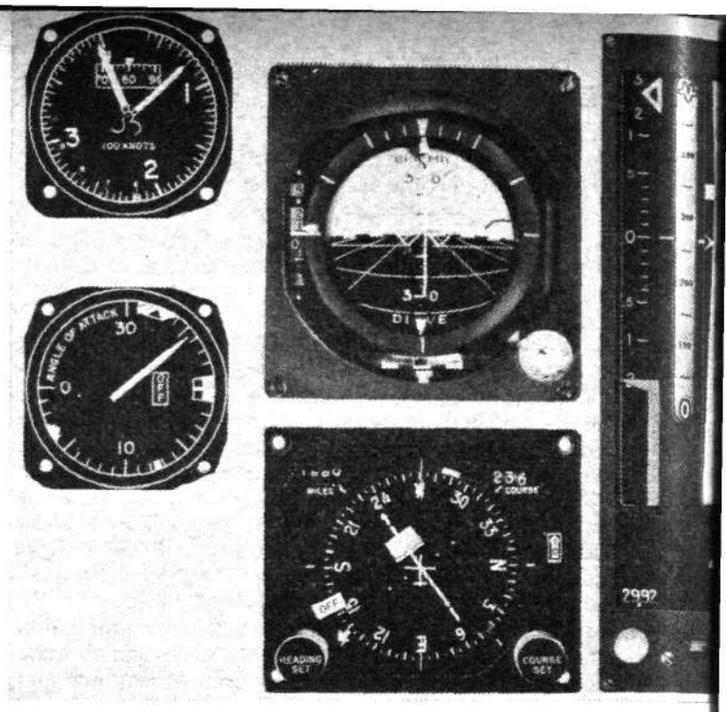
power emergencies. High-powered outputs are available for "super" warning flags and to operate a master warning system. Arrangements are made to bias the glide-slope indicator flags out of sight when VOR mode is selected, so preventing the pilot from becoming used to ignoring the glide-slope flag. ILS self-test circuits are an optional feature. Mechanical positioning and switching have been eliminated by the use of crystal switching with diodes, giving MTBFs of 1,000hr, with the prospect of reaching "fit and forget" procedures. The new marker beacon receiver, for example, has a MTBF of 11,000hr. Reaching these standards of reliability is an extremely valuable contribution to progress towards all-weather operations, and to reduce weight, volume, power requirements and *cost* at the same time is quite an achievement.

Great interest was displayed in the film which supplemented the General Precision Systems presentation on the application of flight simulator techniques to all-weather landing problems. Mr Douglas Wilson described the activities of BEA, BLEU, and GPS in their joint effort to explore pilot performance and the effect of different cockpit procedures on that performance. The equipment being used in the programme is the BEA Comet simulator with GPS visual flight attachment.



Improved instrument display for the captain's panel of the FAA DC-7 fitted with Smiths single-channel Autoland. The tapes show height rate, and barometric and radio height

Operational Aspects

The final session of the symposium was devoted to an examination of the operational aspects of the various current development programmes. Mr J. C. Morrall's description of BLEU experience in operating aircraft in runway visual ranges less than 400yd was supplemented by film sequences of actual landings at London and Bedford. As a later speaker commented, very few pilots have flown at less than 100ft in visibilities less than 400yd, and almost all of them are from BLEU. The film sequences indicated the need for improved airfield ground-aids to help in alignment, flare-out, landing, roll-out and taxying. Windshield rain-removal equipment was also shown to require further effort because, during some of the approaches, water on the windshield was at least as significant as poor visibility in restricting acquisition of visual references.

Various configurations of approach and runway lighting have been explored, and BLEU opinion has hardened against the use of sequenced flashing strobe or discharge lights. The last 1,000ft of approach lighting and the runway touch-down zone are the areas on which improvements in lighting will be concentrated. It was stated that the standard UK approach lights quickly lose their value as RVR decreases below 400yd; and this is also true of the approach-lighting systems of other countries. Different runways have widely varying surface texture and, in daylight conditions, paint is of at least as much value as lighting. Runway centre-line marking and lights are becoming even more important for both roll-out and take-off. The windshield cut-off angles of modern aircraft are already a limitation, and in this area the Canberra results are much more typical of civil airliners than the Varsity. The forthcoming Comet programme will produce even more valid information. Future BLEU work will include an investigation of head-up displays.

Some experience has been obtained with head-up Zero-Reader type of steering information for landing roll-out. One important point made by Mr Morrall in his concluding remarks was that the visual sector required for monitoring automatic landing may be less than that required for manual control. Some later airline speakers obviously support this view for they propose to operate in RVR as low as 700ft, with full automatics or manual control in one axis.

This last point then proved to be one of the major differences between the airlines. Pan American have decided, on the basis of results achieved with a control group of pilots, to go for split-axis autopilots. They will stay manual in pitch during Phase II operations and *all* their aircraft fleet will be modified to this end by January 1964. A radio altimeter will be used to provide accurate ground clearance at lower heights.

For operation in what PanAm describe as the lowest "see to land" minima of 700ft RVR, a single-channel automatic system in the form of flare and de-crab computers and autothrottle will be employed. The aircraft fleet will be so fitted by mid-1965. PanAm has closely examined the economic aspects of this programme and the cost per aircraft in equipment and training has been estimated in relation to the expected diversion rate. No decision has been taken concerning zero-zero capability and the airline will wait until it has a good deal of experience with single-channel automatics before making up its mind. It was stated that blind landing capability appears to be justified for the SST.

United Airlines appear to agree substantially with PanAm and they also will use split-axis autopilots (manual in pitch). UAL for some time used a stabilized approach technique in which the landing configuration is used throughout, giving a high-drag/high-power condition with constant angle of vision, and thereby reducing the changes required for flare and landing. The usefulness of cloud-base as a criterion of low minima was challenged—with the support of other airlines—and the use of RVR was advocated. Pilot prerogative of "look-see" was requested and a plea was made for a more logical way of establishing minima for different aircraft types.

UAL paid a handsome tribute to the Caravelle and the Viscount by praising their handling qualities and requesting lower minima for them. The large 5in diameter Collins flight instruments used by the airline were valuable and the advantages of instantaneous vertical velocity indicators (IVV) were to be examined.

TWA's paper was the first to highlight the importance of maintaining an adequate overlap between the commit-to-land point, and "go-around" capability. The airline proposes to use SCAT throughout its operations, i.e., for take-off, rotation, climb-out (including noise abatement procedures), for autothrottle input during approach, and for the flight director display for "go-around,"

SUMMARY OF BLEU FOG FLYING PROGRAMME TO DATE

Year	Number of landings			Number of landings* in different RVRs								Aircraft available for the programme	
				RVR									
	Total	Day	Night	0-100yd		101-200yd		201-300yd		301-400yd		Varsity	Canberra
				Day	Night	Day	Night	Day	Night	Day	Night		
1959	26	26	—	—	—	26	—	—	—	—	—	1	1
1960	34	31	3	6	3	4	—	5	—	16	—	1	1
1961	40	39	1	16	—	14	—	5	1	4	—	2	—
1962	126†	72	54	15	4	32	40	20	10	5	—	3	—
1963 (to date)	29	21	8	11	3	10	5	—	—	—	—	3	—
Total (to date)	255	189	66	48	10	86	45	30	11	25	—	—	—

*Includes full-stop and roller landings
†Includes 10 landings at London Heathrow (6 by day and 4 by night) in RVR less than 100yd

the last-named mode to be initiated by pressing the autopilot disconnect button. It was claimed that height losses after application of thrust can be kept as small as 8ft when using a SCAT-directed technique. This figure is significantly less than those suggested by other speakers, and could have a vital part to play in critical height minima. Another area where TWA differs from other airlines is that it has no intention at present of using radio altimeters, except for a single installation with which it is hoped to establish the adequate accuracy of barometric altimeters. Thus the equipment programme of TWA is limited to the improvement of autopilot capability and reliability, provision of autothrust using SCAT, and the display of SCAT information for "go-around." With this equipment TWA anticipates being able to operate with increased safety to Phase II weather minima.

The FAA gave an account of its experiences with the BLEU DC-7, which had made 1,149 automatic landings at 47 airfields. During 500 of these approaches the autopilot was still coupled to the ILS glide-slope at a wheel height of 74ft. Virtually no problems were encountered during the programme.

Four occasions when a sequence-switch failure caused a missed approach were traced to a switch contact improperly mounted after maintenance. For evaluation purposes, a US-manufactured radio altimeter has replaced the original S.T.C. unit, but pilots had expressed a preference for the presentation features of the British device. The next phase of the FAA DC-7 programme is to explore flight director landings under instrument conditions. A Collins FD-108 Integrated Flight System has been installed, together with a pointer and drum a.s.i., an angle of attack indicator and a Bendix Eclipse Pioneer vertical-tape presentation of signals from radio altimeter, v.s.i. and altimeter. This new FAA programme will supplement information from USAF trials at Randolph Field.

The IFALPA viewpoint was put forward by Capt R. C. Gerber of ALPA. Stated requirements for ground equipment were similar to those enumerated by previous speakers, but the importance of a 100ft height-marker beacon, narrow-gauge touch-down zone lighting, runway centre-line and turn-off lighting, slant range visibility indication and the provision of compacted under-run, over-run and hard shoulders for runways were particularly emphasized. Airborne equipment specified included dual ILS receivers, improved warning flag displays, radio altimeters, instantaneous vertical speed indicators, windshield rain removal equipment, duplicated flight directors, DME for use during ILS approach, speed-command and angle of attack system for flight director or auto-throttle use and, finally, larger (5in) flight instrument displays.

Capt Gerber called for instrument displays adequate for manual blind landings when required, and stressed the importance of good manual-flight handling characteristics for "go-arounds" and manual reversion. Pilots expected an orderly and planned progress towards lower minima, with each step being carefully worked up through the "de-bugging" period. They were interested in the various forms of stick-steering, control-wheel steering and force-steering and believed that pilot reaction to such systems had so far been favourable. A plea was made for a single internationally agreed standard for approach lighting installations, standardizing either the ALPA or Calvert system with suitable additions. It was also felt that improved pilot training, and training equipment was required for instrument-to-visual and automatic-to-manual transitions, both for the continued approach and for the "go-around" manœuvres. Simulators and reduced-visibility screens in aircraft were regarded as promising devices in this programme.

During the panel discussion mention was made of the high success rate in manual blind landings in a current R & D programme at San Antonio, using T-39s fitted with a flare computer in the flight director system. This has been done with a glide-slope or flight path angle computed from TAS and vertical velocity. The value of the fog simulator chamber at Arcata in establishing the optimum lighting patterns for RVRs of 700ft was agreed, and this particular research tool is likely to be kept busy for some time. Some 254 transmissometers are already installed in the USA and it is likely that every instrument runway will be equipped with at least two.

An impartial observer at the meeting might have been struck by the variety of solutions proposed for the same problem. Particular examples are the PanAm and UAL decision to retain manual control in the pitch axis, while BAC and the two British airline corporations propose to do the opposite and automate this channel first of all. TWA are almost certainly alone in their proposed continued use of barometric altimeters.

Widespread use of angle of attack, both "raw" and processed, by the American manufacturers and operators, seemed to leave the British delegates quite unimpressed, as did the use and instrument display of instantaneous vertical velocity, although the limitations of plain barometric rate are generally agreed.

The FAA evidently do not at present accept the "official" British view that manual blind landings are not worth pursuing. An impressive FAA/USAF research and development programme is under way to examine this possibility. The same applies to the primary guidance system for all-weather operations. The UK is apparently sticking with ILS, while the US is looking for second-generation systems.

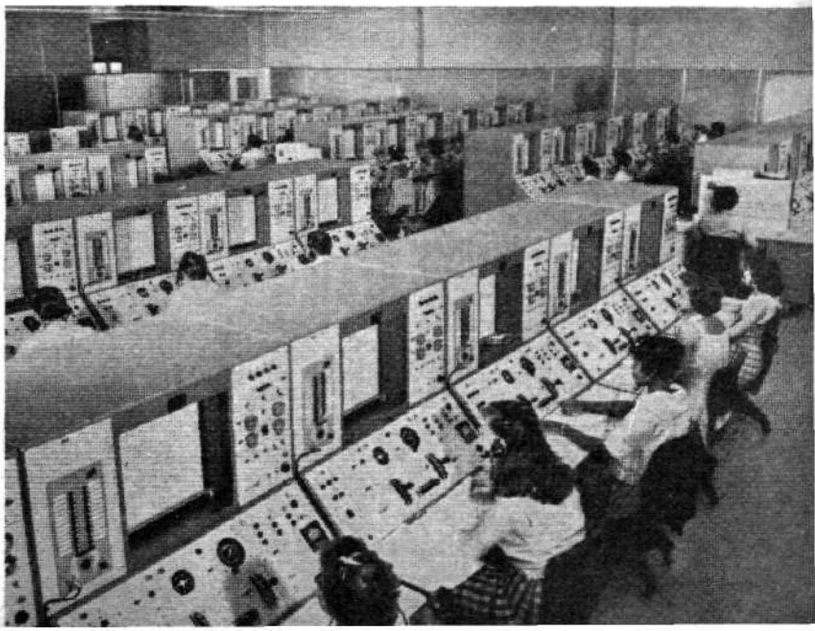
Some US airlines appear to be particularly aware of the limitations of previous flight director instruments, and the new Collins "3-D" FD-108 system appears to be "front runner" among the possible replacements. Five-inch diameter versions are available. A real attempt is being made with this instrument to put all the important parameters on display in the one dial, including attitude, director, radio displacement, yaw and, in some versions, speed-command, DME, radio altitude and command altitude.

The role of the pilot receives different emphasis in the US and Britain. US airlines appear to be very reluctant to abandon the acquired skills of the pilot, and a much greater effort to make continued use of them is apparent in the many ideas and products of the US industry. If this difference of opinion and intention is as real as it appears, there is a real possibility that quite different solutions will be found in the two major aviation countries. The eventual occupants of the first civil aircraft to operate in low minima will know that all practical solutions have been examined. L.A.

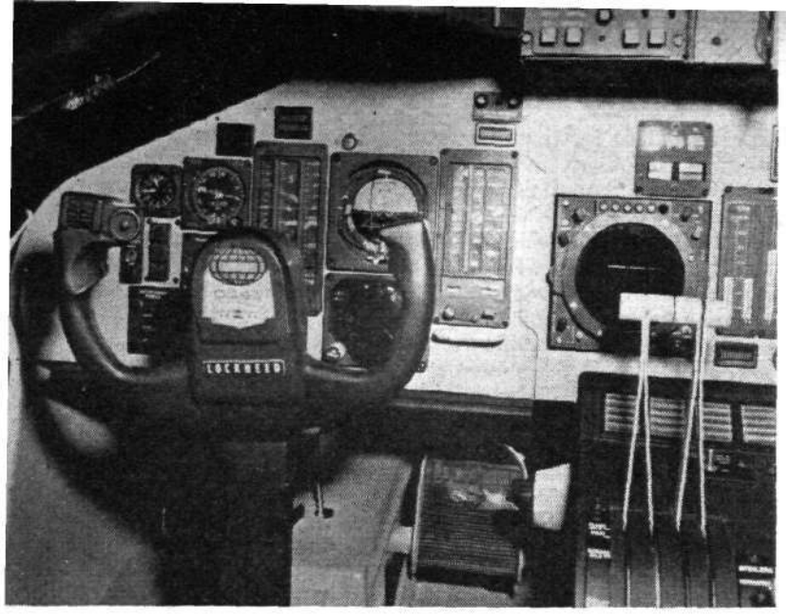
Some FAA and Industry Research Projects

COMPUTERS and simulators of a number of types are being used by the FAA at its National Aviation Facilities Experimental Centre (NAFEC) at Atlantic City for elaborate research projects connected with flight control, operational equipment and traffic control problems. An impressive amount of laboratory instrumentation has been installed at NAFEC to ensure accuracy and uniformity of measurement in terms of national standards. There are a primary measurement standards laboratory, photometric laboratory, navigation aids and flight control laboratory and an environmental laboratory.

An IBM 7090 computer is used to process digital magnetic tape which has been converted from analogue tapes extracted from airborne recording systems. The ratio of time required for measuring data to that required for reducing it has been cut down from



Some of the 60 single-track target generators and "pilots" in the FAA model B ATC simulator at Atlantic City



Captain's flight instrument panel for the Lockheed C-141 Starlifter, with dial flight directors and tape displays for speed and height values

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1 : 60 to 1 : 3. At the time of the all-weather symposium reported in previous pages, two of the FAA fleet of test aircraft were gathering data respectively on extended range VHF and on altitude encoding transponders.

An enormous effort is being made to solve the ATC problems being encountered today. The unique computer-driven simulator environment (CDSE) can be used to simulate various types of data acquisition, tracking and navigation systems allowing the experimenters to control error distributions. With the large digital computer it is possible to collect and analyse simulation data while the problem is in progress. The computer contains 32,678 words of high-speed core memory, plus an auxiliary core of 98,000 words, and it is capable of performing 250,000 additions per second.

Information for viewing by controllers is transmitted direct to Charactron displays and through TV camera chain to individual Conrac TV displays having a repertoire of 52 characters. Simultaneous display of up to 1,000 characters is possible on each of the four displays provided. It is positively uncanny to observe the alphanumeric characters showing aircraft identity, height, position and time early or late on ETA, move across the c.r.t. from the reporting point to the "gate" for the runway in use. What a difference such displays will make to the present-day controllers' task, if and when they become available! The inputs to the computer are provided by "pilots" sitting at keyboards, each "pilot" "flying" five aircraft at a time. Nine keyboards are at present in use, although the maximum capability of the system is 31.

A second ATC simulator, much less exotic than CDSE, was being used in an examination of the current Los Angeles area traffic problems. Sixty radar target generators each produce one trace and are individually manned by "pilots" who "fly" prescribed flight-plans, respond to clearances issued by the controllers and produce a radar target having the characteristics of the aircraft simulated. Performance characteristics of the "aircraft" may be changed by a selector switch, maximum performance being 2,500kt and 80,000ft/min climb or descent.

The simulated airspace is 400 miles square and 100,000ft high. Simulated air-ground communications are provided from each of the 60 "pilot" positions. A further 40 positions are available through a "patch" panel.

System performance data are obtained from data sheets completed by the simulator pilots, and communication workload is measured by the use of electro-mechanical counter-timers. The controllers' displays, of the flight progress board and flat-face radar type, are in a room apart from the target consoles. Control events will eventually be recorded, and a play-back feature will allow reconstruction of the particular problem.

Flight simulators are being used for a variety of purposes. An old F-100A simulator mounted in a gunnery training dome being used for collision-avoidance and proximity-warning indicator (PWI) programmes. A Type 60 Link simulator is being used to examine the instrument-flying problems of light or general aviation aircraft. The complementary Little Guy project, aimed at eliminating a large measure of the skill at present required for instrument-flying, continues and new instrument-panel layouts are being examined.

The joint Netherlands/USA project to establish the merits of various approach and runway lighting configurations is continuing with the use of a Dehmel single-engined simulator. In this programme a camera is positioned over moving rubber belts bearing the various light patterns to reproduce the position and attitude of the simulator during manual ILS approaches. The camera image is projected in front of the pilot and is used for visual transitions in low approaches, landings and "go-arounds." Dutch, Scandinavian, US and British pilots are, or will be involved. Each run is recorded and a questionnaire completed. A minimum of 1,000 runs are planned on the three different light patterns currently available on the belts, which are readily interchanged. Weather conditions are varied by the positioning of a curtain or screen over the belt. This particular programme is a continuation of the valuable work already carried out by the Netherlands in DC-3 and Super Constellation aircraft at Eelde and Cologne airports.

After the FAA meeting, other discussions at Atlantic City ventured into the realms of micro-electronics and it was forecast that autopilots and other black boxes will eventually be reduced to one-fifth of their present size.

Passing mention was made of the experience being gained with flight recorders. The general impression appears to be that increasingly valuable uses will be found for such equipment, perhaps eventually resulting in "on condition" maintenance when required instead of at fixed intervals. Some new developments include the use of an IBM computer for rapid detection of out-of-limits parameters once the analogue tapes have been converted to digital. It is also possible to transmit the information from out-stations to a central computer at main base over the normal telephone circuits, when a maintenance requirement exists.

Flight Director Systems

The supersonic transport featured only briefly, when it was suggested that its weather radar may have to move to K-band frequencies. The FAA also requires, in its request for proposals, that micro-electronic techniques be considered for all the electronic equipment. Considerable interest in the Lockheed C-141 jet freighter is being maintained. Joint military/civil certification is a key part of the project.

The flight instrument layout of this aircraft shows the USAF's satisfaction with vertical tape instruments, which give the main pilot's panel a neat, uncluttered appearance. Although some human factors/medical controversy still remains, there is an increasing swing to the new instruments. Scanning patterns are simplified and an out-of-step parameter is more easily detected. The moving tapes will be coloured if the trend in favour of pure white lighting on the flight deck continues. The C-141 flight engineer's panel provides an interesting side-by-side contrast between dial and tape instruments.

The flight instruments show altitude, vertical speed and terrain clearance (radio altimeter) in one package to the right of the director horizon, and airspeed, Mach number and safe speed to the left of the director horizon. "Command" functions and warning flags are incorporated and height can be shown by separate tapes for thousands and hundreds of feet, if required.

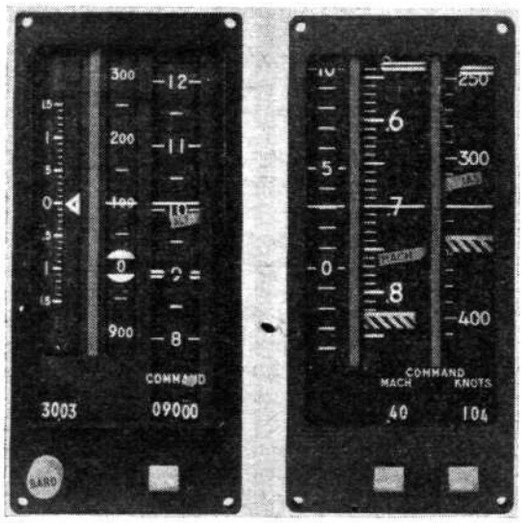
At the Collins Radio Company plant at Cedar Rapids, Iowa, attention is concentrated on the new solid-state radios, the peripheral command indicator (PCI) and the FD-108 flight director instruments. The new radios are being bought by many airlines and significantly reduce weight, volume, current consumption, cost and maintenance. For example, a com/nav package formerly composed of seven cases totalling 2½ ATR, weighing 80.2lb and consuming 432W is reduced to four cases weighing 47.4lb and consuming only 305W. Reliability is greatly increased by elimination of moving parts, and by reduction of temperatures.

The VOR/ILS receiver has self-test feature that gives a similar result on VOR as that obtained when the set is tuned to a ground-based VOR test beacon (VOT) signal. To perform the test a receivable VOR frequency is set and 0° or 180° radials selected on the omni-bearing selector. A spring-loaded toggle switch is operated and the accuracy of the equipment is then checked by the test

circuitry. This feature would be of great value in Europe where the airways system is largely based upon VOR, but where few VOTs are available. An impasse has been reached, because operators and administrations each claim that the other should provide VOTs. Meanwhile, the pilots are forced to use equipment they cannot check unless they have dual equipment. [Three sets are necessary for a "majority vote" decision.—Ed.]

A limited ILS test facility is also provided to check equipment accuracy from the first stage through the indicators. Other improvements, which pilots will appreciate, include removal of the glide-slope needle *and* warning flag from view whenever a VOR frequency is selected. The significance of a genuine glide-slope failure warning must often have been missed, because pilots see the flag showing harmlessly for perhaps 99.8 per cent of the time. Provision is also made to prevent the random wander of RMI needles when ILS frequencies are selected. These and other features all ensure that both maintenance personnel and pilots will like the new generation of radio equipment. Collins have also developed an ADF in the solid-state series.

The new Collins 3-D FD-108 flight director system represents an attempt to reduce the time a pilot spends in scanning and interpreting flight instrument indications. It is also an acknowledgment of the requirement for improved displays for low approaches,



Bendix tape instruments showing, left to right, height rate, hundreds of feet, thousands of feet with command set at 9,000ft, coarse speed, Mach number and fine airspeed, the last two bearing striped never-exceed markers, and command indices at the top demanding deceleration to 104kt and Mach 0.4. The datum is a continuous line across both sets of tapes

"go-arounds," and landings. The parallax disadvantage of the depth dimension has been turned to advantage in this instrument, and "depth" adds realism to the display.

The trend towards pure white flight-deck lighting has encouraged the bold use of colours to assist recognition and interpretation of flight director commands. Aircraft attitude, flight director demands, and radio guidance display are all shown, with speed-command, radio altimeter and DME signals as optional extras. The warning flags on both the director horizon and the associated cause indicator are a great improvement on those of previous instruments. The principle is to cover or remove the unreliable information whenever possible. Developments of the instrument are in the FAA DC-7, BAC One-Elevens for US operators and the Boeing 727 among others. It has been featured in the USAF LANDS programme, and one display uses radio altimeter inputs to move a runway symbol up towards the "wheels" of the model aircraft silhouette during blind landings.

The Collins Peripheral Command Indicators (P.C.I.) are installed in the company's Beech 18 rather as Smiths PVD is fitted in the Trident, and is likely to find a similar application in transport aircraft, i.e., as a back-up for panel-mounted flight directors during approaches and "go-arounds," and especially for monitoring automatic approaches.

One other notable activity at Collins is work on an FAA contract to analyse the performance of airborne collision-avoidance systems by using a computer simulator technique. The contract is expected to extend over a 15-month period. The company is also busily engaged in designing the communications equipment for the Gemini space vehicle.

Growing interest is being shown in head-up displays, and Sperry New York is particularly active in this field. Their proposed system provides on the windshield display, information which replaces or augments the references—they call them cues—present during visual flight. Development and demonstration of the system proceeds at their Long Island, NY, factory.

A joint explanation by FAA and Sperry representatives pointed out that the performance of piloting tasks requires three factors, a sensor for acquisition of information, a computer to process and evaluate information and a servo to act upon the information.

In VMC conditions the pilot can himself perform all three functions and carry out approaches and landings, but in IMC, loss of the first factor through lack of visual cues prevents the performance of the other two functions during the most critical task, which is landing.

If the pilot can retain the visual cues he can perform all three tasks. Before effective cues can be artificially provided from other sources, the exact form of information required by the pilot must be determined, and this aspect is being closely studied. For instance, Sperry are trying to assess how much use the human pilot makes of the apparent *rate* of change of shape of a runway, and how he determines his flight path, as distinct from his flight attitude.

The Sperry head-up display can already replace many of the natural cues lost in IMC conditions. The path marker represents the velocity vector of the aircraft. An airspeed symbol appears alongside the path marker showing relationship to the selected speed and 10kt fast or slow markers.

On the horizon cue a short vertical mark gives a heading reference. The runway guidance cue takes the form of an inverted T representing the threshold and centre-line of the runway. The image varies in size, shape and position as a function of attitude, radio position and range to the runway. Glide-slope cues are also displayed. The system can use ILS or other radio inputs.

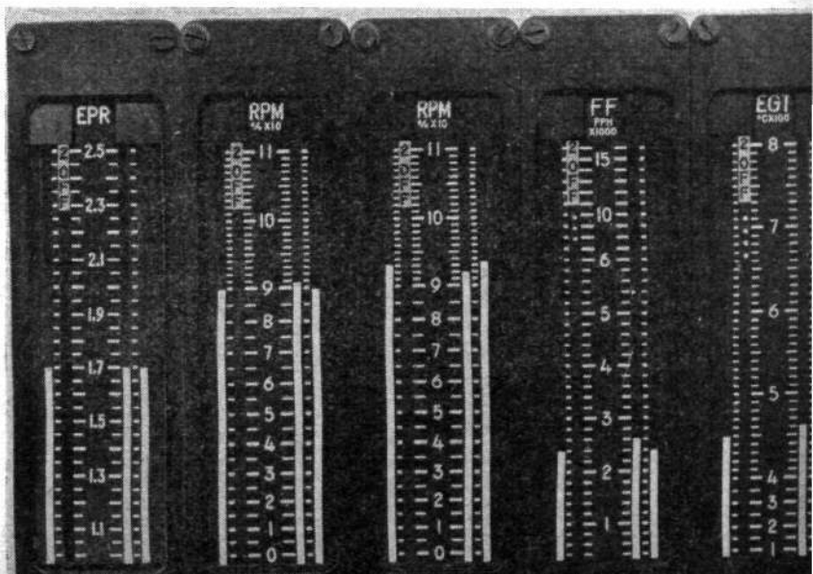
The FAA is closely following development of this head-up display and of the companion system of runway radar beacons called Microvision which could augment the display, or perhaps replace the ILS guidance, by producing an image similar to the view of runway lighting at night.

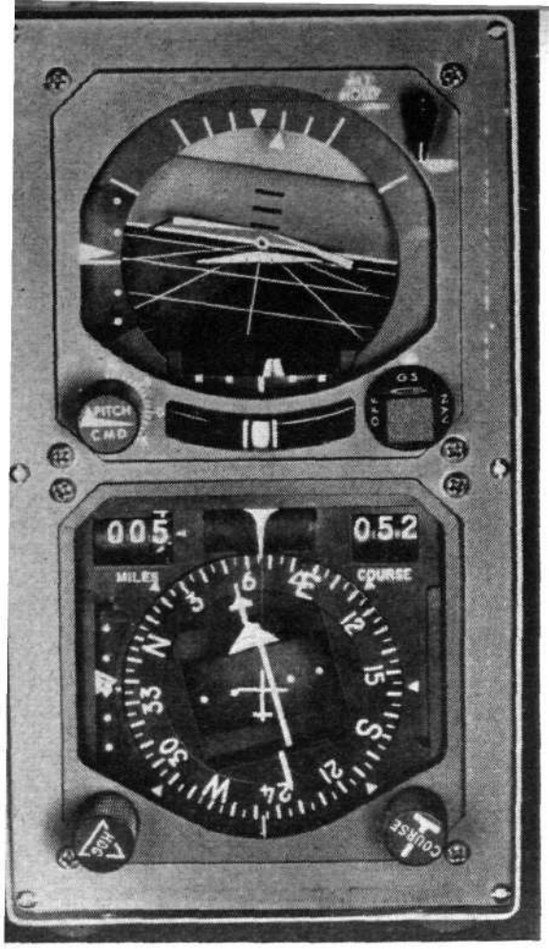
The full package is installed in a DC-3, but some portions of it are also fitted in a T-33 jet trainer. A flight demonstration in the T-33 showed that the equipment can be valuable in VMC as well as IMC conditions.

When approaches are being made to a runway not equipped with a radio aid a "still-air glide-slope" is produced by a computer using instantaneous rate of descent and angle of attack with airspeed.

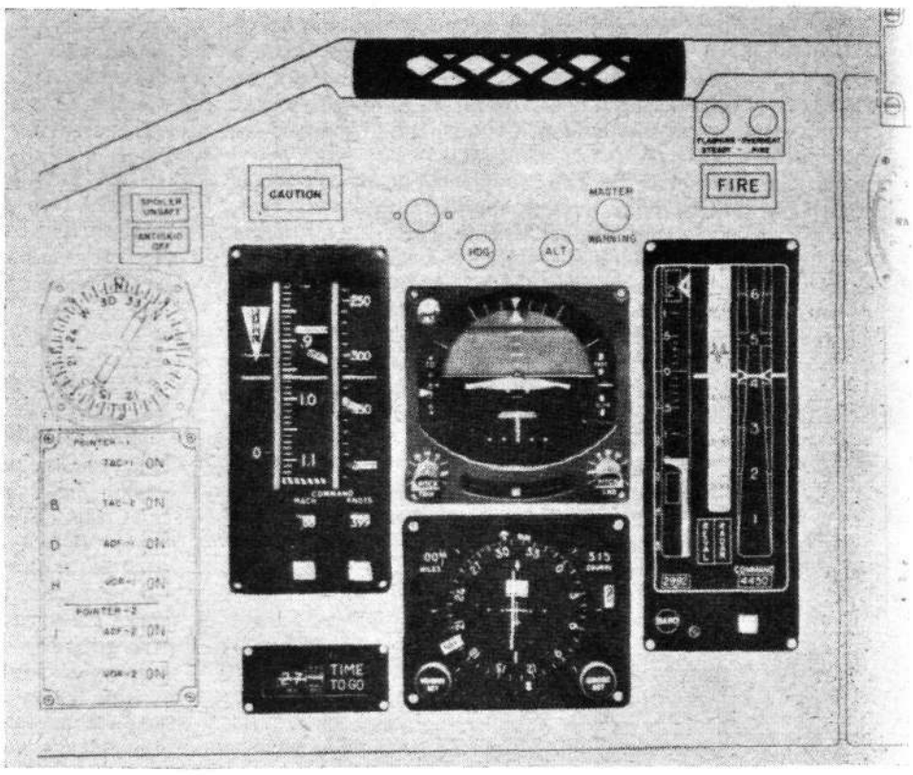
Before take-off, inverter power and the windshield image-generation were checked, and gyro stabilization was checked by pitching the aircraft and observing the behaviour of the path marker and horizon. The datum airspeed and the flight path

Bendix tape engine instruments showing, by four-engine columns, engine pressure ratio, l.p. compressor r.p.m., h.p. compressor r.p.m., fuel flow and exhaust gas temperature. No 2 engine is cut in all cases





Collins FD-108 "3-D" flight director. The three-dimensional delta aircraft shape is flown to coincide with the tapered V of the flight director symbol. Both are coloured bright orange against a blue-black background



The USAF Lands instrument panel, with Collins flight directors, Bendix vertical tape displays and, at the top, the Collins two-axis peripheral command indicator. The lozenges appear to move in any direction in which a control response is required

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angle (adjustable between 0° and 5°) were set. After take-off and some moderate in-flight manœuvres to observe the behaviour of the cues, the T-33 was flown back to Sperry's McArthur Field and some eight approaches were completed. A flight-path angle of 3° was selected, with a datum speed of 135kt. The approaches were all made down to about 50ft to two runways not equipped with ILS, and with drift angles of up to 5°.

The T-33 is notoriously lively in roll, and for this reason the first two approaches were imprecise. Both the path and director modes were used, and it soon became possible to see the valuable contribution such displays can make to flight safety.

At just about every runway threshold at every airport there are signs of short landings, presumably resulting from misjudged approaches. Yet, despite a complete ignorance of the performance, windshield cut-off angles, pitch attitudes and power settings of the T-33, safe and consistent approaches were made. In the director mode, simply flying the path marker on the desired touch-down point, like aiming a rifle, produced a quality of approach accuracy which could not otherwise have been achieved, in view of unfamiliarity with the aircraft. The "go-arounds" were made by aligning the path marker with the tree-tops visible through the display on the far side of the field, and thereby flying level at 50ft along the runway. Airspeed control by use of the error cues proved to be very easy, and the resultant tight control of velocity (in its dictionary meaning) was impressive. The Sperry head-up display appears to be well worth the development effort being put into it, and its possible eventual appearance in transport aircraft is likely to be well received by pilots.

Collins course director for the FD-108 system, showing the extra-large red failure flags covering the displays which have failed. Pure white cockpit lighting allows use of a wider range of colours

Consideration of head-up displays and similar equipment naturally lead to discussion with various people on the subject of the current programmes exploring the possibilities of manual blind landings. It seems to be widely agreed that the human pilot, with the assistance of improved ILS and flight directors can arrive at a landing "gate" about 80ft above the runway threshold. This was established in USAF trials at Randolph Field, Texas, with a control group of pilots.

A programme now under way has progressed to manual touch down. It is reported that a flare computer using instantaneous vertical speed as an input, provides flight director-type flare guidance for these landings. Another possibility is suggested by the appearance of an Eclipse-Pioneer vertical-tape instrument in which radio altimeter information is displayed alongside vertical rate. It appears possible that a flare computer could be used to direct the pilot to reduce his rate of sink from 700ft/min to 120ft/min by keeping the vertical speed pointer aligned with the radio height read-out, thus achieving a controlled landing.

No doubt there are many other possibilities, and the effort being put into US research and development programmes suggests that they will all be investigated before the human pilot is "designed out" of the all-weather operations effort. Some interesting products of these prodigious efforts may well be applied to the improvement of safety in good weather as well as in bad.

L. T.

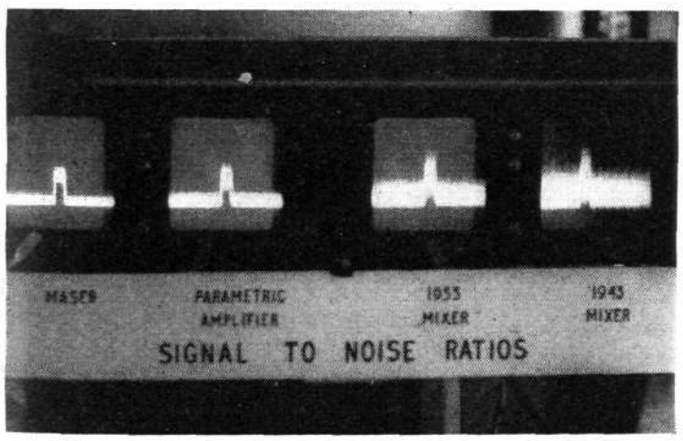
British Electronics for Civil Aviation

THE RAE, RRE, EEA SYMPOSIUM AT FARNBOROUGH AND MALVERN

LAST month the Ministry of Aviation and the Electronic Engineering Association combined to stage a symposium lasting several days both at the Royal Radar Establishment at Malvern and at the Royal Aircraft Establishment at Farnborough to show to invited representatives of foreign governments and administrations current British civil aviation electronics developments of international significance. Both the Establishments and the electronics industry arranged displays and demonstrations, the symposium taking the form of practical review and discussion, rather than of a series of formal papers. These formed the subject, some 60 altogether, in a conference held after the symposium at the Institution of Electrical Engineers headquarters in London.

Introducing the symposium, Mr J. H. Briggs, Director of Electronics Research and Development (Civil Aviation), MoA, noted that the Ministry controlled probably the largest research and development organization in the country. It financed directly or indirectly approximately 90 per cent of the research and development in the British aircraft industry and more than half of that in the British electronics industry. Both RRE and RAE devoted a large proportion of their effort to basic and applied research and therefore relied heavily upon industry to develop individual components and systems. Some of the work was applied to satisfying specific international or national requirements, but much of it was also intended to provide basic information and experience for policy makers and representatives at international meetings.

Contracts for complete design and installations were occasionally placed in industry following competitive tender, but civil development was increasingly being undertaken on a joint basis by industry and Ministry together—a system previously more common in military projects—providing a firm basis for technical and financial control required for government-sponsored ventures into the relatively unknown. Nevertheless, a very substantial amount of private-venture development was undertaken, and financed, in industry, which in no way duplicated government projects.



Radar receiver developments over the years have led to the improvement in definition illustrated by these four sample traces

This has been Farnborough display season, when we are accustomed to comprehensive, perhaps overwhelming exhibitions of equipment. The RAE/EEA Symposium was evidently considered by the manufacturers as a suitable replacement for this year's missing SBAC show, and one in which they could gain a good deal by having a more closely selected audience in less distracting surroundings. They cannot have been disappointed, and one can only hope that similar specialized symposiums are arranged at regular intervals in future. Even though the members of the electronics community are even more closely acquainted than those in aircraft design and operation, the "live" demonstration of new electronic equipment must be as additionally stimulating and informative as that of aircraft. Its effectiveness in stimulating potential sales can be no less great.

The Ministry of Aviation and the manufacturers, partly by virtue of innate British modesty, and partly because there has always been a tradition of reticence in military electronics research—where most important innovations begin—have tended to publicize British developments too little. To open the gates of the two main British research "sancta" is therefore the more welcome because, in electronics as in other fields, the customer will look for the equipment he wants in those places where he knows the development work is in progress—where he can see the properly co-ordinated practical work and appreciate its motives. Visible government support lends honesty and credibility to a sales approach more effectively than any amount of company literature. This, the electronics symposium was able to do very effectively. It was not the first British effort of its kind—a similar symposium was held last year—but it cannot fail to establish a new trend and one which will do more than anything to establish the British electronics industry as an international force. The demonstrations at Malvern and Farnborough showed that, in several fields, British electronics equipment and research is second to none, one important instance being micro-electronics.

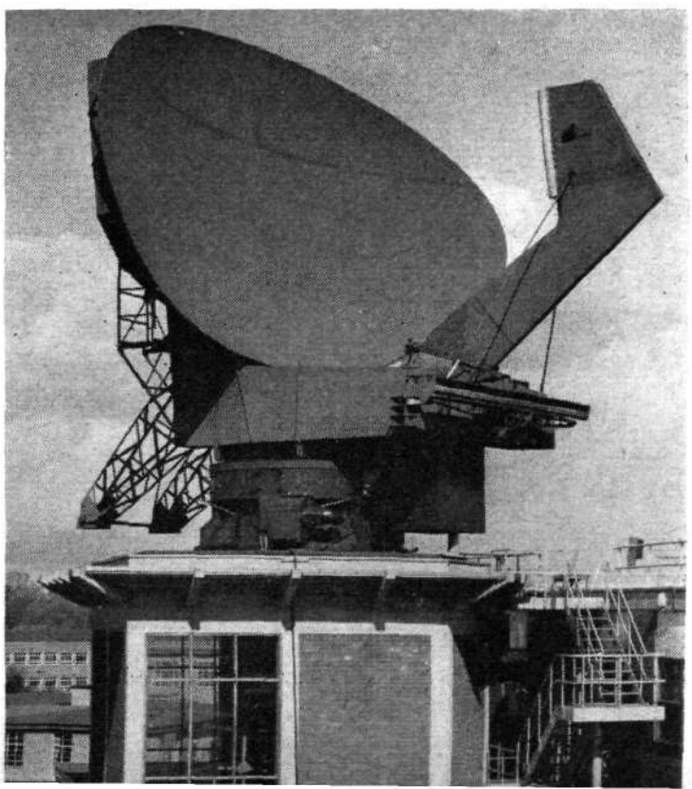
Unfortunately the EEA lecture session in London occurred too late to receive detailed coverage in this issue, but the succeeding pages give a summary of the important new developments shown at Malvern and Farnborough.

Radar and Air Traffic Control

Now that the principle of joint control of civil and military traffic has been accepted and a national ATC authority formed, the question of the development of equipment suitable for this complex task has taken on a more urgent importance. Ferranti, with their Apollo computer at the Prestwick centre, have already begun to obtain practical information on semi-automatic control over the Atlantic: Elliott Brothers (London) are well into the development of their Euclid system to provide a similar experimental environment for the UK airways system. As more and more co-ordinated radar coverage and *ad hoc* control of traffic becomes operationally available, the emphasis is shifting increasingly towards preponderant use of radar in the overall system. So much so, that it is expected that by 1968 something like a fully flexible system, not necessarily based on fixed airways routes, is to come into force.

Several companies in Britain—Marconi, Decca Radar and

The A.E.I. type 4502 stacked-beam surveillance radar proposed for air traffic control and shown at RRE Malvern. The secondary radar aerial is below the main feed-horn assembly



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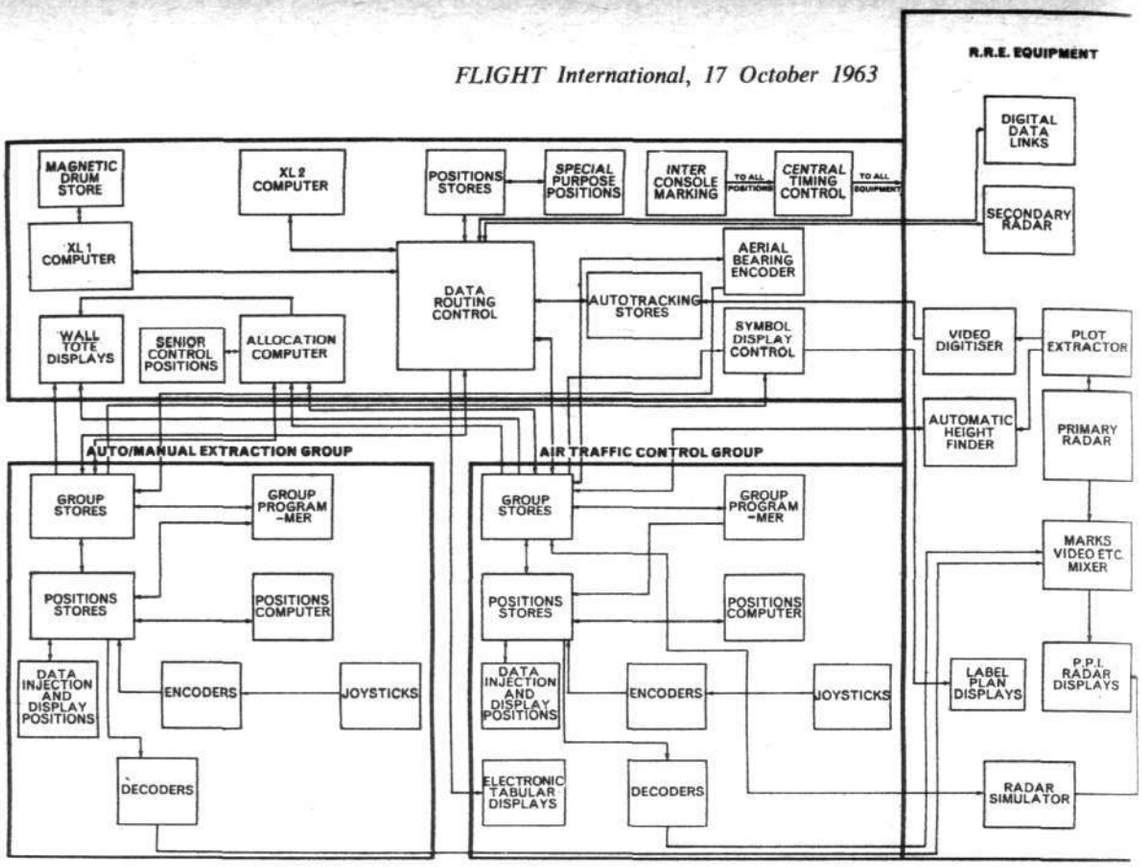
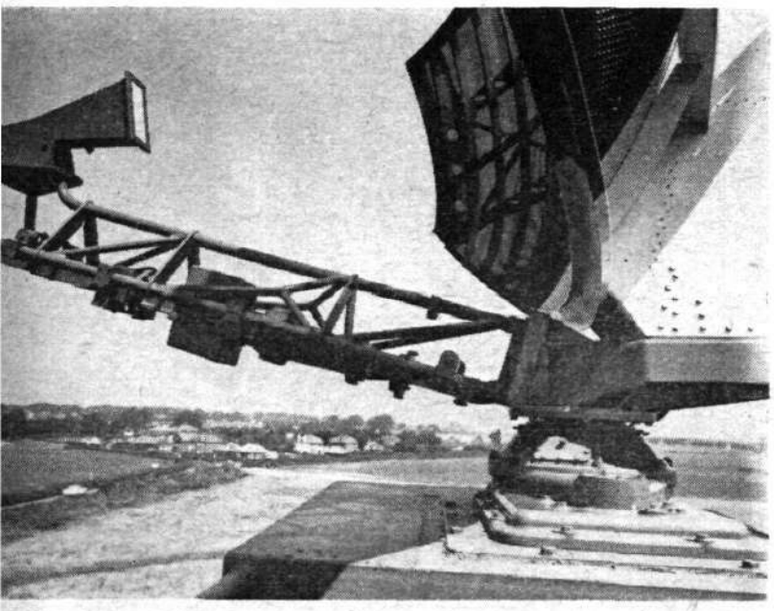


Schematic diagram of an experimental radar data processing system made for RRE by AT&E and proposed for joint civil/military ATC

AT&E—already have very considerable experience of this type of control system by virtue of extensive military work. The first two and Cossor have for some time offered equivalent civil data-handling systems based on radar. Now, the civil and military experience is being directly combined in the form of an adaptation of all the available equipment for the purpose of producing the joint system. AEI are proposing their formerly exclusively military volumetric radar for civil use and AT&E showed at Malvern their data processing system in the joint civil/military application. Considerable advances are also in progress in the development of more effective radar transmitter/receivers, with particular emphasis on low-noise receivers and swept-frequency systems with a number of objectives. Concurrently, much is being done to develop data links, both air-to-ground and ground-to-ground, to accompany the various information-gathering devices.

As noted in a leading article in *Flight International* for October 3, there is an increasing tendency to think of control as an isolated ground-based function, separate from airborne navigation. It seems to have been left to Eurocontrol to consider the whole navigation/ATC problem as a single issue with a truly co-ordinated solution.

Decca AR-1 aerial feed system for frequency diversity and remote-controlled circular polarization



Typical of the transference of military experience into the civil field is the AEI type 4502 volumetric radar which, by pulse compression and circular polarization techniques is able to provide gap-free coverage between 5,000ft and 75,000ft on 1.5 sq m targets at ranges up to 150 n.m., with the ability to detect even at short ranges small targets at high altitudes. Use of stacked beams by means of multiple-horn feed allows the elimination of permanent echoes and the real-time indication of the height of each aircraft. The displays can be split into height bands.

Shown integrally with the type 4502 was the secondary radar system for which AEI produced the aerial and S.T.C. the SGR.1 transmitter/receiver. The latter is fully transistorized except for the output stage, meets ICAO requirements and can be remotely controlled over GPO lines. It is a dual system with the minimum of common parts. The aerial can either be mounted on the primary aerial or synchronized with primary radars on a remote site.

Also at Malvern were components and practical demonstrations of the Automatic Telephone and Electric Co XL2 computer and data processing system for joint civil and military ATC. This is a large-scale system developed for MoA, probably related to existing tactical control centres, and employing large-scale e.d.p. systems. An important factor is the inclusion of self-checking facilities to such an extent that only low-grade maintenance effort is required and need for replacement of faulty units is indicated on a maintenance control board. Redundant units, particularly spare computers, are incorporated. AT&E have closely investigated component reliability and quality control. A few years ago, a system of this elaboration would have been considered prohibitively expensive for civil use. More manageable equipment and a more pressing operational requirement have overcome such objections.

In the operational system, an example of which is installed at RRE, both civil and military raw radar and digital height information is brough in by data links and supplied to both civil and military control elements—to the one for ATC work and to the other for defence purposes. Track extraction and data insertion operations are performed, initially manually, but with increasing automation, and processed by the central computer, the results being automatically routed to the appropriate civil or military controller, with flight-plan updating information where appropriate. Synthetic displays will show information-coded and track-indicating traces, together with tabular and electronically controlled information panels; and there will be facilities for conflict detection and resolution.

Elements of the input and output sections of the Elliott Euclid experimental ATC system were shown by RRE, Elliott themselves

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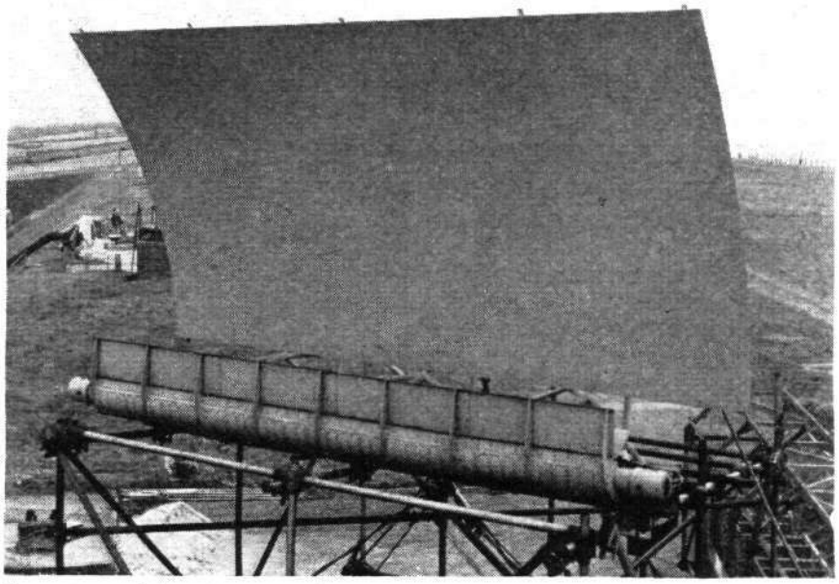
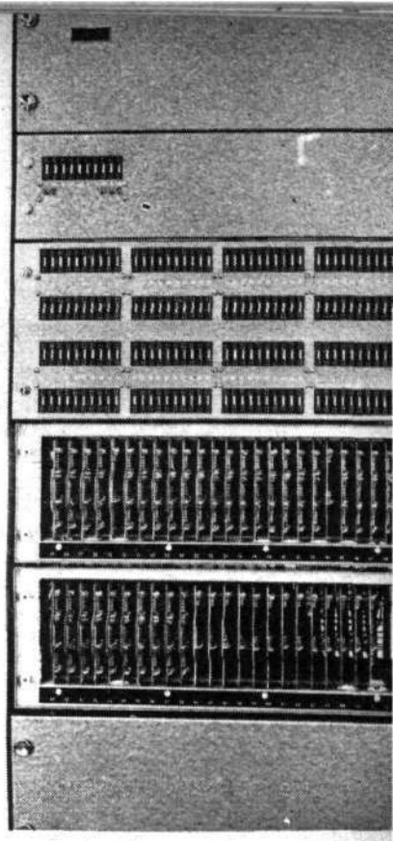




Marconi aerial for their swept-frequency volumetric radar. Right, Decca Navigator VHF data link terminal racks

contributing information on the more immediate application of automatic equipment to existing traffic control systems. The Elliott 502 forms the basis of Euclid, and of a digital 100-track, single-operator radar simulator, but the 803 was used for the Euclid demonstrations at Malvern.

Decca Radar have a number of recent developments in the primary radar field including their new AR-1 surveillance radar. The S-band RF head is suitable for fixed- or variable-frequency magnetron operation and incorporates a low-noise travelling-wave tube head amplifier. Assemblies can be easily changed as new designs become available, Decca offering special modular construction to facilitate such procedure for other radars as well. The S-band frequency-diversity unit for the AR-1 allows two transmitter/receivers whose frequencies are separated by a prescribed guard band to be operated simultaneously with a single-feed aerial system. When the received signal videos are combined the coverage is increased by a similar amount and the affect of target scintillation is reduced. There is instant stand-by in case of failure of one transmitter and the system is less susceptible to external r.f. interference. The frequency-diversity feed is passive and trouble-free and requires neither tuning nor external power supplies.

A special aerial boom arm has been designed for the AR-1 to allow remote control of variable polarization and to provide good quality circular polarization. This is achieved by varying the phase shift between the two orthogonal vectors into which the input into the boom arm is split. The system can handle two diverse frequencies.

Finally, Decca radar are developing a new airfield surface movement radar using a lightweight "cheese" aerial and feed-horn moulded into a balanced foam disc of 6ft diameter and housed in a radome. At a rotation rate of 1,000 r.p.m. renewal rate would be about 16 frames per second, at which the human eye recognizes continuous rather than intermittent vision, without the need for a long-persistence tube. Wavelength used would be about 9mm in the Q-band. A new circular polarization technique using ferrites would overcome rain clutter and the high data rate would allow effective surveillance of aircraft making turns on the ground. Use of a high-intensity, short afterglow tube makes viewing in relatively high ambient lighting possible.

Marconi are developing for RRE a pulse-compression system, which effectively increases the power output of a radar, gives better discrimination between aircraft flying close together and avoids gaps in radar coverage caused by blind or tangential speeds.

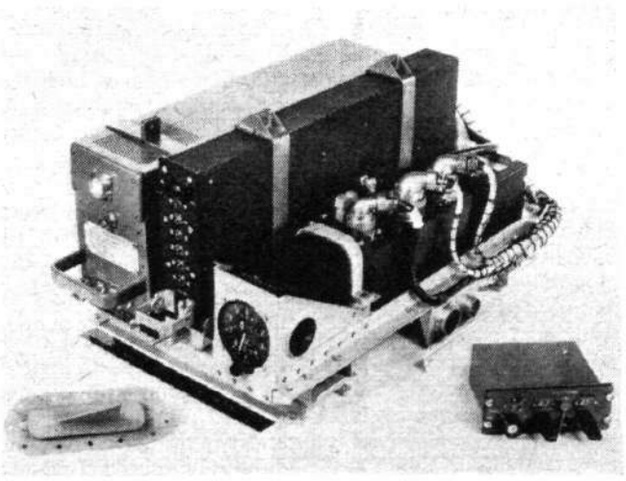
The equipment has been designed to give an effective shortening of the radar pulse-length, thus increasing the effective peak power without increasing the transmitter peak power. Hence the range of the radar is increased and better discrimination of targets is obtained by virtue of the shorter pulse length. It also tends to break up clutter and cloud formations that would otherwise blank off sections of the operator's tube.

Pulse compression may only be applied to a transmitter capable of modulation, such as one employing a high-power klystron. The transmitted frequency is swept linearly throughout the pulse length and, at the receiver end, a dispersive network is used in which the time delay varies linearly with frequency. All frequency components of a pulse received from a point reflector are therefore brought together in time, and combine to produce a single sharp pulse. To reduce ghost pulses or "range side-lobes" produced if all components are of equal amplitude within the pulse, the received pulse may be amplitude-shaped or alternatively a varied rate of frequency sweep may be used instead of a linear one.

Another Marconi development is the swept-frequency radar, in which the transmitted frequency is swept through a band of frequencies, with the result that the beam is electronically tilted through a vertical arc without mechanical movement of the horn or special aerial. Range, bearing and height can thus be derived simultaneously, the height signals having a resolution as good as that of existing "nodding" height-finders. The information also lends itself to three-dimensional display.

An exciting last-minute demonstration at Malvern was the operation of Decca's digital VHF data link in two Decca Navigator-equipped aircraft and the display of the resultant synthetic traces on

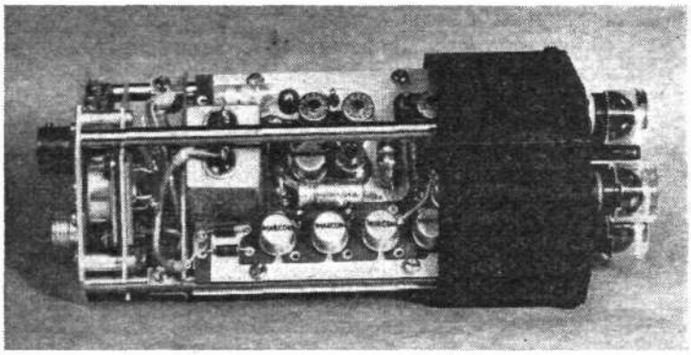
Cossor transponder, G.E.C. digitizer and Kelvin Hughes altimeter for transponder height-coding



a radar display, together with the equivalent radar traces derived from RRE's Type 80 defence radar. The aircraft were interrogated by the ground-air portion of the data link, returning their Decca-derived position co-ordinates to the ground station, where they were converted into rectilinear co-ordinates by an Omnitrac computer. These were in turn converted to co-ordinates relative to the radar site and presented as square and circular symbols on a Decca type 12C autonomous transistorized display console. Very considerable interest was aroused by the sight of the raw radar and Decca traces moving together across the screen.

The data link equipment has been demonstrated in France and is offered in conjunction with the Harco proposal to Eurocontrol. If both data link information, which is already in digital form, and digitized radar information is processed in a computer, it would be possible to perform probability checks to assess the more accurate information at any moment. Aircraft can be interrogated to any required priority and all aircraft in a given area could be on the same frequency.

G.E.C. (Electronics) Ltd have designed a digital data link for multiplex message transmission over land-lines and subsequent conversion for transmission on VHF or UHF radio links to airborne decoders. The system is suitable for either exclusive ground-to-ground or ground-to-air use. Varying rates of transmission could be matched to the frequency spectrum available and the overall capacity is sufficient to cope with 500 aircraft using and overflying a high-density airfield area. G.E.C. have also produced the digitizer

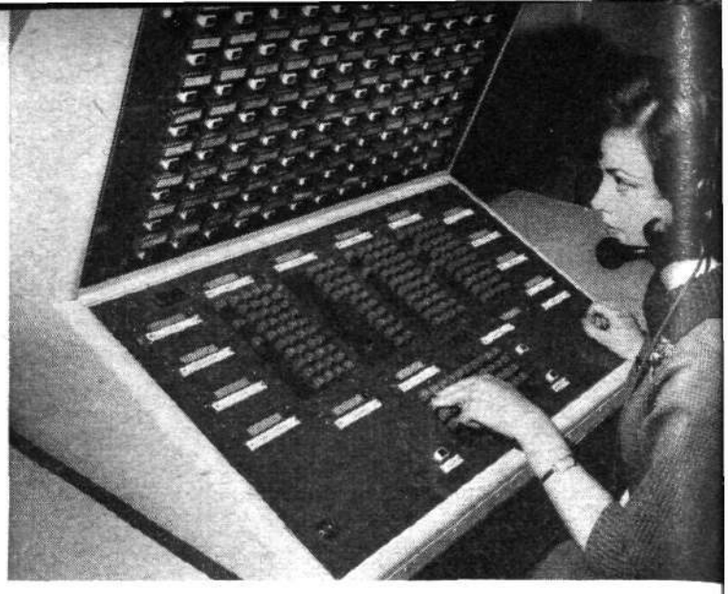


The first British linear microcircuit application is this Marconi civil marker beacon receiver, expected to have an MTBF of 30,500hr

for a transponder height-coding system using a Cossor transponder and a Kelvin Hughes altimeter.

The problem of displaying ATC information for controllers is now finding an ever increasing number of solutions of widely varying types, from straight photographic and projection techniques, through television scan conversion to the range of transistorized radar displays with tracking and marking facilities and c.r.t. tabular displays. Principal civil c.r.t. displays are by Marconi, Decca Radar and Cossor. Marconi have made considerable progress in development of the bright display tested by MoA at Gatwick. In addition, the company has produced a number of variations on the closed-circuit television theme in the form of a new vidicon camera channel which requires no setting controls, can accommodate light variations of 1,000 : 1 or even 1,000,000 : 1 and can obtain a useable picture in an illumination of 0.1ft candles. A storage vidicon tube can be used to provide cheap, flexible remote displays of radar information; and television projector and dry photographic printer can produce a permanent record on paper of closed-circuit t.v. information, thus eliminating one of the major disadvantages of this type of data system over such record-producing systems as teleprinters. New versions of the Kelvin Hughes photographic projection system for c.r.t. displays, including a miniature unit and colour versions, are available.

Secondary radar, in which Cossor did pioneering work, is now an international standard. Marconi recently announced their entry into the ground-based SSR field, in association with Compagnie Française Thomson-Houston, and S.T.C. and A.E.I. are co-operating in the development respectively of the SGR.1 transmitter/receiver and aerial. Elliott and RRE have developed a digital SSR



Keyboard for the Elliott 100-track radar target simulator

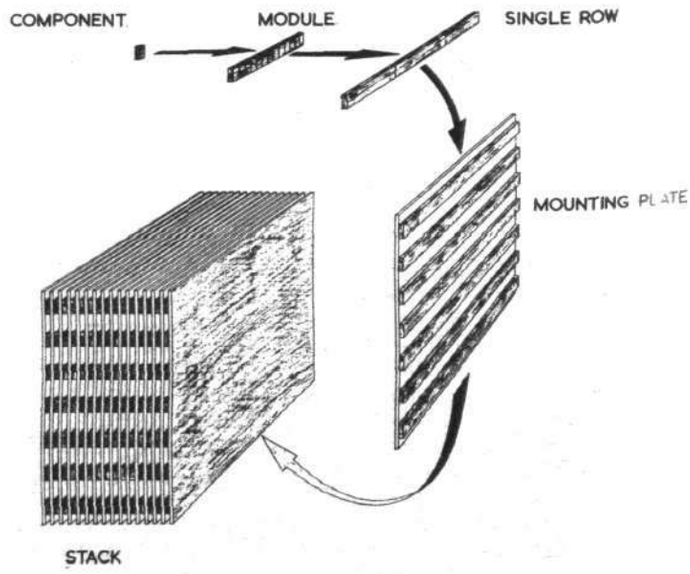
decoding system based on the high-speed logic of the 502 computer. It meets ICAO specifications on all modes and 4,096 codes, allows display of emergency codes, both specific and group identification of aircraft and very accurate height information.

Considerable progress has been made in methods of visualizing, simulating and studying traffic flow, a pursuit which has not proved amenable to traditional methods of formulation. The RAE mathematics department has applied numerical and sampling techniques employing fast digital computers and has gone far beyond the rather simple idealizations which are capable of analytical solution. General Precision Systems Ltd have carried out some studies of this type, using the "Monte Carlo" technique of arriving at a formulation from a relatively random exercise, particularly in studying cross-Channel ferry traffic. RAE themselves have studied trans-Atlantic traffic—and incidentally came to the conclusion that if there were no ATC over the oceanic area between 10°W and 50°W there would be likely to be one collision every seven years with present traffic intensity, and one every three years in about five years' time.

Airborne Digital Computers

The number of digital airborne computers is steadily increasing. First in the field in Britain were G.E.C. Applied Electronics Laboratories with their Dexan, admittedly a bread-board system for experimenting with digital systems in aircraft. It was tied to a navigation system made up of Doppler, directional gyro and air data system, giving outputs in latitude and longitude, and later with

Assembly stages for the G.E.C. rationalized packaging system, which accommodates all types of component and is suitable for manual or automatic assembly



the moving-map display. Dexan has now been superseded and greatly reduced in size to form the G 719 computer for the MoA, with possible civil applications. GEC rationalized packaging of components has reduced the size of the computer itself to a single ¾ATR case, with the addition of an input-output analogue-digital conversion system of approximately equal size, a map display unit, miniature numeric data printer and an airborne tape recorder for recording and extra programme capacity. Only the input-output section need be adapted to meet new applications.

Plessey-UK have developed, in conjunction with RRE, an airborne digital computer for navigational calculations using multi-aperture ferrite cores. Improved reliability and drastic reduction in size and weight are claimed by virtue of the reduced number of components and soldered joints compared with an equivalent semi-conductor unit.

Elliott airborne computing division have produced an airborne version of the MCS 920, called MCS 920A and having one-third the volume and one-half the weight of the original. It is suggested for application in supersonic transports, while the ground-based model may be used for fire-control, surveying, meteorological-data processing, air defence and air traffic control.

Ground-based Aids

S.T.C. and Decca Navigator respectively exhibited elements of Vordac and Harco, the navigation aids they have proposed to Eurocontrol. Both systems are under evaluation and no recommendation has yet been made to favour one or the other. It is an intriguing confrontation, for only in Europe are both the basic aids being used regularly in civil aircraft over the same geographical area. Both require some modification to upgrade them for the specific Eurocontrol requirement. While S.T.C. proved fairly reticent about the results of tests so far completed on the bearing portion of Vordac, Decca were able to stage their demonstration of the VHF data link operating "live" in parallel with primary radar. It is a vexed question, but Decca at the moment appears to be in the ascendant, particularly in view of a change of heart towards the system in the USA.

An important new long-range navigation aid which is now reaching the prototype hardware stage is VLF, a rho-rho system at present based on existing very low-frequency communications stations, such as that at Rugby, and Balboa. For four years RAE have been monitoring VLF transmissions all over the world with Plessey receivers and during long-range flights with a specially equipped Comet. It has been found that diurnal variation of path length can be corrected with surprising accuracy by a suitable computer, which is now being designed. Propagation time is sufficiently predictable for distance measurements accurate to about 5km to be made at ranges of at least 10,000km.

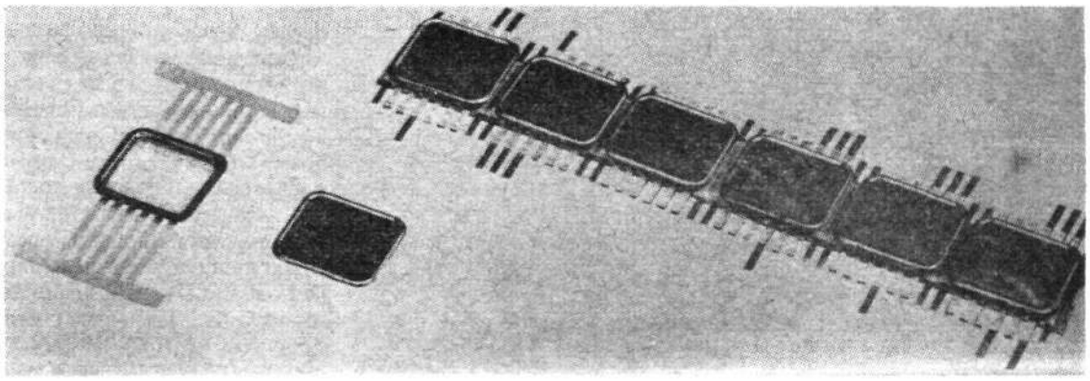
Ten transmitters should be sufficient to make four stations receivable anywhere in the world, by aircraft or surface craft. Existing stations would serve if their carrier frequency was stable to 1 in 10^{10} per week, no breaks in transmission of more than a few seconds occurred (because range measurement is incremental) and modulation did not interfere with the carrier or its phase stability. Ground stations would have atomic frequency standards and be locked together to an accuracy of one microsecond.

Frequencies lie between 3kc/s and 30kc/s. At 10kc/s phase shift is 22° per nautical mile and one wavelength 16.2 n.m. Propagation velocity changes could cause range errors of 6 miles in 3,000 miles.

The basic airborne system would include a receiver and a highly stable oscillator (HSO) to measure phase changes in the received signal as the range between aircraft and ground station changed. Starting position would have to be preset. The receiver might have up to five channels to allow range measurement from a group of stations to form the conventional fix pattern. An MTBF of at least 10^5 hours would be necessary to ensure continuity and therefore accuracy of range measurements. During early flights in the Comet, the Marconi laboratory HSO was used, but Marconi have now developed a new, more compact, transistorized HSO specially for airborne use.

Interpretation of the fix, application of predictable corrections, probability assessement and memory would be performed by a special computer, which might also accept other aids for cross-checking purposes. Path length corrections can be applied very accurately by dividing path length into light and dark sectors. Probable HSO errors would also be estimated. A suitable display would be needed, but a wide variety of scales of equipment is possible. RAE have evolved a computer logic for the corrections and showed at Farnborough a model of the proposed five-channel receiver, incorporating thin-film circuitry, and occupying a ½ ATR case. The HSO would occupy ¼ ATR and the computer 1 ATR.

VLF could give a world-wide occuracy of ± 3 miles, sufficient for all high-accuracy terminal areas. Provision of one new transmitter would, as a first step, ensure full coverage of the North Atlantic.



G.E.C. assembly of modules in rows, with contact strips regularly spaced along the main edges. This rationalized packaging is described overleaf

In the landing guidance field, RAE have been evaluating several new systems. Development of the interferometer method of plotting flexible approach paths to a VTOL landing area continues, and initial experiments have been completed with an ILS localizer, capable of being utilized by existing airborne receivers, mounted at the downwind instead of the upwind end of the runway. The system is bi-directional, so that guidance continues after the aircraft has flown over the aerial. Main advantages are better distribution of the guidance over the approach area, by virtue of simpler siting and location closer to the critical final approach zone by some 10,000ft. The aerial is 200ft long, lying across the runway centre-line. The first aerial proved unsatisfactory at ranges of less than 500m, and a second aerial is under construction.

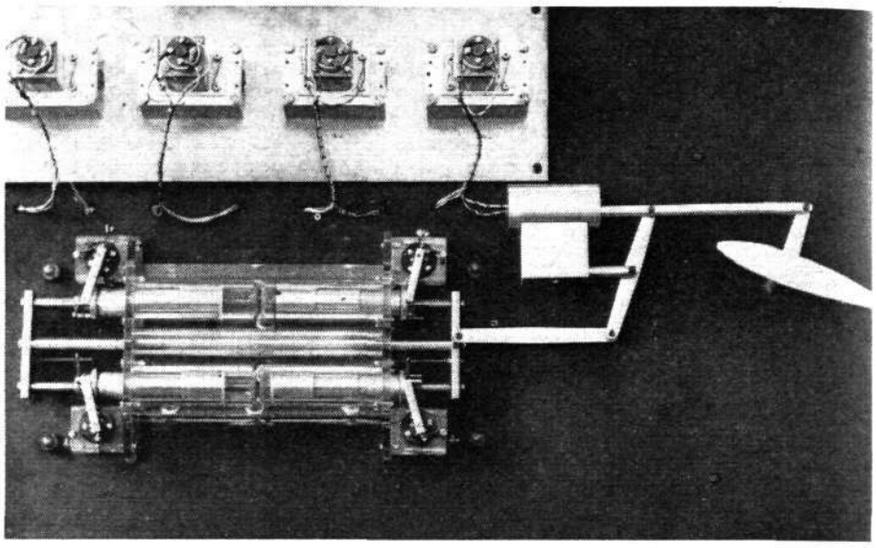
Components and Techniques

One of the satisfying features of the RAE/EEA symposium was the indication that, in microelectronics, British development is by no means lagging behind that of other countries. RRE and many of the established manufacturers have devoted considerable resources to basic research and the first fruits are beginning to appear in the form of actual working equipment.

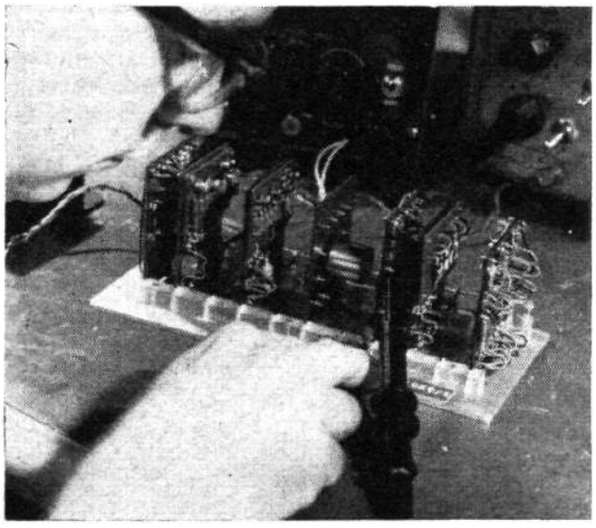
The first linear microelectronic device exhibited—at least two other units should be announced shortly—was the Marconi marker beacon receiver, which meets all current operational requirements and conforms to the RTCA specification. It is less than one-quarter the size and weight of the current Sixty Series marker receiver and should have an eventual MTBF of no less than 30,500hr.

The receiver is housed in a standard 2 ATI instrument case only

AVIATION ELECTRONICS . . .



Right, Elliott bread-board model of a quadruplex hydraulic actuator with electrical signalling. Below, Elliott transfluxor store for autopilot information. The transfluxor is visible on one of the central circuit cards



5in long, with traditional arrangement of three "press-to-test" dimmable lamps and three-position sensitivity switch. The circuitry is mounted on two printed boards supported by four pillars rigidly mounted on a backplate. Printed connections are gold-plated copper, giving extremely low contact resistance and improved resistance to corrosion. Individual circuit modules are built up on slices of silicon, with transistors, capacitances and resistances formed by photo-lithographic techniques, and the slices mounted in type TO.5 miniature transistor cans with gold connections welded to the actual micro-circuit and to the external contacts on the can. With the exception of the micro-circuit modules, established construction techniques have been used throughout the receiver.

Three identical amplifier circuits give the required gain at 75Mc/s, with a crystal filter at this frequency to give a bandwidth of approximately 40kc/s at 6db, increasing to 125kc/s at 60db. The amplifier is regulated by conventional amplified AGC derived from the detector. After detection, the three audio modulation frequencies are separated by resistance/capacity filters, the outputs of which are applied to three identical audio amplifiers whose outputs are used to operate the appropriate lamps on the front panel.

The complete unit is designed to operate from an aircraft 28V d.c. supply, power for the transistorized circuits being derived from a series regulator which is in turn controlled by a micro-circuit control system. Developed to operate throughout the entire climatic range appropriate to aircraft electronic equipment, the receiver is expected to provide valuable operational information on this type of circuit construction, which seems likely to play a major role in the next generation of airborne radio.

Rationalized packaging is the term used by the product engineering department (MQ) of G.E.C. (Electronics) to describe a method of mounting components on boards in such a way that, even with components of conventional size, packing densities of up to 250,000 components per cu ft can be achieved. In addition, conventional and microminiature modules can be used side-by-side with the same mounting technique, and the whole system lends itself to circuit design by computer and automatic assembly. More advanced components can replace normal ones as they become available. Prototype equipment can be built up with conventional components to simulate the eventual microminiature format.

Components are mounted, either individually or in pre-assembled modules in straight rows across a board, stacks of boards subsequently being mounted in racks, leaving free passages between surfaces and rows for cooling air. Contacts from the modules on the strips are led out at exact intervals along the two main edges, interconnection patterns being easier to derive for this layout than for the sometimes complex patterns of components on conventional boards. During hand assembly, connections are formed by double-sided welding, for which machines are readily available.

For the construction of prototype equipment, G.E.C. suggest the use of metal frames of appropriately scaled dimensions, on which circuit modules in normal components can be mounted, with wiring laid out and arranged to simulate the paths of the eventual printed connections. The format and printing pattern of the eventual equipment can thus be accurately determined with the minimum of difficulty.

Elliott Brothers (London) continue to expand their range of automation equipment and exhibited a self-monitoring autoflare computer, an amplifier computer for electrical signalling systems incorporating integral redundancy, and a quadruplex actuation system for a similar application. Four electrically signalled and shaped channels control the quadruplex actuator, which has mechanical disengage and idling devices so that it can survive two faults before reversion to manual signalling, and three before reversion to manual actuation.

Elliott have produced a self-monitoring circuit which can be added to a standard glide-slope receiver to introduce automatic failure detection. Another innovation is an experimental all-electronic storage system, without moving parts, for autopilot information. A transfluxor stores information indefinitely as a flux pattern inside the core and has the property of non-destructive read-out.

Electrical signalling featured also in RAE and Ultra Electronics/Boulton Paul displays. RAE showed a large, Concorde-like model controlled by electrically signalled servos and simulated aerodynamics from a miniature control column. The object was to show the effect of rate-demand control at simulated speeds from 160kt to Mach 2. While shaped electrical signalling is of obvious assistance in one channel for an aircraft with such a large speed range, it becomes almost imperative when both roll and pitch axis control have to be shaped and exercised through only two elevons.

Ultra Electronics and Boulton Paul respectively produce the electrical and mechanical portions of a five-channel electrical system, using amplifiers, torque motors, rotary valves and hydraulic pistons in each channel to operate the single main powered-control unit in each control axis. Rate gyro shaping is added in the yaw channel. A collapsible strut withdraws mechanical leverage from the output of any channel which fails, allowing the output linkage to idle with the remaining channels.

Letters

The Editor of "Flight International" is not necessarily in agreement with the views expressed by correspondents in these columns. Names and addresses of writers, not for publication in detail, must in all cases accompany letters. Brief letters will have a better chance of early publication.

Facing the Rear

From Air Cdre Sir Vernon Brown, CB, OBE, MA, FRAeS, Hon SLAET, RAF (Ret)

SIR,—In respect of your article "Facing up to rear-facing" (October 3 issue), in a lecture I gave on March 1, 1954, before the Royal Society of Arts, I said: "... I am certain that if seats were constructed to withstand at least 20g, and if in addition they faced backwards and were provided with adequate head, back and leg protection, the mortality figure would, in the case of survivable accidents, be reduced to an almost negligible quantity. I feel very strongly about this and recommend anyone interested in the subject to read Mr Hardingham's short paper *Can Chances of Survival be Increased?* which was printed in the RAeS *Journal* in July 1948."

Nothing has happened since then which has made me change my views.

It may also be of interest that when the late Air Officer Commanding-in-Chief, RAF Transport Command, relinquished that command in May last year, it was reported in the Press that he said that "the Command's safety record is unequalled by any other Air Force or airline. All passengers sit facing the rear, a modification insisted upon because it has been proved the safest way to travel."

In my experience, serving air marshals don't thoughtlessly say things like that.

Staines, Middx VERNON BROWN

Over-specialized Specifications?

SIR,—14½kt was a good speed for 1863, and the *Great Eastern* did a good job of Atlantic cable-laying; but she was built for the Far Eastern services. Similarly, the Vanguard will be operating successfully soon on domestic routes; but the aircraft was bought primarily for international services. Even before the aircraft entered service, BEA itself realized that it was not competitive with the jets and ordered Comets in increasing numbers. The hard, business verdict must be that the board of BEA should have foreseen this; and the misjudgment was as much the reason for recent unprofitability as the engineering problems.

However, the main significance of the Vanguard episode is that it casts doubts on the wisdom of building aircraft to overspecialized specifications, in this case one originated by BEA and to some extent by TCA. Britain's central economic problem is the balance of payments, not the profitability of the State air corporations, and the export of civil airliners can make an important contribution to national solvency. If the Vanguard had been a short-range first-generation jet, Britain would have been better off, and so would Vickers' shareholders. A sad sequel for the joint authors of the Viscount success story, but such is life in a truly competitive environment.

The length of the order books for the VC10 and Trident cannot be comforting to the manufacturers, or those concerned with export earnings; both were built to specialized specifications. The Trident in its present form may be ideal for BEA, but a more important question is "would the original '727 size' version have sold better abroad?"

The resolution of this conflict of interests between airlines, manufacturers and Treasury could be amongst the tasks of the "National Aviation Authority" proposed at the recent Cranfield Society symposium.

London SW15 A. J. LUCKING

Getting There Safely

SIR,—I was glad to see criticism of the presentation of some aspects of air safety in recent issues of *Flight International*. In the September / October issue of *The Professional Engineer* I commented that, on the air industry's basis, one could almost live for ever if only one lived in an aeroplane! Indeed it is only when the records of particular aircraft or companies are analysed that the world becomes a statistically real one again.

There may be travellers who are reassured by such statements as " the fatality rate per 100 million passenger miles fell below unity," but I have never met one, and it certainly does not reassure me. As a frequent long-distance passenger since 1947, the only question in my mind as regards safety has been "What are the chances of this particular airline flying this particular aircraft between these particular termini getting me there safely?" Mind you, I have not always thought of safety at all, but that is not because of the industry's obsession with passenger miles.

Crawley, Sussex N. J. COCHRANE

Canada to Old Warden

SIR,—It was very pleasing to read the article by Humphrey Wynn, "Old Warden's Veteran Legacies," in the August 22 issue.

Last June I had the pleasure of taking my wife to Bedford, in which I had grown up, and one of our side trips was to Old Warden. My day-to-day work is aviation and as we both now share the same enthusiasm, we decided not to miss this historical collection. Travelling through the picturesque village, one would never imagine that it is so full of history. To stand next to a World War I Bristol Fighter and others, was indeed an honour.

Today, we hear such a lot about Mach 2.2 and Concordes, that a visit to Old Warden makes one realize how far we have progressed in the last fifty years.

The lighting in the hangar was not ideal for photographs, as no flash was allowed, but the one enclosed [*unfortunately not suitable for reproduction—Ed*] shows Sqn Ldr Jackson talking with an RAE engineer. At that time the Rolls-Royce Falcon engine was undergoing an overhaul, but I was informed that it is the oldest R-R engine still in flying service.

To anyone interested in aviation, who is visiting England, I advise them to visit Old Warden; and if you take the road from Bedford, you can still see the giant hangars that once housed the R.101.

Weston, Ont L. E. FULLER

Grand Cayman Island

SIR,—Referring to the news item appearing under the heading "Britain and Cuba" in your issue of August 1, I note that your journal has fallen from its usually high standard of accuracy.

The island of Grand Cayman lies approximately 275 miles south of Havana and approximately 325 miles west of Kingston.

If you look at your map again, you will find that the Cayman group does not constitute part of the Bahamas. (Until last August, the Cayman Islands were in fact dependencies of Jamaica.)

Kingston 10, Jamaica P. L. WARD

More Thoughts on the Concorde

SIR,—As a member of the aeronautical laity, I can only trust that you will pardon my temerity in entering into the SST controversy. However, I feel I must comment upon the remarks of Mr Korab-Moers, contained in his letter published in your September 19 issue.

In championing the SST cause, Mr Korab-Moers' argument would appear to rest on two rather insubstantial pillars. Initially, he introduces what is to me, at least, a new and somewhat naïve-sounding term when talking of "flight

The Dutch two-seat Spitfire referred to by Mr Leslie Hunt in his letter on this page

LETTERS . . .

time/safety relationship." Looking back over twelve years of first-hand experience in the servicing of airborne electronic equipment I would be loath to place any great faith in such a bald inter-relationship as this; and there is little point, in these columns, of stressing the fact that any SST must carry more electronics than are required to operate the public-address system.

Similarly, on the issue of the pessimists who have through the ages persisted in condemning innovation, technical or otherwise, I find I am in sympathy with Mr Korab-Moers. But, surely, there is a difference in the order of magnitude between the advent of the car and even the jet engine, to that of the SST. The populace have in the past reacted with hostility towards the noise of cars and aircraft. It will be interesting to discover their reaction to "over-pressure carpeting" on what can only be an ever-increasing scale.

Finally, while I can only endorse the writer's hope that the SST will initiate greater benefit for air transport than is at once apparent, I must confess to having some reservations about its absorption into the already congested air traffic control pattern.

Kings Lynn, Norfolk HUGH W. COWIN

History of H-99

SIR,—When I wrote to Holland seeking a photograph of any aircraft retained as "gate guardians" or in museums, this print [reproduced herewith.—Ed] was enclosed without comment, other than the caption. Would any reader know if, in fact, this machine is still in existence or be able to give any information concerning the history of H-99?

Leigh-on-Sea, Essex LESLIE HUNT

Goldfish Club 21st Anniversary

SIR,—The Goldfish Club, founded in November 1942 for those aircrew members who had survived a wartime aircraft ditching, and who owed their lives to the successful use of their Mae West or rubber dinghy, this year celebrates its 21st anniversary.

The club's badge shows a white winged goldfish flying above two blue waves, gold symbolizing life and fish the sea, and has been woven into blazer badges, emblazoned on cuff-links and lapel badges, and embroidered on ties.

By permission of the chairman of the Port of London Authority, the club organizes each year its own Remembrance Day service on the Thames. A simple but moving ceremony is held, at the end of which a wreath, incorporating the club badge, is cast on the waters, in memory of many comrades who have only a watery grave.

The Goldfish Club continues to thrive and recruits new members at the rate of fifty per year, including as it does members from the 1914-1918 War and the Second World War to the present time. Social functions are organized, Service charities supported, and the main event of the year, the Annual Reunion Dinner, is this year being held on November 2 in the Members' Dining Room at the House of Commons, which is being made available through the courtesy of the Rt Hon Mr Edward Heath, who will be the guest of honour at the coming of age of this most exclusive of all Service clubs.

Prospective members may obtain further information from the honorary secretary, The Goldfish Club, at 14 South Street, Park Lane, London W1.

Crawley, Sussex R. J. SAUNDERS

Irish Military Aviation

SIR,—The three Walrus amphibians referred to in Mr W. R. Snadden's letter (September 12) were in fact operated by the Irish Army Air Corps and not by the Irish Navy, which has no separate air arm. On their delivery flight in 1939 the formation was broken up by bad weather over the Irish Sea and the aircraft landed at scattered points. A further incident marked the career of N.18, the aircraft which is to be preserved: in 1942, a young officer under open arrest at Rineanna (now Shannon) air base flew the aircraft to England; his crew of two were unaware that the flight was unauthorized and fuel was barely sufficient for making a landfall.

This aircraft was sold to Aer Lingus in 1945 and, as EI-ACC, was used for training for a short period during the airline's post-war expansion, before being sold as G-AIZG.

South Ruislip, Middx D. M. MACCARRON

SIR,—Your correspondents on Military Aviation in Ireland (September 26 issue) made no mention of three more D.H. Vampire T.55s, the first having been delivered early in 1961.

London SW6 J. READ

Still on the Drawing Board?

SIR,—Re the last paragraph in Roger Bacon's column for September 12, I think you should know that we also have a lot of TSR.2-type drawing boards here.

Warton, Lancs R. N. OVERSBY

FORTHCOMING EVENTS

Oct 5-20	*Aeronautical Exhibition, Cristoforo Colombo Airport, Genoa.*
Oct 17	*RAeS, Halton Branch: "Rebuilding and Flying of Historic Aeroplanes," by Air Cdre A. H. Wheeler.*
Oct 17	*RAeS, Gloucester and Cheltenham Branch: "All-weather Operations," by W. H. McKinlay.*
Oct 18	*RAeS Agricultural Aviation Group: "Agricultural Aviation Potentials in Asia," by E. C. S. Little.*
Oct 21	*RAeS, Henlow Branch: "Air Traffic Control," by H. D. Mitchell.*
Oct 22	*RAeS, Luton Branch: "Development of Civil Aircraft in USSR," by E. A. Smirnov.*
Oct 22	*RAeS, Bristol Branch: "The Legal Liability of Aircraft Designers and Manufacturers," by H. Caplan.*
Oct 23	*RAeS, Weybridge Branch: R. K. Pierson Memorial Lecture, by Sir Dermot Boyle.*
Oct 23	*RAeS Graduates' and Students' Section: "British United Airways," by F. A. Laker.*
Oct 23	*Royal United Service Institution: "Masers and Lasers in Military Optics," by Dr J. W. Orton.*
Oct 23	*Kronfeld Club: "Gliding in the French Alps," by Peter Hearne.*
Oct 25	*RAeS Rotorcraft Section: Fourth Cierva Memorial Lecture, "Unsteady Airloads on Helicopter Rotor Blades," by Prof R. H. Miller.*
Oct 28	*RAeS Historical Group: "First Flight Round the World," by Wg Cdr N. Macmillan.*
Oct 30	*Kronfeld Club: "Puffin, the Man-powered Aircraft," by J. C. Wimpenny.*
Oct 31	*United Kingdom Flight Safety Committee: One-day symposium at RAeS.*
Oct 31	*British Institution of Radio Engineers, Southern Section: "Laser Communications," by M. Dore and G. W. Waters.*

The 1964 version of the Cessna 150 incorporates the "omni-vision" rear canopy already featured on the larger Cessna types. Powered by a 100 h.p. Continental O-200A, the new 150 has an increase in gross weight from 1,500lb to 1,600lb. Price of the standard version is $7,825

SPORT AND BUSINESS

Slingsby's New Baby Development work on the new Slingsby T-51 fifteen-metre sailplane is expected to be complete by the end of this year, with production deliveries planned for early 1964. Aircraft of this type will fly in next year's National Gliding Championships, and "will be available in quantities" before the next world championships. The following description of the machine (illustrated last week) has been given by the company.

"The object has been to create a machine which incorporates the latest aerodynamic refinements in design, while still being comfortable and pleasant to fly. The fuselage has low, clean lines but still allows the pilot to sit in a natural seating position where he has good visibility through a large aerodynamic shaped canopy. Extremely reclining seats were considered in the early stages of design but were rejected on the ground of reduced pilot efficiency. Considerable saving in fuselage depth has been obtained by running all flying controls along the side of the cockpit instead of under the pilot's seat.

"The wing has an aspect ratio of 18, and is of low taper ratio with a straight leading edge. The constructional methods allow a very clean profile to be obtained and all external excrescences have been avoided by running the flying controls entirely inside the profile.

"The tailplane is of the all-moving type, and tail unit areas have been kept to a minimum by the use of a long rear fuselage. The overall length of this component is the same as one wing.

"The ailerons and elevator are operated by open-circuit, push-rod controls. These are unaffected by variations in temperature. Throughout the control system, all moving parts are mounted on either "sealed-for-life" aircraft bearings or p.t.f.e. plastic bearings. This means that the control system will not require lubrication in the life of the aircraft. The only components requiring lubrication on the aircraft are the tow release and the landing wheel.

"Great care has been taken in the design of components to ensure straightforward servicing and maintenance. All components in the control system can be readily removed through access holes. Control cables and push rods can be withdrawn and replaced in the components without cutting away the ply skin or fabric. The fuselage nose round the cockpit area is made up of separate units which can be replaced by unskilled labour in the event of damage.

"The undercarriage consists of a mainwheel, which is mounted well forward of the c.g. forward point on the aircraft. A light rubber-mounted skid is positioned along the underside of the forward fuselage to prevent damage in the event of nosing over on landing. The tailskid is rubber-mounted. A band-type wheel-brake is fitted on the main landing wheel, but a highly efficient internal expanding brake is also available at small extra cost."

This attractive ultra-light, designed and built by John O. Isaacs of Southampton, is based on a seven-tenths scale version of the pre-war Hawker Fury. Spanning 21ft and powered by a 65 h.p. Walter Micron III, the machine made its maiden flight on August 30 with John Heaton at the controls

WHAT'S WRONG WITH AIR RACING?

By Lewis Benjamin

WHAT has happened to air racing? How many remember the giant meetings in Europe of the twenties and thirties and the time when a 100,000 spectator event both in Europe and America was almost commonplace? And the aircraft—sleek, potent, race-designed hot ships, compact bundles of power. Dangerous, exciting, crowd-compelling. Of all the countries that once proudly presented air racing on a national scale only Britain still retains recognized annual events, and they are but a poor mockery of things that once were.

What vintage racing years they were! In 1936, the year that Charles Gardner won the premier event, the Kings Cup was a 20-lap, 312-mile full-throttle race, and *that* after an eliminating dash of 1,224 miles! Ever since 1922, when King George V gave racing popular recognition, the sport had attracted tremendous crowds, and had half the country keenly following the contestants, who were themselves household names. Remember a few? Alex Henshaw, Amy Mollison, Geoffrey de Havilland, Tommy Rose. In the USA, where racing was done on a gigantic money-making scale, pilots raced for fabulous purses and were feted and probably better-known than many so-called film stars. Huge concerns backed their men and machines, in a manner more reminiscent of a wartime project.

The USA produced some fine new machines immediately after the war and the initial races were well-attended, but they were a sad reminder of greater things and, after a few years, had all but faded from the scene. That was nearly 20 years ago. Now only Britain is left still running obsolete races that no longer attract the public in sufficient numbers to attract the money, which in turn means nothing being ploughed back into the sport—a dreary circle that must eventually mean the death of racing in this country.

Just how little interest is shown is best illustrated by the fact, that since 1961, *none of the races has been televised.* The sports viewing every year on that day has included motor racing, athletics, swimming and (naturally) cricket, and the national newspapers have given the scantest cover, usually a few inches somewhere inside. Was it the repetition of the same old warriors battling around the same old course that lost the races national coverage?

In 1961, of the aircraft that got through to the once-proud Kings Cup, only three were postwar and one was even 30 years old in a handicapped race for odd aircraft racing flat out at speeds from 100 to 300 m.p.h. This year there were still six over 20 years old. Race? Its a handicapper's nightmare, with wily pilots trying to pull the wool over the eyes of wily handicappers.

There is nothing wrong with the standard of racing—the pilots probably have never been better—but the chances of winning are not strictly by skill alone. So what keeps racing going in Britain? It certainly isn't the prize money. Never in the field of flying endeavour have so many pilots flown so much for so little (if the parody may be forgiven).

The race of the year is for a cup—spell it any way you wish but it remains just a cup, and on loan at that. Nothing else, and racing an aeroplane—even as we do in Britain, on the cheap—isn't cheap. No, pilots do it for the fun and the honour of winning, the pleasure of pitting their skill against one another, the community of good pilots and friends, a few days away and several good parties.

The Kings Cup was, at least until this year, the ultimate race of a series whose eliminating rounds earned cash prices, £25 for the first in each class, £15 and £10 for the second and third. Not much, is it? (Incidentally the entry fee was £10.) This year, however, there was only *one* qualifying race. Seven laps of an 18-mile circuit and the National Air Races were over for another year. Seventy minutes of glorious flying on the strength of which the handicappers attempted the impossible, and a good pilot found himself with the uneasy title of British Air Racing Champion.

It is not hard to foresee the eventual decline and fall of air racing in this country for, as time goes by, the backers are going to be even harder to find. This does not reflect either on the pilots or on the organizing bodies, all of whom do a fine job. Another factor, financial backers apart, is that machines get more expensive and less expendable. Since few can afford two aircraft, one solely for racing, the family or business mount must be spared the caning of a full-throttle, low-level race.

But what's wrong with racing aeroplanes? The public once loved it and the pilots enjoy it. What it wants is a new approach, something nearer the modern conception of a race, be it sailing dinhgies, cars or horses. *There must be one class, one start and everyone for himself.* Bring racing back. Give the public, and after all they are the real backers, the spectacle of genuine, closed-circuit racing. Give the pilots the incentive and they will risk their cash if, by their skill and endeavour, they stand a chance of getting it back with interest. I firmly believe there is a space in the public's ever increasing leisure-time to watch *real* air racing.

Leave air racing for a moment and consider motor racing. Motor racing was having a heyday when Bleriot crossed the Channel, and through its subsequent ups and downs it is still as popular as ever. Why? First, the salient points. It is compact, the spectator is always in the picture, the noise and atmosphere are constantly with them. It is international—not always, it is true, but this can be an important point because, patriotic feelings being what they are, anything that can induce national pride (or chagrin) is a sure-fire draw. It is sponsored by interested companies, manufacturers and by the great big happy public—and because *they* watch, so do their eyes and ears, the national Press, radio, newsreels and television; a wonderful snowball effect that spells success to anything it touches. I do not believe that Mr and Mrs Smith watch motor racing because Joe Smith sees himself as another Fangio but because it is a spectacle, dashing, exciting and sheer escape. There is nothing humdrum about magnificent metal screaming at its limit.

Now substitute aircraft for cars and be guided by these factors: one class, compactness, sponsorship and international participation.

Here is the basis for a revival of air racing. I do not believe that an all-metal racer, regulated in size and power, would cost more than a Formula I car, and in the junior class the aeroplane equivalent would not cost as much as a sports car. Given weight and construction limits and with one engine specified for all, the initial cost could be as little as £600, well within the pocket of any syndicate.

Neither is the venue a problem, for the major motor-race tracks all over Europe and this country are often converted airfields anyway, and most of them have excellent facilities for flying-in. This might in itself present the initial way to re-start racing with a minimum of bother, as a same-day attraction at motor race meetings. Regardless of aircraft that may one day be designed and built to set formulae, there is at this moment a suitable junior-class racer in general use—the robust Turbulent.

The right body to investigate the potential and to set up the regulations is already in being—the FAI, with its well-established offices in every country. (The writer puts this suggestion with tongue in cheek: the FAI *ought* to be the organizing body.) The exciting thing about the one-class air race concept is the undeniable fact that it *could start now* and, what is more, on an international scale if need be. This is not a pipe dream. From this modest return to racing big things could develop (MoA and ARB willing), from new racers to perhaps a World Air Racing Championship.

"Flight International" photograph

CONTOUR ENVELOPES

A Suggested Contribution to Solution of the Safety-height Problem

BY CAPTAIN T. FREER (British European Airways Corporation)

In a previous article in this journal (November 15, 1962) the author put forward a number of rules for the proper calculation of safety heights and suggested that navigation charts ought to give better portrayal of relief. In the contribution below he develops this suggestion in more detail.

IN 1962 there were 56 fatal accidents to civil transport aircraft (*Flight International*, January 10, 1963, pages 40-41). Among the various ways in which they occurred, there is one which is repeated at frequent intervals all down the list—"Hit mountain." No fewer than 14 of the accidents (i.e., 25 per cent) were due to this cause. Such a percentage would have been bad enough 30 or 40 years ago, when radio facilities and aircraft performance were far less developed than they are now: but in these days, when aviation reckons to have found most of the answers, the fact that such a succession of aircraft has come to grief in this way can only be described as a disgrace.

These accidents were almost all "avoidable"; they seem to have occurred not because the aircraft was definitely lost or in trouble, but because the relationship of aircraft to mountain was not correctly assessed. Indeed, if one reads between the lines, one can often deduce, as a common element in many of them, that right up to the moment of the disaster the crew were unaware and unconcerned.

It is significant that of the 14 accidents 11 were to scheduled aircraft and only three to non-scheduled. The problem is therefore not predominantly one of route experience, but is shared by all classes of operator alike. In fact, one characteristic of these accidents is that none of us is seen to be immune: we just don't seem able to avoid hitting mountains.

How has such a situation come about, and why does it persist, instead of showing an improvement commensurate with general progress? I suggest that the explanation is largely wrapped up in the history of chart development.

Air navigation began with topographical maps. Next, dead-reckoning processes brought in the plotting chart, but the topographical maps were still in constant use, especially for any functions concerning terrain. Now, however, the operations of take-off, climb, cruise, descent, and landing are all performed with various specialized charts, and it is rare for the topographical maps to appear on the flight deck at all. Terrain clearance in the air is therefore determined not at first-hand from the maps (which are not used), nor from the charts (which do not show terrain), but by the use of pre-calculated flight altitudes.

At modern airspeeds such pre-calculation is of course essential, and it would be ridiculous to advocate a solution along old-fashioned lines, with the pilot attempting to work out everything in the air; but it is valuable to take a very close look at just what we are now doing.

The pre-calculated altitudes are each based on certain assumptions. For example, any en-route safety altitude must have assumed that the aircraft will not stray more than x miles off the intended track; again, safe acceptance of a particular ATC Clearance may depend upon adequate confirmation of ground-speed; and so on. The details do not concern us here; the important thing is that all such altitudes and clearances, for whatever phase of a flight, are valid only within the assumptions necessarily used in their preparation.

It is elementary, therefore, that pilots should at all times be alert to the effect of any discrepancy in flight or any deterioration in the navigation below the standard assumed; and that they should have the means, whenever such is the case, to re-assess the situation and decide what action is safe. The present philosophy of the charts, however, invites the opposite: because the charts do not show terrain, pilots are not only deprived of the means but are also encouraged to forget even the need. There is almost an unconscious agreement that the mountains are not really any longer a pilot's direct concern.

It is therefore a valid proposition that, whatever the care with which all the pre-calculated altitudes, etc, have been prepared, real safety cannot be maintained unless pilots have a reliable portrayal of the terrain, so that they will be re-assessing it according to circumstances; and that, since the thing to be assessed is the relationship of terrain to route and aids, the portrayal is not satisfactory in the form of a separate topographical map, but needs to be incorporated in the various charts which pilots use regularly when flying by instruments and on which the routes and aids are displayed.

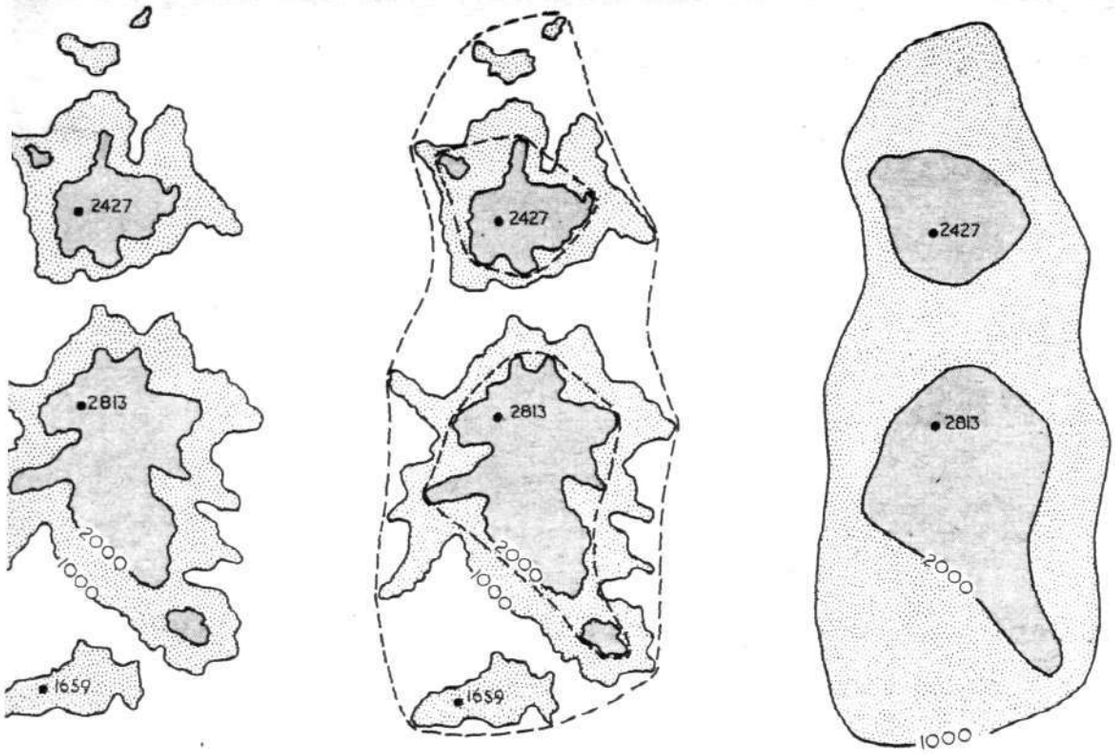
Spot Elevations Alone are not Enough The above requirement is a considerable burden to place on the congested charts of instrument flight. There is therefore an understandable desire to satisfy it by portraying the relief with the minimum means possible, and in consequence the majority of such charts customarily show just a selection of spot elevations.

By this means they have not in fact satisfied the requirement at all; moreover, by *appearing* to have done so, they unwittingly prevent any progress towards a real solution. It is therefore necessary to explain here at some length exactly why it is that spot elevations alone are not enough.

Each spot merely indicates that at that point the elevation has a particular value. As one moves away from the spot, one can usually take it for granted that the ground falls; but on the nature of the fall there is no information. It is therefore unsafe to fly past the side of a spot elevation at any lower height than one would fly over the top of it, and this can be true whatever one's distance off to the side.

Careful selection by the cartographer of an adequate number of spots can sometimes make the problem less apparent, but it does not really solve it. The difficulty is one of principle—a pilot on instruments needs a guarantee that everywhere in his potential area ahead the terrain is all below him: the real need is *positive indication of the areas of low*. This can be accomplished only by contours: outside a particular contour the terrain is seen to be all below that contour. It is therefore unavoidable that any requirement for portrayal of terrain must be given effect by the use of contours.

Continued overleaf



CONTOUR ENVELOPES...

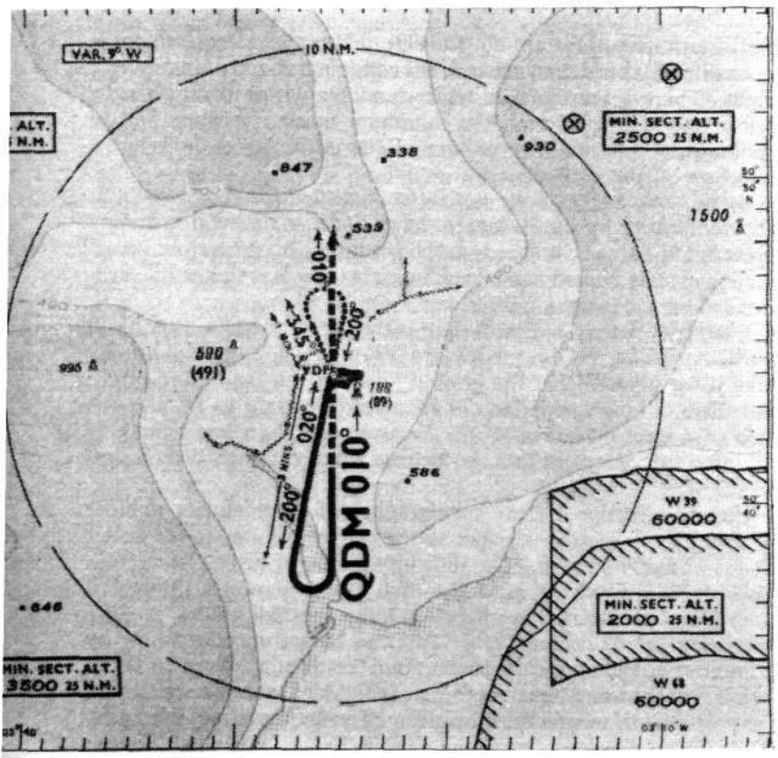
Figs 1-3 How "contour envelopes" are derived from contours. The degree of smoothing (enveloping) employed will depend upon the scale and function of the final chart. The two spot elevations in Fig 3 are retained only after verifying that they really are the highest points within their respective envelopes

"Contour Envelopes" Contours are all very well in theory; but as soon as they are applied to the charts in practice considerable difficulties of legibility become apparent. These difficulties are of course much reduced if in addition to contour lines there are also layer tints, and layer tints are therefore an obvious feature for adoption; however, a large part of the legibility problem is connected not with the use or non-use of tints, but with the intricate meanderings and multiple small pieces of the contour lines themselves; and unless this aspect is first remedied the use of tints will not by itself achieve clarity.

Now, on a chart intended for navigation on instruments, detailed intricacies do not contribute anything extra. Nothing is lost, therefore, if contours are smoothed by the elimination of unnecessary re-entrants and by the joining up of any closely adjacent pieces into larger blocks. This is illustrated in Figs 1-3. The resultant "contour envelopes" enclose the higher ground, but a better view is that they guarantee that the ground outside them is below.

Drawing the contours as envelopes makes possible a clean portrayal of the relief, the meaning of which can be interpreted by the user instantaneously; moreover, the chart's general legibility is least obstructed. An excellent example of their successful application is the United Kingdom Ministry of Aviation Instrument Approach Charts, series GSGS 4939 (Fig 4); it is unfortunate that for quite other reasons these Ministry charts are not much used and are consequently not as well known as they should be.

Fig 4 A Ministry of Aviation instrument approach chart (Exeter). The terrain is shown by contour envelopes; the spot elevations, however, do not quite conform to the author's rule. (Reproduction approximately three-quarters actual size of coloured original)



Proper Function of a Spot Elevation When contours (or contour envelopes) are present on a chart they have a definite bearing on the correct decision of what spot elevations ought to be shown. This fact is not often appreciated; it should be applied, incidentally, to topographical maps also.

Suppose a chart has contours at 2,000ft and 4,000ft, and a hill is to be shown which rises to 3,500ft. Insofar as the contours are concerned, this hill will be shown by a closed contour of 2,000ft. If no spot elevations are added, the whole area inside this contour has to be assumed to reach 3,999ft, because there is no evidence that it is less; but if the top of the hill is indicated by a spot elevation (3,500ft), the area inside the contour can be assumed to be nowhere else above 3,499ft.

Thus the function of a spot elevation, when contours are present, is not to show the height of a point, but to show how low the area within the contour can be overflown; within each hill's top contour there should therefore be only one, and there should be none whatever between its lower contours or outside the bottom one.

This rule, when applied to contour envelopes, has a significant effect on the subject of clutter: contour envelopes place the strictest limit on the number of spot elevations to be shown, so their adoption can surprisingly *reduce* the clutter even on a chart that previously had no contours or layers at all.

Application to Particular Charts Having arrived at contour envelopes as the only solution that can be considered satisfactory, it is incumbent on us now to examine more closely their application to particular charts.

Instrument approach charts Here the application contains no problems at all. Reference has already been made to the MoA instrument approach charts, on which contour envelopes have for some years been used without fuss (Fig 4). Far from causing congestion and difficulties of legibility, the effect is the opposite; when compared with the spotty and confused appearance presented by most other charts (e.g., Fig 5), the interpretation of these is extraordinarily clear. It is regrettable that other publishers are so slow to follow the obvious lead.

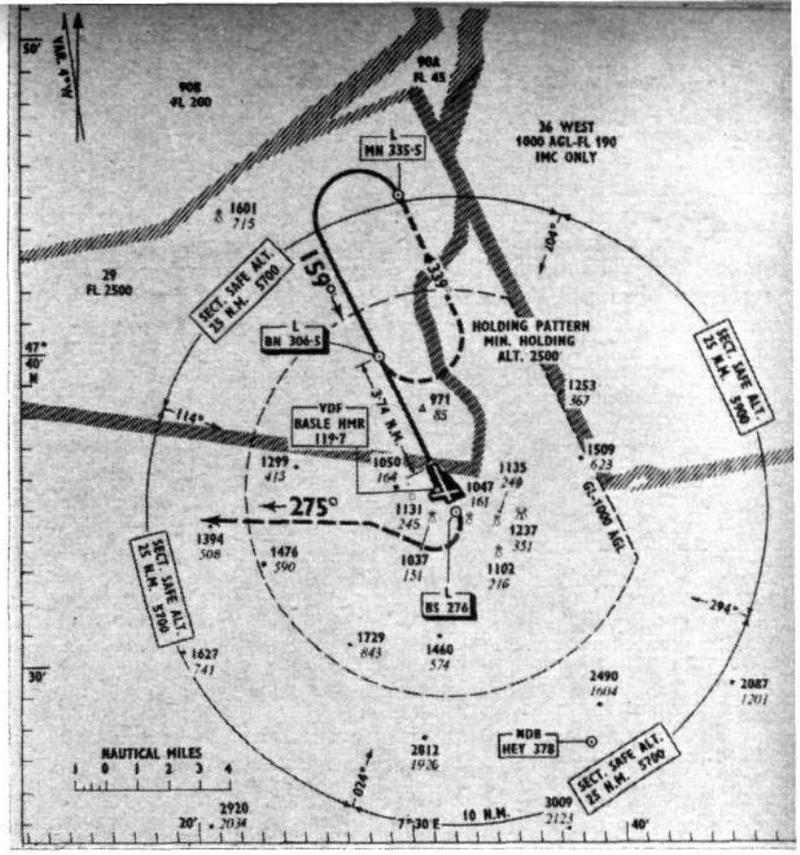


Fig 5 Most charts, like this one, use spot elevations alone. It is impossible for any reliable appreciation of the terrain to be obtained from them. (Reproduction approximately three-quarters original size)

Terminal area charts These charts, intermediate between the charts of instrument approach and the charts used en-route, have gradually come into being in order to supply adequate information on the entry and exit patterns introduced with increasing Air Traffic Control. In consequence, terrain problems have been given only token recognition: there are many such charts that show just a small random selection of spots (high points), thus inviting all kinds of false assumptions about the ground being low elsewhere (e.g., Fig 6). Contour envelopes would rationalize all this; and the effect on the appearance of the charts would be very similar to the above-mentioned instrument approach charts (Fig 4), except that to accord with the function of a terminal area chart the vertical spacing of the contour envelopes would of course be greater.

Possibly on these terminal area charts the need for a proper portrayal of the terrain is greater than on any other type. These charts are in use during phases of flight where questions of climb or descent, or of an unexpected re-routeing by ATC, are predominant; and that such questions are at present habitually being tackled without having a handy picture of the terrain is really very remarkable. (It should here be emphasized that responsibility for terrain clearance is not a part of ATC's terms of reference, so every climb, descent, or re-routeing has to be verified as to terrain by the pilot.)

Radio-navigation charts (used en-route) The requirement here (Fig 7) is exactly the same as in the case of the terminal area charts, i.e., instead of the usual token spots there ought to be appropriately spaced contour envelopes. Though this is nothing unreasonable, the suggestion that these charts should show terrain properly is often received with surprise. The surprise is due to the charts having a misleading name: as the name implies, they were originally conceived as fulfilling only the special function of *radio* navigation; and in order that the overall requirements should be covered they were expected always to be supplementary to other charts or maps. This situation, however, has long since been modified in practice, and it is now true to say that for the en-route phase the radio-navigation chart is generally the only chart (or map) that is used. It therefore has an obligation to consider the whole navigation rather than only a part, and of the whole navigation one of the primary aspects is terrain.

Critics will say that a requirement for one chart covering the whole navigation is all very well, but that since radio-navigation charts are already congested they cannot reasonably take the addition of anything not already on them. This argument is valid only if the whole of the information at present on them is more vital than terrain. It is a matter of priorities; and I suggest we

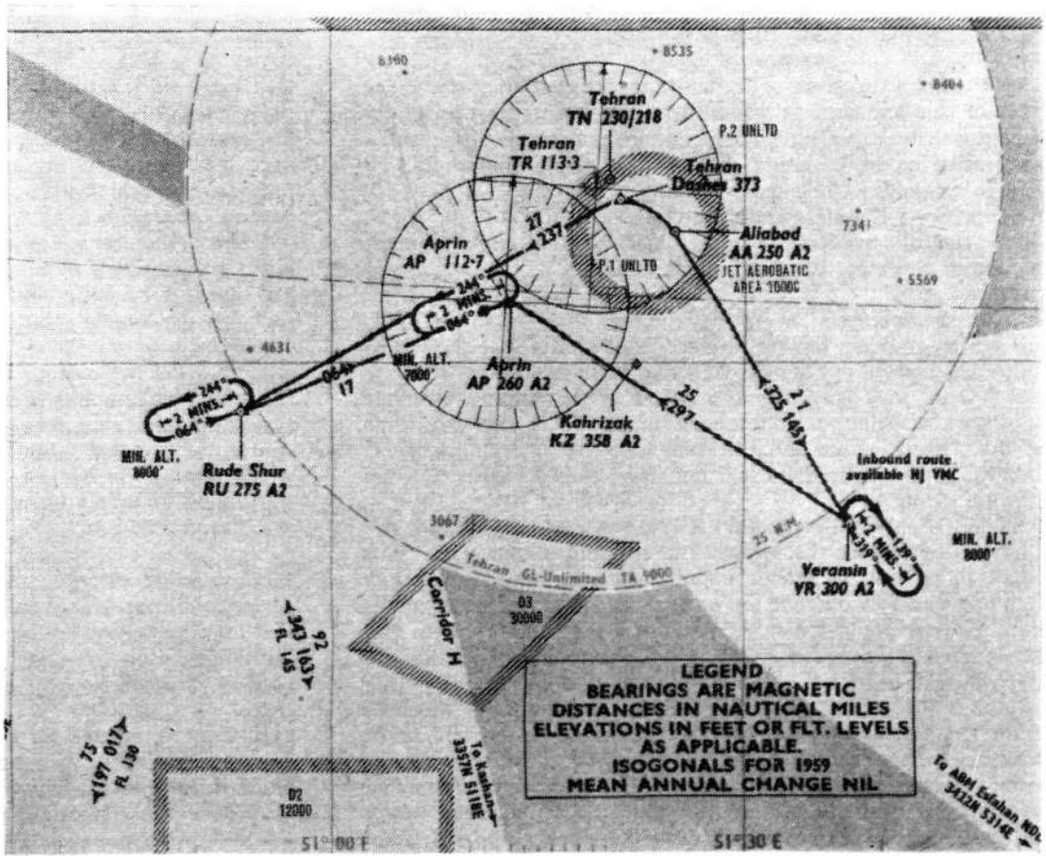


Fig 6 A terminal area chart (part of, reproduced here approximately three-quarters the size of the coloured original). The few spots shown can do more harm than good, because they can encourage pilots to assume that elsewhere the ground is lower. Just how much lower?

CONTOUR ENVELOPES...

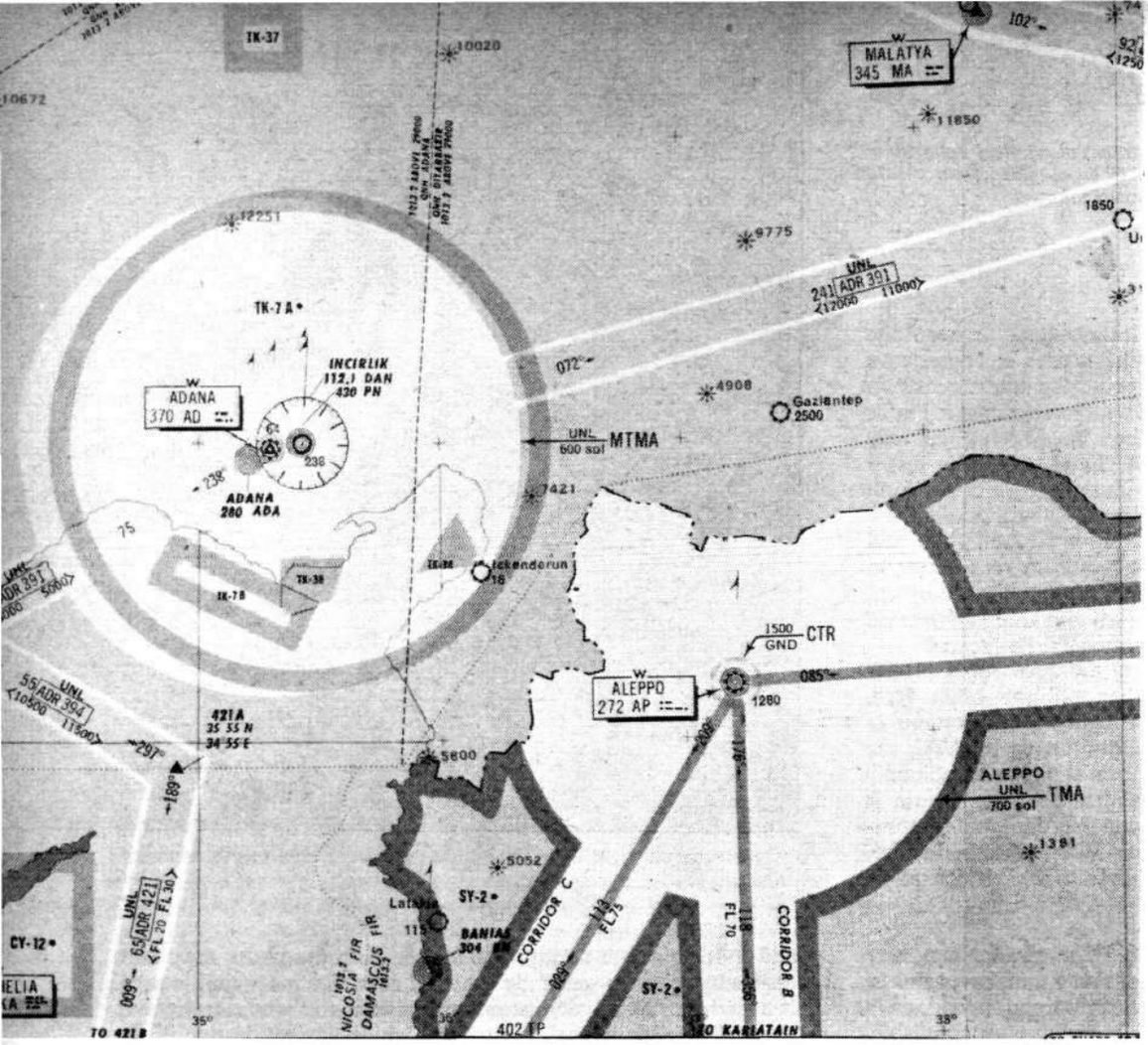


Fig 7 A radio-navigation chart (part of, reproduced here approximately three-quarters the size of the coloured original). As in Fig 6, the few spots shown cannot possibly answer the user's essential question "How low is this or that area?"

have not yet got a chart with the priorities right. The relegation of terrain to a separate chart (map) has not been decided on priorities, but is a historical accident arising from the way in which navigation was developed. The need at the present time is to re-think the priorities; re-build a "general navigation chart" (not calling it "radio-navigation" chart); and if it becomes congested choose for display elsewhere some of the less important items that do not have such serious consequences as do the sides of mountains.

Some Possible Objections The above three examples of particular types of charts should be sufficient to show how the application of contour envelopes is intended; it seems unnecessary here to list every other type of aviation chart and to detail what should be done in every case—the important thing at this stage is to establish the principles. The most useful way to conclude, therefore, will be to give careful consideration to the objections that might be made to contour envelopes; they are roughly four:—

(1) *Contour Envelopes "a luxury"* There must be many pilots and navigators who, having regularly used charts that show only spots, are inclined to take the view that there is nothing wrong in that system; they may therefore object to the contour envelope suggestion as being an unnecessary luxury. This view may even be put forward quite forcibly, but I believe it is precariously founded and its supporters will not have looked closely at what they are saying.

Under the sub-heading "Spot Elevations Alone are Not Enough" I have tried to give the proof. The essential sentence is: "It is unsafe to fly past the side of a spot elevation at any lower height than one would fly over the top of it, and this can be true whatever one's distance off to the side." Now if a particular chart in fact shows spots in large numbers, there is a reasonable chance that the user will take in by eye not only the spots that lie obviously "on" his route, but also all those others that are relevant but which lie to the side; he will do this because commonsense shows it to be necessary. This procedure has worked more or less well (it can never be quite reliable) on the smaller-scale plotting-charts that often do have spots in considerable numbers. If, however, we try the same procedure on most other charts (on, say, a typical radio-navigation chart), the system utterly collapses: the number of spots is far too few; and their spacing on the paper is so wide that it is certain the user's eye will *not* take in those that lie off his route to the side; commonsense is unable to reach that far, because the distance-off that ought to be searched is so very much greater.

You cannot champion the spot-elevation system and then be unconcerned about the density and distribution of the spots provided.

(2) *Congestion* On this subject I have already said much in earlier paragraphs, especially with reference to the radio-navigation charts: but since this objection seems likely to be the most serious of the four, it is worth looking at again; moreover, the remarks which follow are not confined to one particular type of chart but have a general application to all.

It is true that the addition of contour envelopes to charts as they are at present would in most cases be bound to increase congestion. But that is not a fair comparison. Since the present charts usually carry an inadequate selection of spots, the only fair comparison would be between (a) contour envelopes (plus those few spots coming under the contour rule given in an earlier paragraph) and (b) spots by themselves *in adequate number* to ensure that the user makes no false interpretation. The latter choice would mean, of course, a chart that is spotted all over. There is no doubt at all which system will win on congestion; indeed, in the case of the instrument approach chart it has already been demonstrated by the charts of the MoA (Fig 4).

(3) *Insufficient surveys* Any specified requirement for contour envelopes of particular values can run into difficulties if it is found that some parts have not been sufficiently surveyed, but this is not a justifiable reason for taking no action; it has not, for instance, been used as a reason for providing no contours on the topographical maps.

If there is insufficient basic information for the drawing of contour envelopes, then any corresponding portrayal by spots alone is not only inadequate for the reasons already given, but is also likely to be concealing the basic deficiency: a chart can be produced showing only such spots as were available to the draughtsman,

and it is nobody's business then to consider whether these are "sufficient." In an extreme case, an instrument approach chart of a hilly area may be produced with scarcely any sign of relief appearing on it at all.

The insufficiency of some surveys is not, therefore, a reason for avoiding contour envelopes, but the reverse.

(4) *Expense* Whenever improvements are discussed in anything already in use, the question of increased costs always has to be considered; and it is only natural that those responsible for chart production should shrink from adopting something that may make their costs go up. This increase should be judged, however, in the light of what is gained. Apart from the issue of safety—which must, of course, be our main concern—it is in fact doubtful whether the cheaper chart is in the long run any real economy. The cost of even the most elaborate charts will always be a mere drop compared with the total costs of a flight; and an extra two or three minutes of flying, necessitated by inadequate terrain information having held up the descent, can cost more in fuel than a new set of charts all in many colours.

Having said that, let us then look at the nature of the cost increase that contour envelopes would involve. In an earlier paragraph I mentioned that it would mean the adoption of layer-tinting, which immediately brings to mind the expensive processes of high-class cartography; and these are undesirable for charts that need frequent revision. Such ideal processes, however, are for our purposes unnecessary; there are perfectly adequate ways of printing layers at very small cost, and as soon as the need is fully recognized the technical solutions can be expected to follow quite easily.

Summing-up Will a better portrayal of the terrain make any difference, ultimately, in the number of mountain accidents? If the real trouble is that the pilot is not always where he thinks he is, then better portrayal of the terrain is no answer. Yet isn't it—at least in part? If a good portrayal can be provided on the charts that pilots are always using regularly, there will be a greater hope of their cultivating a permanent awareness of the possibility of hitting something, instead of taking things for granted. In addition to the immediate value in the handling of any particular situation, contour envelopes will therefore have also an educational value of far-reaching effect.

Acknowledgment is made to British European Airways for permission to publish this article, but the opinions expressed are not necessarily those of the corporation.

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A PIONEER'S CURIOUS AUTOBIOGRAPHY

IT is a great pity that Gabriel Voisin ever decided to publish his autobiography,* the French original (with the less snappy title *Mes Dix Mille Cerfs Volants*) having appeared in 1961, when he was already over eighty: for it can only be a great disappointment to historians.

This fine old pioneer first arrived on the aviation scene in 1904, when he became assistant and glider-pilot to Ernest Archdeacon. Thereafter, with his box-kite machines of 1905-09, he made a valuable contribution to aviation by helping to establish the stable European biplane, initiated by Ferber in 1904. It was Ferber who said he introduced Gabriel to aviation. But, like his fellow Europeans, Gabriel and his brother Charles made slow going, and Voisin machines only became practical vehicles in 1908; even then, the Voisin brothers stubbornly refused to pay any attention to lateral control and, as a result, nearly suffered eclipse during 1909-10.

One of the curious problems of early aviation history is the amount of credit due to Gabriel Voisin in the machines he produced. It is virtually certain, for example, that the first Voisin to achieve success in 1908 (Henri Farman's machine) owed much of that success to the modifications Farman himself had made. Colliex, too, is believed to have played a large part in later Voisin designs. These and many other questions would, one hoped, have had light thrown upon them; and one also looked forward to fascinating sidelights on that great period of flying history.

But the autobiography which has come from Gabriel's pen is the worst monument to his reputation that could have been devised. Apart from the regular reports—often vulgar and seldom funny—on the ladies whose favours he and his friends often shared, his account of aeronautical life and work is so full of demonstrable inaccuracies and obscurities that one feels unable to trust even his recollection of events in his personal life.

The reader may take a little time before he tumbles to the *leitmotiv* in the book: put quite simply, it is that Gabriel Voisin was the inventor of the modern aeroplane! "The first aeroplane officially observed to leave the ground under its own power, to manœuvre in pitch and azimuth, and then to return safely to the ground, was a Voisin, piloted by Henri Farman (on January 13 1908)." It is a melancholy fact that no Voisin aeroplane could stay in the air for 60 consecutive seconds until November 1907. Gabriel denigrates one after another of his contemporaries, or omits them altogether. Perhaps because the Wrights must always have loomed as his worst obstacle, the unfortunate boys from Dayton are treated, in the final chapter, to a 33-page farrago of such nonsense that Edward Lear seems sober truth by comparison. But just in case someone exists who believes whatever he sees in print, I cannot avoid mentioning a few points, typical of many, presented by Gabriel.

(1) He says that the No 1 *Flyer* of 1903 was the "same machine" flown by Wilbur in France in 1908! No comment.

(2) Speaking of the Wrights' No 3 *Flyer* of 1905, the first practical aeroplane of history, Gabriel writes: "it could have flown, and it did fly, with the engine stopped, by means of favourable upcurrents." This is surely one of the most egregious statements of history.

(3) "No technician of real standing can admit that the Wrights inspired anything at all." No comment.

(4) "Wilbur Wright made his first flight in France on 8 August 1908. On 24 July 1909 he packed his bags and went back to America. The Wright aeroplane was dead and contributed not a tittle to future designs." Gabriel may have forgotten that Wilbur, in 1908 alone, was airborne for *over 25 hours*, with seven flights of over an hour, and one of 2hr 20min, to say nothing of 60 passenger flights; that he taught aviators how to control an aeroplane; and that Gabriel's old friend and Voisin-pilot Delagrange cried amidst the general acclaim: "*Nous sommes battus! Nous n'existons pas!*"

(5) "The Wright aircraft was never able to leave the ground under its own power until the 1908 period when it was fitted with a French engine, built in France by the firm of Bariquand and Marre of Paris." Leaving aside the first absurdity, Gabriel was evidently never informed that this triumphant "French engine" was the excellent standard Wright 30 h.p. engine built under licence in France by the firm in question!

"Truth," says old Gabriel piously on page 237, "is the objective."

C. H. GIBBS-SMITH

*"*Men, Women and 10,000 Kites*," by Gabriel Voisin. Translated by Oliver Stewart. Putnam, London; price 30s.*

INDUSTRY International

Products

Company News

Great Britain

Miniaturized Cooling To meet the increasing demand for forced cooling of densely packed electronic equipment, the Plessey Co (UK) Ltd have developed what is described as an extremely compact 5oz axial blower capable of operating continuously at a maximum ambient temperature of 100°C. Maintenance-free life of the unit under normal working conditions is said to be 2,500hr.

Designed to meet MoA specification EL 2005, it utilizes a totally enclosed three-phase squirrel cage induction motor working from a 115/200V 400c/s a.c. supply. Single-phase operation is achieved by means of a 0.75μF capacitor.

Measuring only 1⅝in (41.3mm) in diameter × 2¾in (69.9mm) long, the blower develops through its moulded impeller an airflow of 20 cu/ft min in free air or 10 cu ft/min when working against a back pressure of 1.5in s.w.g. Although designed primarily for the aircraft industry, the blower has a vast range of applications in other industries where compact temperature regulating equipment is required.

Marconi Instruments Director Prof H. E. M. Barlow, PhD, BSc., FRS, MIMechE, MIEE, Pender Professor of Electrical Engineering at Universty College, London, has been elected to the board of Marconi Instruments Ltd. Well-known in scientific circles for his work in the microwave field and in power measurement, he worked during the war on the development of radar with the Air Ministry Telecommunications Research Establishment and in 1943 was appointed Superintendent of the Radio Department at RAE Farnborough. After the war he rejoined University College as Professor of Electrical Engineering, being awarded a Fellowship a year later and in 1949 being appointed Dean of the engineering faculty.

HAL's Orpheus Century The 100th Bristol Siddeley Orpheus engine to be built under licence by Hindustan Aircraft Ltd at their factory in Bangalore completed its normal test schedule for delivery to the Indian Air Force on September 30 and was formally handed-over to the Directorate of Development and Production at Air Headquarters, New Delhi.

Co-operation between Hindustan Aircraft and Bristol Siddeley dates back to 1954, the engine factory coming into operation at Bangalore in 1959 and the first production Orpheus coming off the line on November 21, 1960. HAL also manufacture Hawker Siddeley Gnats for the IAF, and Orpheus production is primarily to provide powerplants for these aircraft; but Orpheus engines are also being manufactured to provide booster units for IAF C-119 Packets.

The managing director of the aero-engine division of Hindustan Aircraft, AVM Ranjan Dutt, commented that, judged from their performance in the past two years, it could be assumed that HAL was today engaged in the manufacture of engines from raw materials. It was the authorities' intention to make them, within a year, from completely indigenous raw materials and components. For this purpose, Hindustan Aircraft was setting up a forge and foundry division.

Normalair-Drägerwerk Partnership A new British company, Dräger Normalair Ltd, with headquarters at 29/31 Minshull Street, Manchester 1, has been formed by Normalair Ltd, Yeovil, and Drägerwerk, Lübeck, Germany, in equal partnership. Through this new organization, it is stated, will be channelled the joint experience and resources of both companies in the industrial breathing and safety fields. General manager of Dräger Normalair will be Mr A. V. Broadhurst, previously with Drägerwerk. Mr A. W. Bridge, who has pioneered Normalair's industrial work and the long-standing co-operation between the two companies, will maintain his connection by acting as consultant.

Charles Ward Retires Capt Charles Ward, London office manager for Blackburn Aircraft (now the Hawker Blackburn Division of Hawker Siddeley Aviation) for nearly 20 years, retired at the end of September, thus ending a connection with aviation which has lasted since he served as a pilot with 70 Sqn in the RFC.

He first came into contact with the civil aircraft industry when he joined William Beardmore & Co as a test pilot in 1920. In the following year he undertook the first of several overseas missions, becoming pilot-manager of an air survey expedition in Venezuela; then in 1923 was a civilian flying instructor with the Spanish army. Subsequently he became a director of Cobham-Blackburn Air Lines, remaining

Mr Kamil Sindi, Director of Civil Aviation, Saudi Arabia, seen (right) during a recent visit to the Marconi Co Ltd. With him are, left to right, Mr H. J. H. Wassell, works manager; and Mr E. L. T. Barton, Director of Telecommunications (Plans), MoA

Testing an Orpheus engine at Hindustan Aircraft Ltd, Bangalore, where the 100th engine of this type has recently been produced (see item above). Because of the factory's high altitude, and high temperatures experienced, the whole system of test calculations differs from those in Britain

with Sir Alan Cobham to manage the latter's own ventures and also acting as air correspondent to *The Bystander*.

Capt Ward was p.a. to the Director of Aircraft Production during the Second World War, then renewed his connection with Blackburn Aircraft, as London manager. He rejoined Sir Alan Cobham in 1947 to carry out Services' liaison and publicity for Flight Refuelling Ltd, then came back to Blackburn as London manager in 1950.

Bristol Aeroplane Director Sir Keith Murray, KCB, who recently relinquished the chairmanship of the University Grants Committee, has been elected to the board of the Bristol Aeroplane Co Ltd and will take up his appointment in the early summer of 1964.

Kuwait Airport Services G. N. Haden and Sons Ltd, PO Box No 14, 7/12 Tavistock Square, London WC1, have recently been awarded, in the face of strong international competition, a sub-contract valued at £510,000 for the complete mechanical services at Kuwait International Airport. The tender by Haden, one of 12 firms invited to submit, covers air-conditioning of numerous scattered buildings ranging from the control building to an isolated radar site, fuel oil storage tanks for diesel generators, airport fire mains, sewage pumps, large pressurization sets and distributing mains. Consulting and co-ordinating engineers are Messrs Frederick Snow & Partners.

USA

CF700 Agreement Signed International General Electric, overseas marketing division of US General Electric, has signed an agreement with Générale Aéronautique Marcel Dassault to provide CF700 turbofan engines for the Mystère 20. The order represents the first commercial application for this 4,200lb-thrust aft-fan version of the J85 turbojet. Dassault has announced a production line of 500 of the ten-passenger aircraft, of which 160 are to be purchased by Business Jets Division of Pan American World Airways for distribution in the United States, Canada and Latin America.

Testing of the first CF700 was begun in 1960. First application of the engine was in the Bell lunar landing simulator. Certification by the US Federal Aviation Agency is expected in mid-1964, and production engine shipments will follow shortly after.

Kollsman USAF Contract Kollsman Instrument Corp, Elmhurst 73, New York, a subsidiary of Standard Kollsman Industries Inc, have been awarded a contract by the Air Force Systems Command's Research and Technology Division, Wright-Patterson AFB, Ohio, for the development of a new gear generating system and an in-process control capability. The development contract is directed by the Manufacturing Technology Division, Air Force Materials Laboratory. Objective of this development, it is stated, is a control system embodied in a gear generator continuously measuring errors and applying correction through feed-back mechanism to provide an accurate and reliable manufacturing capability which will produce fine pitch spur gears for use in complex aerospace systems.

The Kollsman president, Mr David B. Nichinson, has commented that "up to now, accuracy limitations of gear generating equipment has constituted perhaps the greatest single barrier to the development of guidance and control systems for aircraft, missiles and spacecraft." Reliability of these systems, he added, depends greatly upon the accuracy of fine pitch gears. Successful development of the Kollsman gear generator and measuring device would constitute a significant breakthrough.

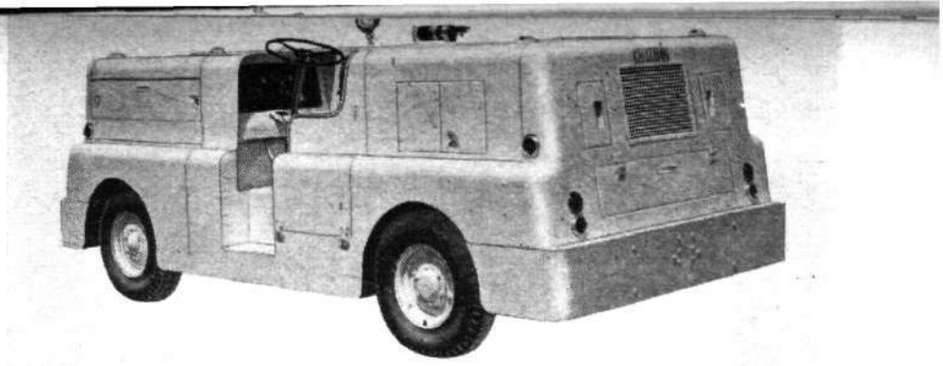
The Kollsman design concept, it is stated, will provide an accuracy to three seconds of arc in the mid-range of diameter gears and five seconds of arc in the smaller diameter range. Diametral pitch range objective is 20 to 200.

Describing Seal Design The Advanced Products Co, 62 Broadway, North Haven, Conn, have recently published European editions of the seals design manual which describes in detail what Metal-O-Rings are; how they may be used; what variations in metals, platings and coatings are available and many other engineering details. These static face type seals, fabricated from tubing of various alloys and produced in a wide range of shapes and sizes, are widely used to seal liquids and gases under a wide range of temperature and pressure extremes and corrosive conditions. The manuals (in English, German and French versions) are available from R. H. Symonds Ltd, 47 Victoria Street, London SW1, UK representatives for Advanced Products Co.

Gemini Airspeed Transducer The new Type TP-350 airspeed transducer by Fairchild Controls (a division of Fairchild Camera and Instrument Corp), 225 Park Avenue, Hicksville, Long Island, NY) has been selected for precise airspeed measurement during the descent phase of Gemini flights.

With the Rogallo-type paraglider employed, to ensure manœuvrability during landing operations, anticipated airspeed of the spacecraft during final descent stages is estimated as between 25 and 75kt; and in order to measure this slow rate of motion accurately a highly critical low-pressure system is required. The TP-350 is designed to measure changes in air pressure in the 0 to 1lb/sq in range; and for the paraglider, a unit has been designed to the exact requirements of 0 to 0.236lb/sq in d.

Selected by McDonnell Aircraft Corp, who are building the Gemini for NASA, as the airspeed transducer for the paraglider being developed by North American Aviation, Space and Information Division, the TP-350 is a potentiometer output type unit employing precision Fairchild potentiometer windings and wipers. It is 3.5in in diameter and 3in long and weighs approximately 2lb. Airspeed accuracy is rated at ± 3 per cent over the 25 to 75kt range.



Jetmobile self-propelled ground power unit by Motor Generator Corp (a Hobart Brothers affiliate) of Troy, Ohio. Power is provided by a Hobart salient-pole, revolving-field-type generator rated at 90kVA or 72kW at 0.8 p.f., 120/208V, 250A, 400-cycle a.c. driven by a V-8 International UV-549 engine of 187 h.p. The unit can also be supplied in a trailer-mounted version

Canada

Lightweight collapsible food-serving cart, 70 of which have recently been delivered by Timmins Aviation Ltd, Montreal International Airport, Dorval, Que, to TCA. Designed by the company and the airline in conjunction, they are believed to be the first of their type to be used on aircraft. When not in use, they can be folded flat for storage

SERVICE AVIATION

Air Force, Naval and Army Flying News

Smiles all round when Mr Peter Thorneycroft, Defence Minister (in raincoat), visiting 17 Sqn at RAF Wildenrath recently, discovered that among low-level photographs taken by the squadron's Canberras was one of his country home

RAF Carlisle Jubilee

ROYAL AIR FORCE CARLISLE celebrated the 25th anniversary of its formation on September 26 and to commemorate the long association of No 14 Maintenance Unit with Cumberland and the City of Carlisle, the CO, Gp Capt J. A. D. Sturges, made presentations to the chairman of Cumberland County Council and the Mayor of Carlisle. Since its opening on September 26, 1938, No 14 MU has grown to become the second largest employer in the city. Commenting on this, the unit says that "although its function, that of the receipt, storage and issue of RAF airborne and ground equipment, has remained unchanged over the years, the equipment and the nature of the various processes involved in its handling has become more complex and specialized. It is also pertinent that the RAF would not be able to operate without the support provided by No 14 Maintenance Unit."

Honouring the Chatelain

TRIBUTE WAS PAID BY THE ROYAL AIR FORCE on October 5 to the memory of a Frenchman who served it with great distinction during the war: Sqn Ldr Philippe Livry-Level, DSO, DFC, chatelain of the Normandy village of Audrieu, who died there three years ago, was commemorated by a memorial tablet unveiled in the church—said to be the first monument erected by the British Services to a Frenchman—and by a silver salver inscribed with famous names, presented to his widow. The unveiling was jointly performed by General Martial Valin, formerly Chief of the French Air Force, and Air Cdre G. F. W. Heycock, Air Attaché in Paris; and the presentation was made to Mme Livry-Level by the air commodore. Also present were AVM L. M. Hodges, who during the war was Sqn Ldr Livry-Level's squadron commander; and Mr L. P. Ratcliff, who for 18 months was his pilot on operations with the French Resistance, for example the picking-up of General de Lattre de Tassigny at Macon in 1943.

Philippe Livry-Level left his chateau and family in 1940 when the Germans invaded France, turned down an offer to join de Gaulle and subtracted 13 years from his identity document age to join the RAF. He flew as a navigator with 161 (Special Duties) Sqn on operations into Occupied Europe and took part in the Mosquito attack (Operation Jericho) on Amiens prison, which is especially commemorated in the memorial tablet. On this attack he lost his close friend Gp Capt Charles Pickard, whose photograph (Mme Livry-Level disclosed) was in her husband's wallet when he died.

Documenting 105 Sqn

A FULL SQUADRON HISTORY OF 105 SQN, at present based in Aden and equipped with Argosies, is being compiled by Flt Lt C. D. Roberts. He hopes to include cuttings and photographs relating to the squadron since it was first formed with RE.8s in 1917, and would be glad to hear from anyone who has relevant material. His address is No 105 Squadron, Royal Air Force, Khormaksar, BFPO 69.

The unit has had four periods of existence. After First World War service, it was disbanded in 1920; it was re-formed in 1937 with Hawker Hinds, subsequently becoming a Blenheim then a Mosquito squadron; disbanded in 1946, it was re-formed with Mosquitoes and then Canberras; and disbanded for a third time in 1957, it was re-formed last year with Argosies.

Sqn Ldr R. B. Gubbins (right), CO of the new University of Wales Air Squadron, referred to on this page last week, handing over duties at Woodvale recently to his successor as CO of Liverpool UAS, Sqn Ldr F. D. G. Clark

NO 39 SQN, only RAF unit in the southern NATO region, took part in a large-scale air show celebrating the tenth anniversary of 6ATAF when they flew over Izmir, Turkey, on October 13. The squadron is equipped with Canberra PR.9s and based at Luqa, Malta.

A DAY AT SEA IN HMS "VICTORIOUS" formed part of the itinerary of the First Lord of the Admiralty, Lord Carrington, during a Far East tour he has been making (to Kuala Lumpur, Singapore, Hong Kong and Aden) between October 7 and 18).

AIR CDRE J. B. COWARD, Commandant of the Air Training Corps, is flying to Geneva on November 3 to attend the 1963 International Air Cadet Exchange Conference, which is to plan next year's exchange of cadets between the United Kingdom, United States, Canada and European countries.

A MEMORIAL SERVICE for Gp Capt A. G. ("Sailor") Malan, who died in South Africa recently (*Flight International*, September 26), was held in St George's Memorial Chapel, RAF Biggin Hill, last Sunday, October 6, and attended by many of his famous wartime contemporaries.

"Every day of the year, except Sunday," says an Air Ministry news letter, a Comet 2 of 216 Sqn leaves Lyneham with Service passengers for the Mediterranean. Here SACW Christine Dykes, an operations clerk on duty in the Lyneham control tower, talks to a Comet captain

Straight and Level

I HOPE nobody thinks I am deliberately trying to "knock" the British Press. Though I often have a good old tilt at Fleet Street, I have a lot of respect for it too. At the moment I feel a slight knock coming on. Consider this:—

On September 17 the Press was invited to see the BMEWS Station at Fylingdales. Everybody was given the same package of written information. Everybody's questions were answered promptly and, presumably, correctly. But the newspapers of September 18 gave us four different periods by which the station has slipped from its original schedule (all of them less than the truth), four different values for the cost, and four different values for the diameter of the giant radar domes. And I don't mean the diameters were a few inches out: the reader can choose between 100ft, 116ft, 140ft (correct) and 180ft.

● *"A [BEA] domestic fare increase is both inevitable and overdue."*—from an article on increased MoA airport charges in *The Economist*.

Inevitable? Is it inevitable that an airline which makes a loss on a 68 per cent domestic load factor and a fare level higher than US domestic should increase fares? Would it not be better to see whether costs can't be cut first—even more than they have been in the last year—to absorb the higher airport prices?

Overdue? BEA increased domestic prices by 5-20 per cent at the beginning of the summer. If an increase is overdue, when would it have been timely?

Sir Charles Boost, chairman of Plummet Air Lines, comments: "I remember one day a couple of years ago old Blackie and I went to the Club for lunch. Admittedly it went on a little longer than usual because we had serious matters to discuss—he had a *super* pigskin-bound brochure on his new Mach 3 plasma-jet airliner project. Anyway, believe it or not, when I got back to the office our fares were still the same as they had been when Blackie and I left for lunch! I shoved 'em up 20 per cent at once and sacked the entire commercial staff on the spot."

● *Seven d.c. motors will be used for the aircrew feathering pumps and windscreen wipers.*—Equipment manufacturer's press release on the Belfast.

This modern technique of aircrew feathering reminds me of when I was doing some dual with Plt Off Prune during the war. He had recently come off operations, having been credited with destroying two Spitfires, three Hurricanes, a Defiant and an Airacobra, and was having a twin conversion. We were about to practice some asymmetric flying when Prune, who tended to be hamfisted, struck me a smart blow which feathered me for the rest of the sortie. After waking me up with his landing, he explained mildly that what he thought I said was "feather the aircrew," and responded promptly.

● I am content to print this news-agency item exactly as received:—

"NEW YORK. To help keep aircraft and hangar floors clean from roosting pigeons and sparrows, the US Air Force is employing two great horned owls. The owls are in a cage high in a B-47 jet bomber maintenance hangar near Columbus, Ohio. After they are acclimatized, they will be released and patrol the premises. Great horned owls are creatures of the woods, however, and may head back for their quiet home. Barn owls would perhaps be more content."

IDIOT! I told you not to open up to full throttle with the chocks on

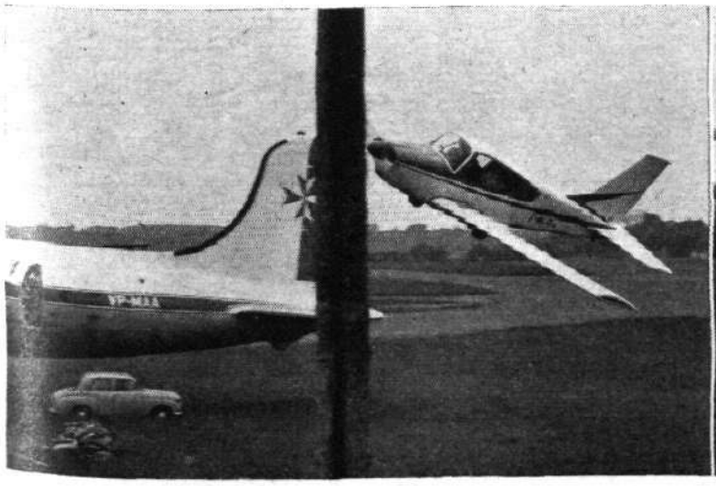
● From a news agency report: "AIRLINE HIRES JEST TO BEAT STRIKE."

From *The Daily Telegraph: "The pilot, Captain Daleford, did a brilliant job in saving the pet from going over the end of the runway."*

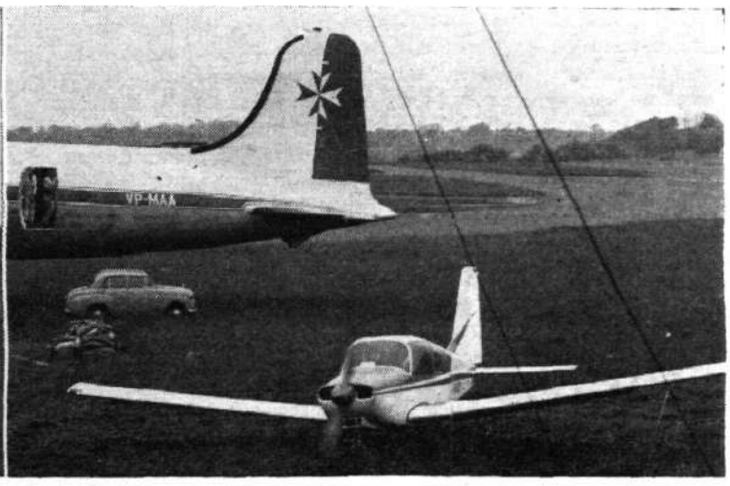
● I liked Allen Wheeler's story of the Fw190 and Lt Robinson in . . . *that nothing failed them*, reviewed in our pages last week. A Naval pilot at RAE, the lieutenant was briefed about the engine of a captured example being "indescribably rough." At 3,000ft he thought to himself, "I am glad I was told about this engine"; at 5,000ft, when it was getting worse, he reiterated this comment; and at 6,000ft, after a loud explosion, slight smell of fire and "a horrible silence," muttered: "Well, they certainly didn't tell me about this"—signing-off these unspoken comments with a magnificent deadstick landing, in an enemy aircraft which was not easy to land even with a live engine.

ROGER BACON

"Yes, I'm all right . . .



. . . thanks"



Missiles and Spaceflight

SPACE RECORDS CLAIMED

Eight world records for space flights have been claimed by the Soviet Union in submissions to the Fédération Aéronautique Internationale. These relate to the flights by Valery Bykovsky in Vostok 5 and Valentina Tereshkova in Vostok 6 made during June 14-19.

For Bykovsky's flight in Vostok 5, absolute and orbital-flight records were claimed for duration, approximately 119hr; and for distance, approximately 3,326,000km. In the case of the Vostok 6 flight, figures of 71hr duration, 231km altitude, 1,971,000km distance and 4,713kg payload were submitted as women's world records in the orbital-flight category.

The documents submitted to the FAI stated in addition that total maximum thrust of each of the Vostok 5 and 6 launch vehicles was 600,000kg (approximately 1,323,000lb). It was further stated that, four days before the launch of Vostok 5 from Baikonur, the pilot's seat, equipment compartment, the cabin of the space-ship and the braking engine assembly were weighed separately. The total weight of these items plus the fully equipped cosmonaut was 4,720kg. The document stated that, using "radiotechnological" methods, the measurements of time were accurate to one-millionth of a second, and the error in the distance measurement was not greater than 3 metres.

The following sequence for Valentina Tereshkova's re-entry and landing on June 19 was listed:—

GMT			
7hr	*20min*	*11sec*	*Orientation systems switched on*
7	*54*	*48*	*Braking engine assembly switched on*
8	*10*	*38*	*Cover of catapult hatch ejected; 2sec later, cosmonaut's parachute system switched on*
8	*11*	*00*	*Landing system of space-ship switched on*
8	*15*	*55*	*Landing of space-ship*
8	*20*	*00*	*Landing of cosmonaut*

The locations of Bykovsky's and Tereshkova's landing places were given as 53° 23′ 45″ N, 67° 36′ 41″ E, and 53° 16′ 18″ N, 80° 27′ 34″ E respectively.

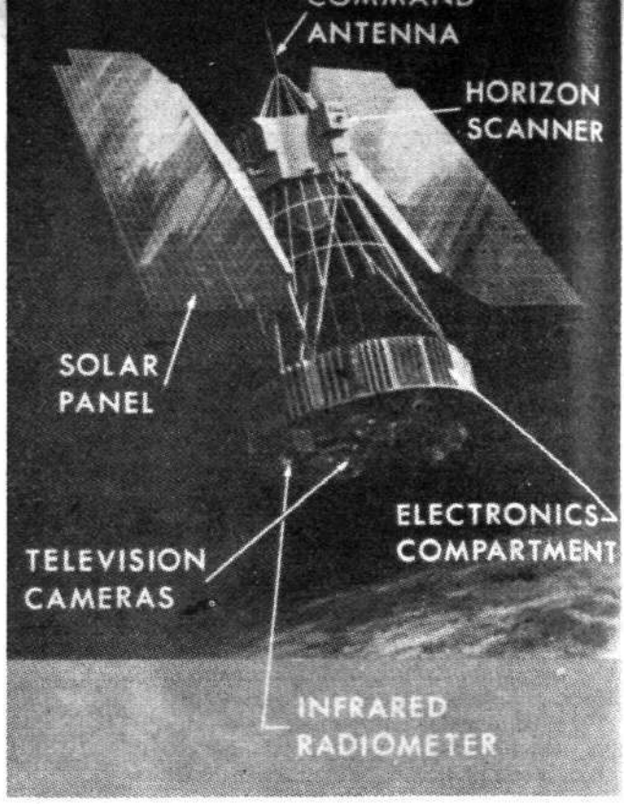
NIMBUS PROGRAMME CANCELLED

The US Weather Bureau and the National Aeronautics and Space Administration announced on October 4 that "further obligation of Weather Bureau funding in an operational meteorological satellite system based on the current Nimbus weather satellite configuration is being discontinued." Both agencies will together develop another type of long-life operational satellite to meet national requirements. The official statement continued:—

"The desired system will be based on a spacecraft specifically designed for use in a continuing operational system with the reliability and lifetime required to assure low annual cost of collecting weather data from satellites but at the same time to provide sufficient data for weather forecasting.

"It is planned that the future operational system will evolve from one based on an improved version of the already tested and highly dependable Tiros satellite to one that will give complete global coverage from satellites having a lifetime of the order of several years. Tiros, at present, does not give the scope of global coverage desired and the current configuration of Nimbus does not include a design lifetime of more than one year."

NASA is continuing to develop the currently approved Nimbus spacecraft for flight tests as part of a research and development programme. It is envisaged that the ultimate operational system will use subsystems and components from both Tiros and Nimbus.



As reported on this page, the US Nimbus meteorological satellite has been cancelled in its operational role, although it will be flown by NASA as a research and development project. The Nimbus satellite weighs 675lb, of which 116lb represents instruments

PROGRESS IN EUROSPACE

Membership of the industrial association Eurospace has increased over the past year from 84 (including active, corporate and corresponding members) to 143. This was reported to the general meeting of Eurospace in London on October 3 by the Council of the Association. As briefly reported last week, the need for establishing "an intergovernmental European organization capable of surveying spaces problems as a whole" was also mentioned in the Council's report. This, it was suggested, might be a co-ordinating federation of national space bodies such as those now being set up in several countries.

"We are often in touch with the European Launcher Development Organization," the report continued. "It is significant that, in July 1963, the ELDO Preparatory Group took the intiative in consulting Eurospace before submitting to the United States National Aeronautics and Space Administration a proposal for 'Arrangements concerning the exchange of technical information and their use within the framework of an ELDO/NASA Agreement.' "

Concerning the Preparatory Commission for European Space Research, the forerunner of ESRO, the report comments; "Delays in the parliamentary procedures of ratification have slowed down the growth of this organization and prevented us from establishing all the structural relations we should like to have built up."

"More recently, the governments of 15 European States have established a European Conference on Space Telecommunications which will seek to promote a joint attitude towards participation in a worldwide system of communication by satellite, as proposed by the United States. Following meetings in Paris and London, specialized committees were set up to examine various aspects of the problem. . . .

"We hold it to be self-evident that Eurospace should do everything in its power to assist the success of this scheme, in the hope of winning a good measure of scope for European industry. It will not be enough for the latter to be allowed to make a technical contribution to the engineering side—it must also be able to present solutions to the economic, financial and organizational problems that arise. Hence the establishment of the Financial and Industrial Studies Group.

"Possibly it will be advisable to go further and set up a grouping of the industrial and financial concerns interested in the development of this scheme. Your Board is doing all it can to promote such a body, which, be it clearly understood, would eventually become a separate entity."

AMERICA'S UNMANNED SPACECRAFT

The US National Aeronautics and Space Administration celebrated its fifth Anniversary on October 1. Among the many spacecraft launched by NASA during this five-year period has been the significant series of automatic, unmanned craft which have obtained a vast amount of scientific information and opened up new possibilities in meteorology, communications and interplanetary exploration. Such satellites and probes formed the subject of a paper "Automated Spacecraft of the United States," presented at the recent IAF Congress in Paris by Mr Edgar M. Cortright, Deputy Director of NASA's Office of Space Sciences. This article is based on Mr Cortright's paper.

ONE of the most exciting technological aspects of space exploration has been the development of automated spacecraft. Most of the scientific exploration of space and the useful applications of space flight thus far have been made possible by automated spacecraft. Development of these spacecraft and their many complex subsystems is setting the pace today for many branches of science and technology. Guidance, computer, attitude control, power, telecommunication, instrumentation, and structural subsystems are being subjected to new standards of light weight, high efficiency, extreme accuracy, and unsurpassed reliability and quality.

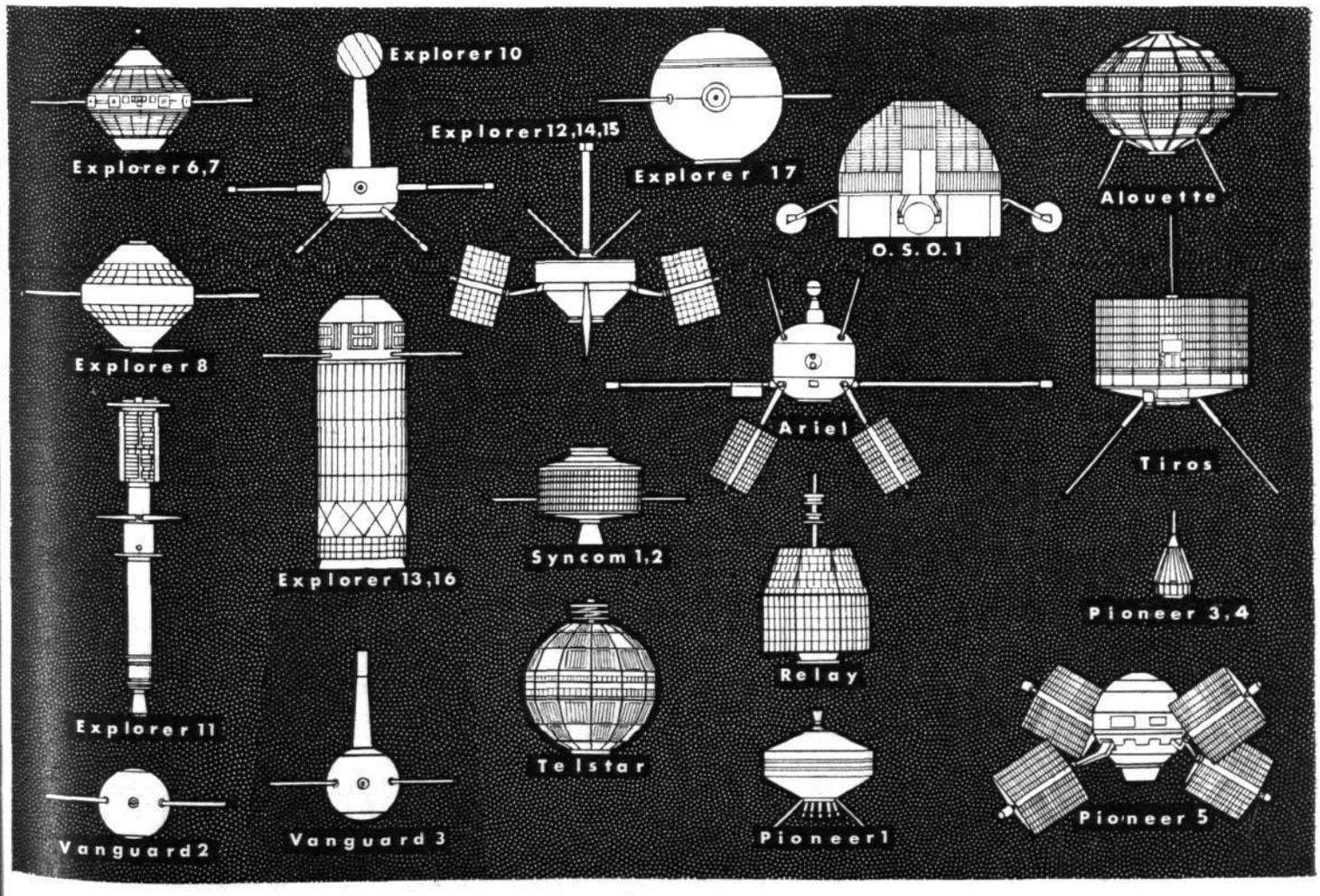
Our experience with scientific satellites (Table 1, p. 673) illustrates the gradual maturing of the United States programme to its record of 100 per cent successful missions in 1962. Prior to 1962, the more modest success rate was almost entirely attributable to the use of unproven launch vehicles which have since been discarded. With one exception, Vanguard 2, all satellites performed quite well when successfully orbited, at least during their initial days of operation. Among the prime lessons learned from these early experiences were the following: (1) To effectively accomplish space exploration, one should develop a limited family of reliable launch vehicles and *use* them; (2) Long-lived satellites are required to observe and monitor space phenomena; (3) Reliability and long life are the two most important ingredients of economical space exploration; (4) Reliability is best achieved on the ground; by sound design, skilled workmanship, strict quality control, and a very thorough environmental test programme.

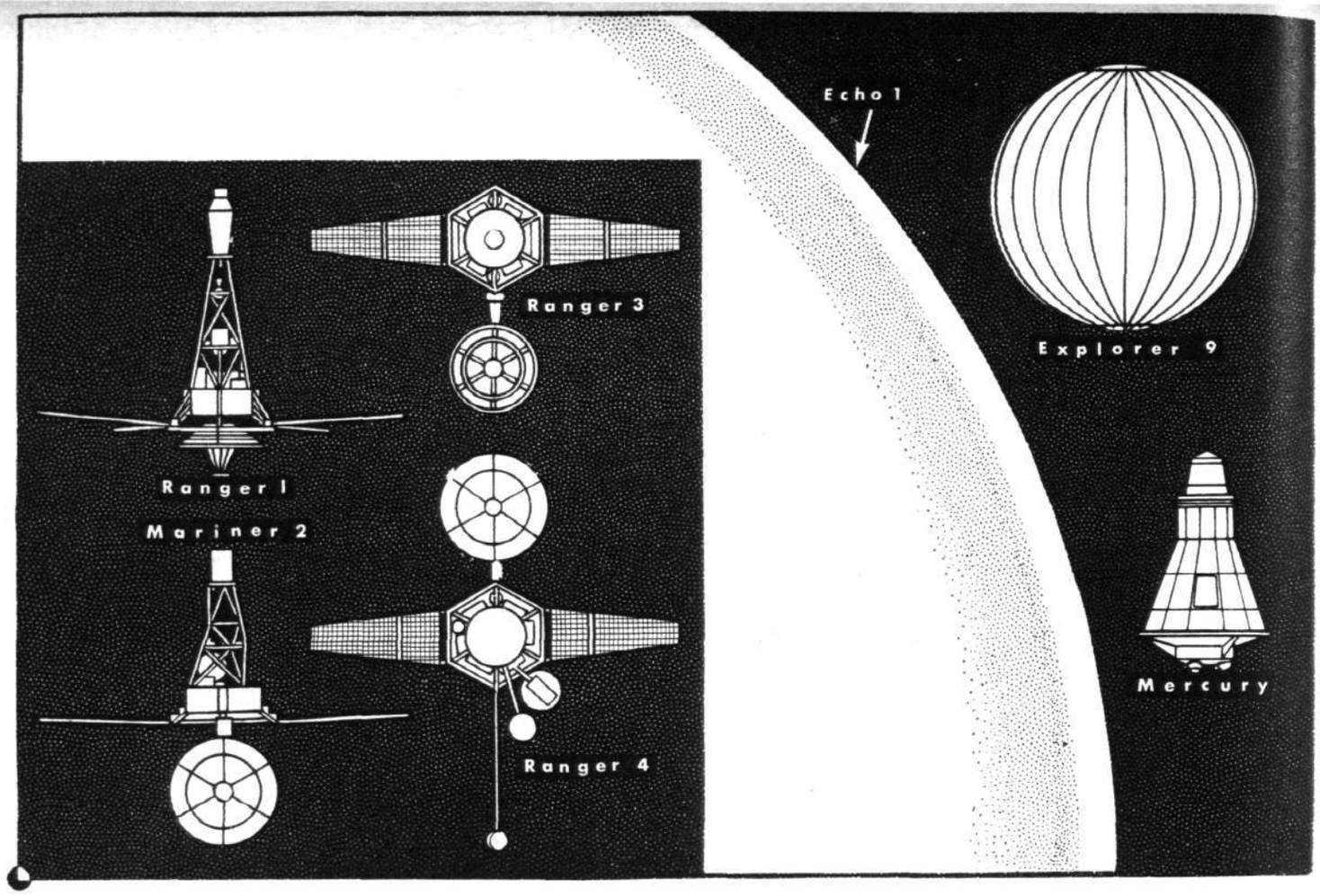
Among scientific satellites launched to date, Explorer 12 is typical of a series of geophysical satellites designed to survey the Earth's magnetosphere, the magnitude and direction of the Earth's magnetic field, the charged particles trapped therein, and the flux of solar and galactic cosmic rays. Accordingly, the satellite is designed to operate in highly elliptical orbits. It features the simple spin stabilization and solar power system used on many of our satellites.

Another area of geophysics being studied with satellites is the structure of the atmosphere. Explorer 17 was launched this year and is unique in that it measures atmospheric temperature, pressure, and composition directly. In order to eliminate all possible sources of contamination from the spacecraft itself, including vaporizing solids, all equipment was hermetically sealed within a stainless steel shell.

The Orbiting Solar Observatory is unique in many respects. It was the first true observatory in orbit, and was designed to point selected experiments at the centre of the Sun with the direction measurable to within one minute of arc. These experiments are mounted on the solar panel which is de-spun by gas jets in the

This "Flight International" drawing shows Earth satellites successfully launched by the US National Aeronautics and Space Administration since its formation on October 1, 1958. Those launched by the United States before that date comprise Explorers 1, 3 and 4 and Vanguard 1





In these "Flight International" drawings of further NASA satellites and space probes, the arc labelled Echo I indicates the radius of this satellite, with centre at the bottom left-hand corner of the diagram. This radius is 50ft

Missiles and Spaceflight

coarse pointing mode, and finely pointed by electric servomotors to an accuracy of between two and three arc-minutes.

This spacecraft must re-acquire and stabilize on the Sun once each orbit, which it has done thousands of times with great precision since its launching well over one year ago. Below this pointing section is a spinning electronics compartment whose plane of rotation includes the Sun. This section, spinning at 30 r.p.m., carried experiments which thus saw the Sun for two seconds per revolution.

With regard to the important area of ionospheric physics, the Canadian Alouette is particularly noteworthy. The Alouette, which utilizes the topside sounding technique, has had the best test and flight record of any scientific satellite with which I am familiar. There were a minimum of malfunctions during developmental testing and Alouette is functioning perfectly after almost one year in orbit and has recorded thousands of ionograms. It has not even been necessary to activate any of the redundant systems built into this satellite.

Our experience with applications satellites has been even more encouraging, as shown in Table 2. Since the programme began in 1960, we have experienced only two mission failures for any cause. The first attempt to launch the Echo communications satellite was on the first of the Delta launch vehicles, which failed. Because of prior experience with the stages of the Delta, however, it was possible to correct the deficiencies so that all nineteen subsequent Deltas have been entirely successful.

Tiros 6, Relay, and Syncom are typical of the many applications satellites launched to date. The Tiros 6 is spin-stabilized, as were most first-generation satellites, but has an added feature of a magnetic coil which can interact with the Earth's magnetic field and precess the spin axis on command. Picture-taking is limited to 32 stored pictures per orbit taken along the spin axis.

It is planned that a later version of this spacecraft will be magnetically torqued so that the spin axis is parallel to the Earth's surface. On this satellite, the two cameras will be pointed perpendicular to the spin axis so as to see the Earth twice during each revolution throughout the entire orbit. In another experiment, Tiros may be flown to a 22,300-mile apogee to explore the effectiveness of weather photography from that altitude. Thus, this spacecraft has shown an excellent and somewhat unexpected growth capability.

The Relay satellite, like Telstar, is an experiment in wide bandwidth communications via signal relay beyond the horizon by an active transponder aboard a satellite. Relay differed from Telstar in its communication frequencies as well as its design details. Both spacecraft achieved most of their design objectives including high-quality real-time television transmission between Europe and the North American continent. An operational system would include at least 20-30 such satellites.

The Syncom communication satellite is designed for operation at 22,300 miles altitude. At this altitude, it takes only three operating satellites to provide worldwide coverage at all but very high and low latitudes. Quasi-fixed but large ground antennae are required. The first Syncom achieved its orbit but failed to function thereafter. Syncom 2, however, has been successfully orbited and manœuvred precisely on to a predetermined station. It is working very well.

In contrast with our scientific and applications satellite missions, our experience with deep space probes has been relatively poor to date (Table 3). Pioneer 4 was the first United States space probe to reach escape velocity and orbit the Sun. Pioneer 5 was our first highly successful deep space mission. Communication was maintained with the Pioneer spacecraft to 22.5 million miles. Since Pioneer 5, the Mariner 2 flight to Venus has been our only completely successful deep space mission. Whereas prior to 1962 all failures resulted from launch-vehicle malfunctions, 1962 saw three Ranger spacecraft experience malfunctions on their flights to the Moon.

There are some additional lessons here. The deep space missions are the most difficult of all automated spacecraft missions. They demand the utmost in performance from both our launch vehicles and spacecraft. Our newest and least-developed launch vehicles must be used for these missions; and the spacecraft will continue to be complicated. It will be very difficult to equal the reliability of

Earth satellite missions with our missions to the Moon, Mars, and Venus.

I have chosen Pioneer 5, Ranger and Mariner to illustrate our past spacecraft experience with interplanetary, lunar and planetary flight, respectively. Pioneer 5 was a spin-stabilized, solar-powered spacecraft bred from Earth satellite technology. It was designed to make particle and field measurements in interplanetary space. The success of this relatively simple spacecraft in returning valuable data from up to 22.5 million miles convinced us that interplanetary monitors of this type should become a basic part of our programme. We will begin a new Pioneer series in 1965 in support of the International Quiet Sun Year (IQSY).

The Ranger is really a second- or third-generation spacecraft. It was designed to fly to the Moon and land an instrumented capsule at less than 250ft/sec within a 50-mile circle. Because of the unique requirements of this mission, Ranger incorporated a number of technical innovations. Three-axis stabilization was achieved with an Earth sensor, which pointed the directional antenna and locked the spacecraft in roll, and with a Sun sensor which pointed the roll axis and solar panels at the Sun and locked the spacecraft in pitch and yaw.

The spacecraft could be programmed to any attitude for a midcourse velocity correction capable of reducing the dispersion diameter at the Moon from several thousand miles to about 50 miles. After the midcourse manœuvre was complete, the Ranger could reacquire its Earth-Sun lock until arrival at the Moon.

Upon arrival, the Ranger could be programmed to the proper attitude to align its capsule retro-rocket axis with the vertical descent velocity vector. The retro-rocket would be triggered by a radar altimeter and would slow down the instrument capsule to a probable resultant impact velocity of less then 250ft/sec. The extremely sensitive seismometer capsule could withstand this impact by virtue of a ruggedized design and a protective layer of balsa wood. On the most successful of the three flights made with this spacecraft, it performed all automatic functions properly prior to arrival at the Moon and executed the first midcourse correction made by a space craft. One of the Rangers hit the Moon but none returned lunar data. Our plans include additional Rangers of this type.

The Mariner 2 was by far our most successful deep space probe. Its attitude control and midcourse manœuvre subsystems were functionally similar to those of the Ranger just described. On its 109-day and 180 million-mile flight to Venus, Mariner 2 performed beautifully despite minor problems including excessive temperatures, a solar-panel short, and a weak Earth sensor signal. Less than 4lb of nitrogen were consumed for attitude control. Mariner's midcourse manœuvre corrected the Venus miss distance from about 233,000 miles to 21,600 miles. We aimed for a miss of 10,000 miles but designed Mariner to scan Venus effectively at up to 40,000 miles distance.

At the planet, all experiments worked well and returned invaluable radiometric observations of the planet's atmosphere and surface. The telemetry signal strength at Earth was less than 10-18 watts but was well within the design signal-to-noise ratio. The technology developed by Ranger and Mariner will continue to be used in the NASA lunar and planetary spacecraft.

There is no good substitute for extensive ground testing in the development of spacecraft. The test history of an average Explorer-type spacecraft shows that, in the five test phases of checkout, vibration, temperature, vacuum, and thermal vacuum, this average spacecraft experienced 18.2 electrical failures and 4.6 mechanical failures. Most electrical failures occurred during thermal vacuum and most mechnical failures during vibration.

The long-term effectiveness of such thorough testing standards is evident. The average time to the first malfunction of any sort in flight of all of NASA's unmanned spacecraft had climbed to about two months in 1962. The average useful life has exceeded six months and is still rising because some of last year's spacecraft are still functioning at a useful level. [*Continued overleaf*

Table 1: Scientific Satellites (unsuccessful craft in italics)

1958	*Explorer 2, Vanguard, Vanguard, Explorer 5, Vanguard,* Explorer 1, Vanguard 1, Explorer 3, Explorer 4.
1959	*Vanguard, Explorer, Vanguard,* Vanguard 2 (partial success), Explorer 6, Explorer 7, Vanguard 3.
1960	*Explorer, Explorer,* Explorer 8.
1961	*Explorer, Explorer, Explorer, Explorer 13,* Explorer 9, Explorer 10, Explorer 11, Explorer 12.
1962	OSO, Ariel, Alouette, Explorer 14, Explorer 15, Explorer 16.
1963	Explorer 17.

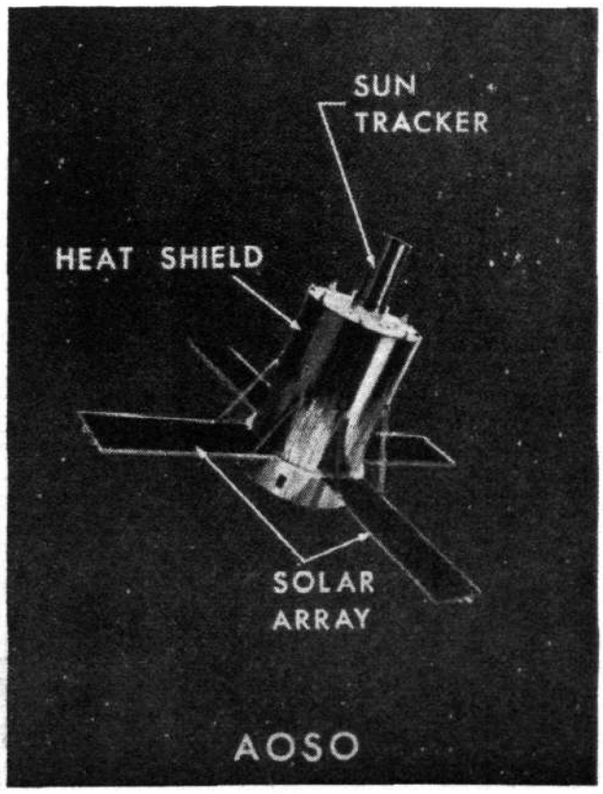
Table 2: Applications Satellites (unsuccessful craft in italics)

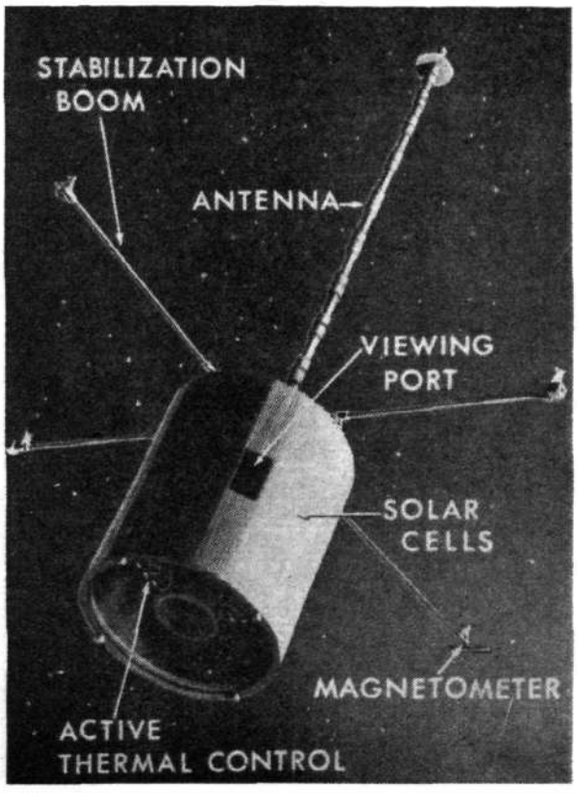
1960	*Echo,* Tiros 1, Echo 1, Tiros 2.
1961	Tiros 3.
1962	Tiros 4, Tiros 5, Telstar 1, Tiros 6, Relay 1.
1963	*Syncom 1,* Telstar 2, Tiros 7, Syncom 2.

Table 3: Deep Space Probes (unsuccessful craft in italics)

1958	*Pioneer 2,* Pioneer 1 and Pioneer 3 (partial successes).
1959	*Pioneer,* Pioneer 4 (partial success).
1960	*Pioneer, Pioneer,* Pioneer 5.
1961	*Ranger 1, Ranger 2.*
1962	*Mariner 1, Ranger 3, Ranger 4, Ranger 5,* Mariner 2.

Among the future spacecraft mentioned by Mr Cortright were (left) the Advanced Orbiting Solar Observatory, which will weigh 900lb (including 250lb of instruments) and will make its first flight in 1967; and (right) the forthcoming second-generation Pioneer series of interplanetary spacecraft. These latter craft will weigh 115lb, of which 20lb will consist of instruments





Missiles and Spaceflight

During the same time period, our space launch vehicles had achieved a demonstrated reliability of 82 per cent, paced by the Delta, which has now had 19 out of 20 successful launches.

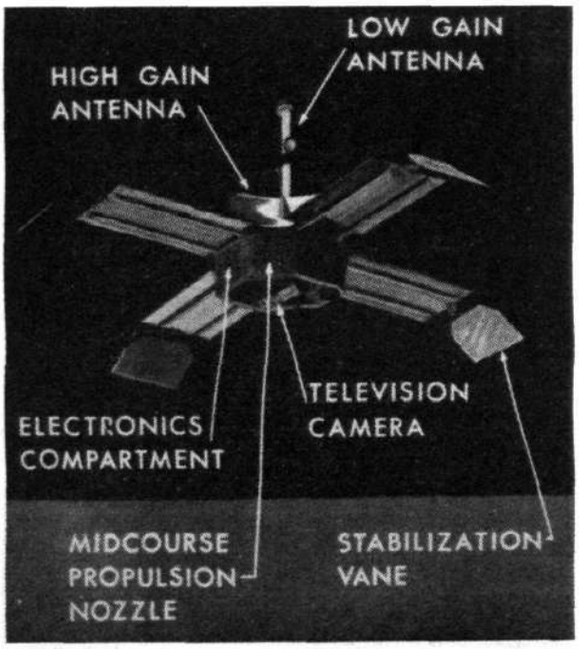
A real challenge faces us in maintaining these upward reliability and life trends in the face of increasing complexity. This can be illustrated by listing the approximate number of piece parts for three of our advanced spacecraft: Mariner 2, Surveyor, and the Orbiting Geophysical Observatory. These spacecraft contain about 54,000, 82,000, and 100,000 parts respectively, and a sizeable percentage of these are critical for effective mission performance. Only time will tell whether we have moved too fast to this degree of sophistication.

Turning to spacecraft now under development, the Orbiting Geophysical Observatory (OGO) is a 1,000lb satellite designed to carry 20-50 experiments in either circular polar orbits under 1,000 miles, when launched with a Thor Agena, or in highly eccentric inclined orbits with apogees of around 70,000 miles when launched with the Atlas Agena. The spacecraft is designed to hold its attitude with the bottom looking directly towards the Earth, its solar panels towards the Sun, and selected experiments towards Earth, space, Sun, or in the direction of motion. A prime feature of the OGO is its data-handling system which can store up to 43.2 million bits of data at an input rate of 1,000 to 4,000 bits per second and a readout rate of 64,000-128,000 bits per second.

Certainly, one of our most ambitious and significant scientific satellites is the 3,600lb Orbiting Astronomical Observatory (OAO), to be placed in a 500-mile circular inclined orbit in 1965. Basically the spacecraft is designed to sense and point the optical axis to any point in the celestial sphere, with the exception of a 90-degree cone about the Sun line, to an accuracy of one minute of arc. Using the experimenters' prime optics and a suitable error sensor, the spacecraft control system is designed to achieve a fine pointing accuracy of 0.1 second of arc for extended periods of time. This has turned out to be a formidable task with which we are still having some problems. A combination of gas jets and inertia wheels are the prime movers.

A new observatory called the Advanced Orbiting Solar Observatory (AOSO) has recently been initiated. This is designed for extensive and detailed observations of the Sun not possible with the first-generation OSO. The field of view will extend to about 10° centred on the solar disc; yet a 5-arc-second pointing precision will permit some 400 observations in one pass across the Sun's diameter. These will permit spectral analysis of individual sunspots and other detail structure. A particularly challenging technical problem is to locate and record in the brief time available major solar flares which occur relatively infrequently and emanate from a small portion of the solar disc.

This version of the Mariner craft is being designed to explore the vicinity of Mars. Weighing 570lb, of which 40lb represents the scientific instruments, this craft will be launched by Atlas Agena next year



The most advanced meteorological satellite is the Nimbus, which is designed to fly late this year or early next year. This 675lb satellite will initially fly in a circular 80° retrograde orbit so that the rate of regression of the nodes will maintain the Earth illumination relatively constant (i.e., 12 o'clock noon orbit). The Nimbus is fully stabilized to look at the Earth while its solar panels seek the Sun. Multiple videcon television cameras provide complete daylight observation of the Earth once each 24hr. Cloud pictures are stored for readout at two wide-band readout stations in Alaska and Canada, once each orbit.

The follow-on series of Pioneer deep space probes is designed to monitor particles and fields at distances up to 50-90 million miles from Earth. Two probes launched ahead of and trailing the Earth, plus Earth satellites, will make possible the monitoring of a large segment of the solar sector. This small probe will deliver a data rate of 16 bits per second up to 80 million nautical miles, with much higher rates early in the flight.

Mariner for Mars

Our next planetary probe is designed to duplicate the Mariner 2 feat of a close planetary fly-by, but in this case the target is Mars. Although Mariner-Mars does not look much like Mariner 2, it uses much of the same technology. Some interesting variations include the following: the use of a fixed high-gain antenna, made possible by the particular Earth-Sun-planet geometric relationships for this flight; a change from Earth reference to Canopus reference for one axis; and the addition of solar pressure vanes at the tips of the solar panels to supplement and back up the gas stabilization system. The Mars mission is more difficult than the Venus mission because of increased lifetime, increased communication distance and power requirements, and a decreased solar constant. The Mariner-Mars payload will include a television telescope for surface photography.

For the 1966 Mars mission, a version of this spacecraft will be fitted with a capsule to land and survive on the Martian surface. The Atlas Centaur launch vehicle will be required. The capsule landing will not be attempted unless we can be assured that it is biologically sterile. The basic spacecraft, as on the 1964 flight, will not be sterile but will use a trajectory providing less than one chance in 10,000 of impact. From a technological point of view, we have found the use of heat, gas, liquids, and radiation to achieve complete spacecraft sterilization without degradation of reliability to be beyond the state of art at this time. Thus our lunar spacecraft such as the Ranger and Surveyor, will settle for surgically clean procedures which are now deemed sufficient for the Moon.

The next series of Ranger flights are now scheduled to begin late this year with a series of four spacecraft. These spacecraft are similar to earlier Rangers, but with a high-resolution television subsystem substituted for the landing capsule and its retrorocket. This television subsystem will take pictures of the lunar surface during descent. The last full frame before impact should resolve objects of about one metre in diameter within a square 60 metres on a side. These flights will provide spot sampling of the many conflicting theoretical models of the lunar surface. Our detailed surface reconnaissance must await the Surveyor and a lunar photographic orbiter which we hope to soon initiate.

The last US spacecraft to be covered in this paper is the Surveyor. This 540lb spacecraft weighs 2,100lb when coupled with its retrorocket. It will fly to the Moon in a stabilized mode similar to the Ranger but with a Canopus rather than an Earth sensor. Two midcourse manœuvres can be made with three small liquid rockets which are also used for landing. During descent, the main retrorocket is fired by a marking radar altimeter, and attitude is maintained during this firing with the three small liquid rockets. After firing, the main retrorocket is jettisoned and the Surveyor will land under its own control using a dual doppler radar system.

Once on the Moon, the surface will be observed with television cameras, seismic activity will be monitored, and local surface physical and chemical properties will be analysed. Later Surveyors may carry a small roving vehicle. When these local sites are observed from orbit and interrelated with broad area photographic coverage, we should be in a good position not only to describe the Moon scientifically with some accuracy, but to select a landing site for man.