Paris Show Review
ALSO Air-Cushion Vehicles
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FLIGHT

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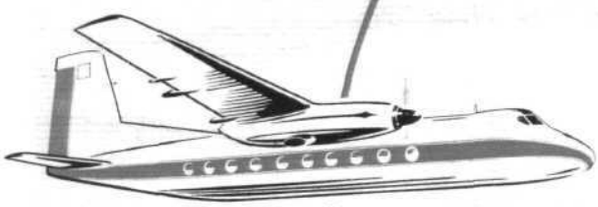

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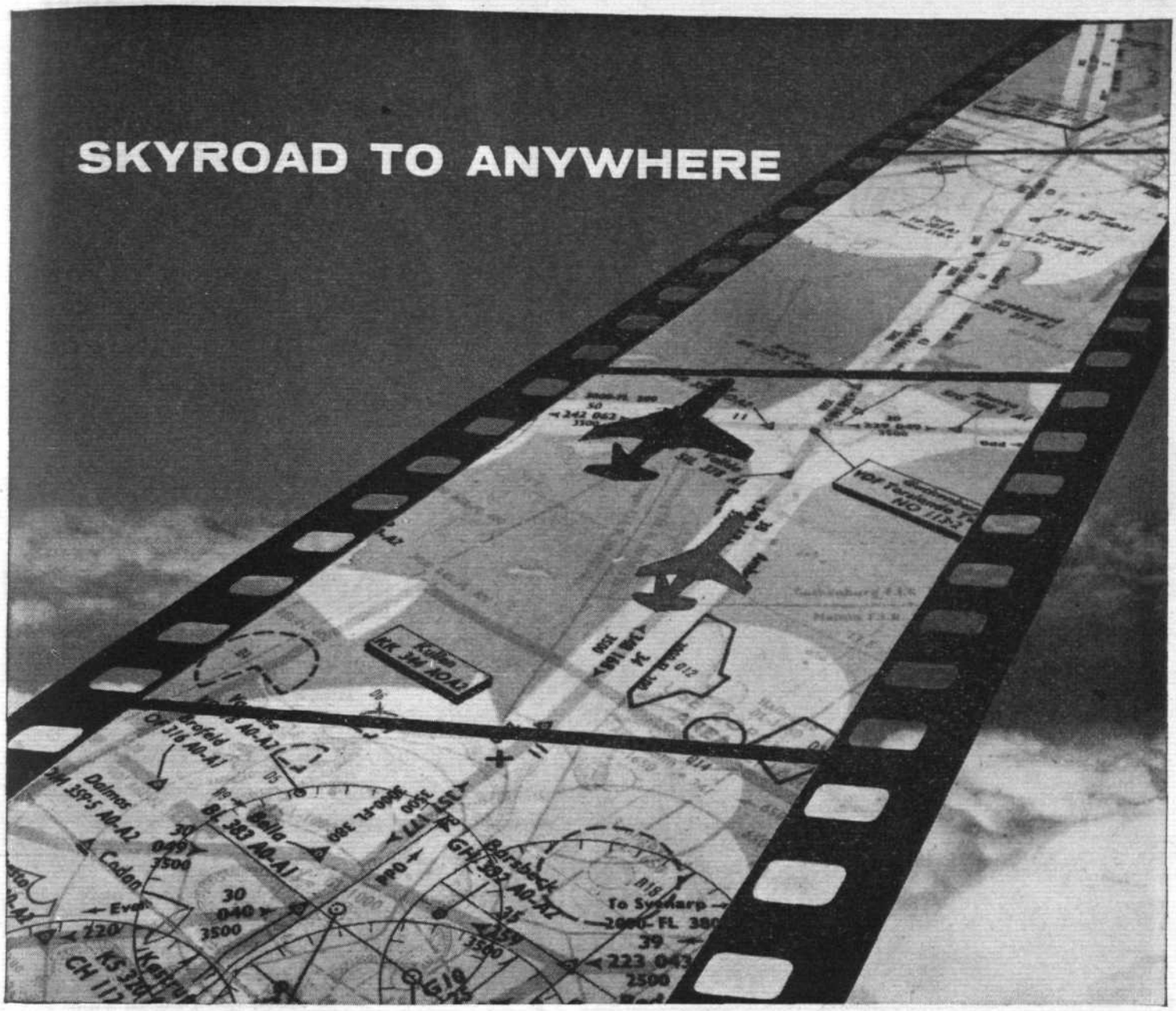

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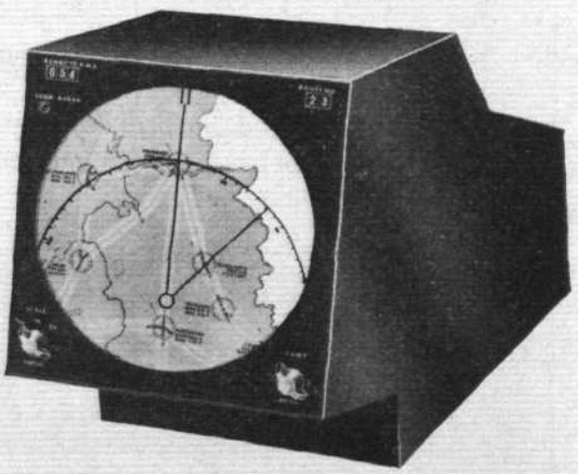

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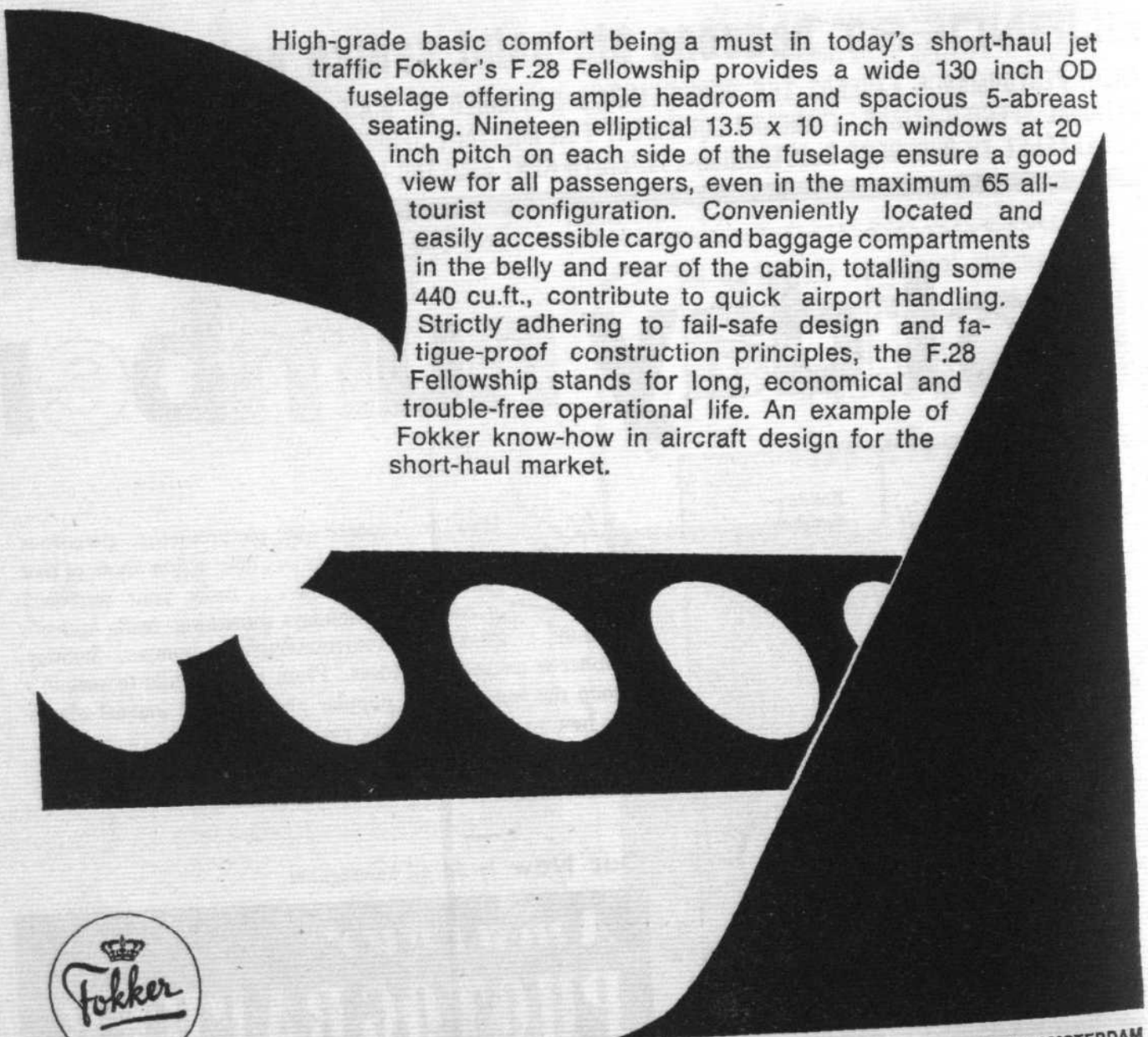

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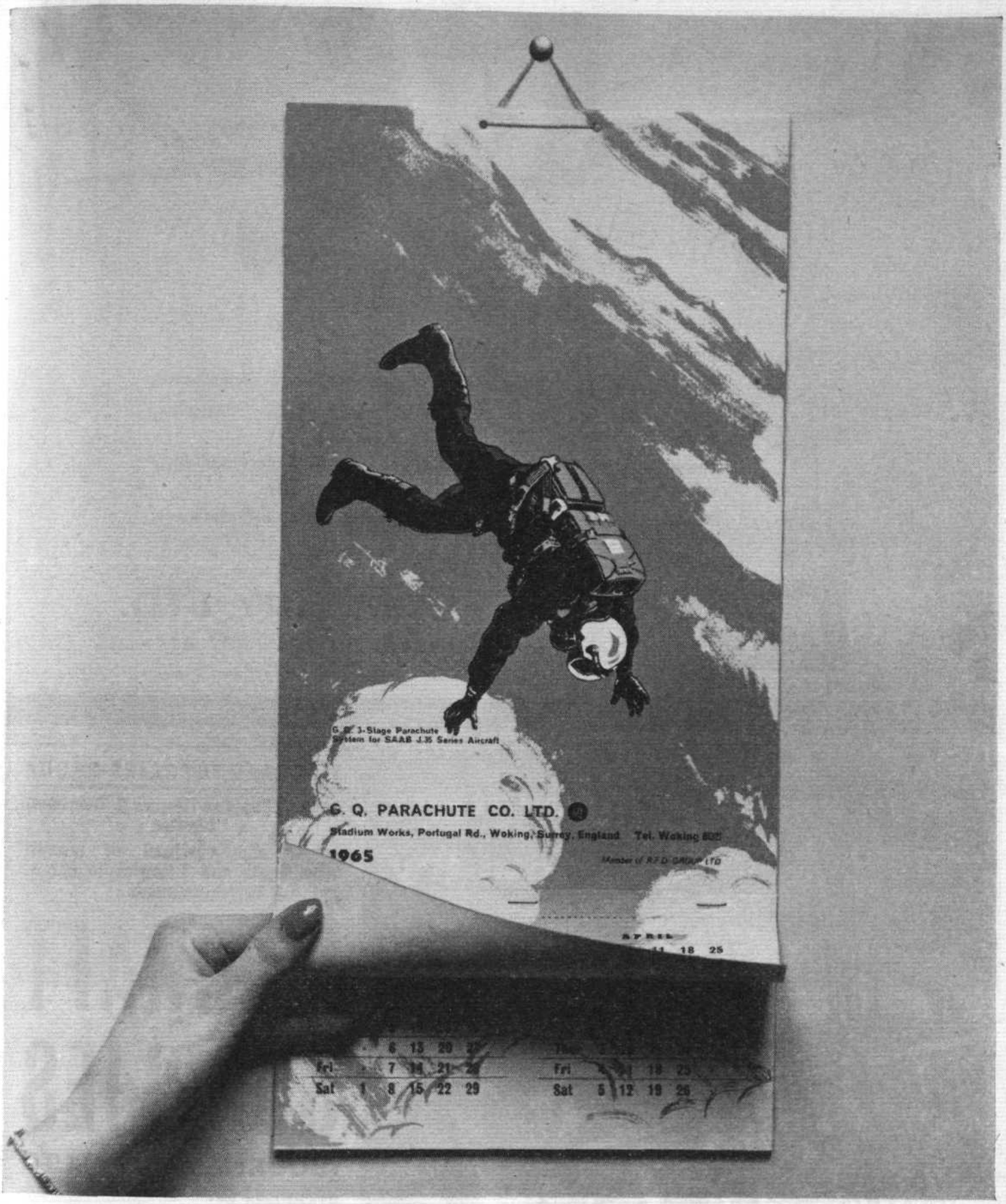

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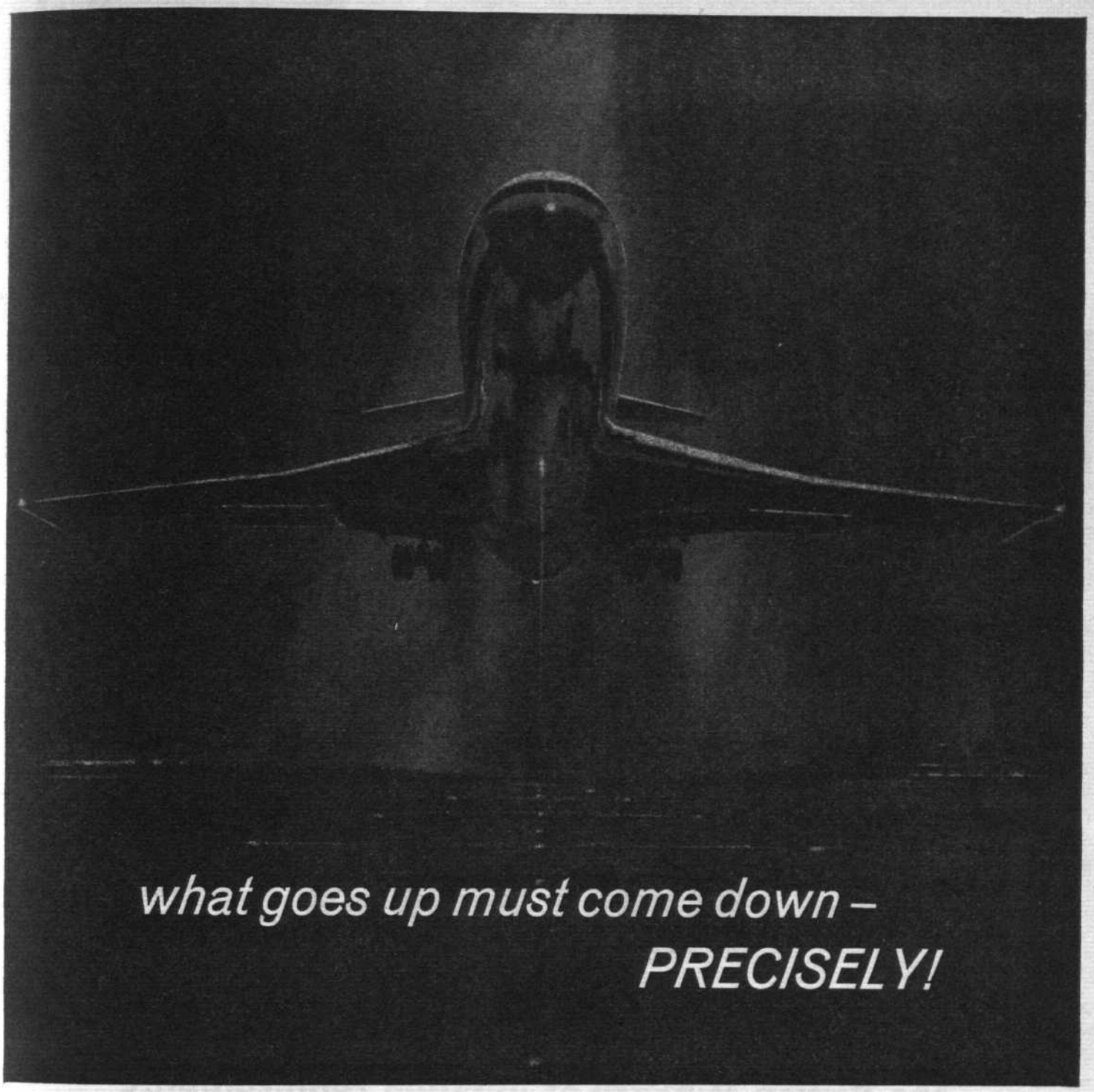

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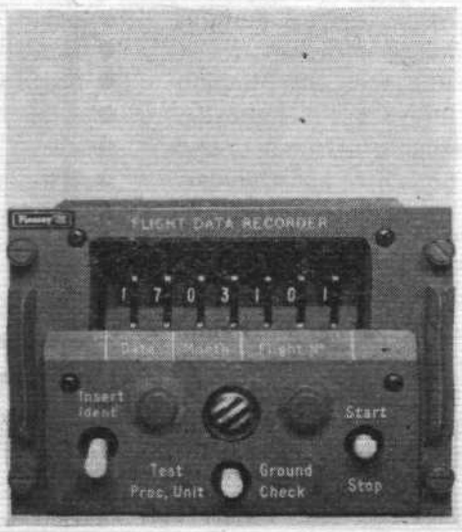

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Long-range Strike for the RAF . . .

SHOULD Britain, having cancelled TSR.2, remain in the long-range strike business? This is essentially a political question, and upon it turns the great defence re-appraisal that is now under way. The Defence Minister, Mr Denis Healey, has already answered in what might be termed a non-committal affirmative. His colleague Lord Shackleton, the Minister for the RAF, has on a number of occasions made his position clear. Like the air marshals of the RAF, Lord Shackleton is in no doubt whatever that Britain must possess, and must be seen by her potential adversaries to possess, long-range aircraft capable of delivering a heavy strike—with conventional, not necessarily nuclear, weapons—upon strategic as well as tactical targets.

This was why Britain took an option on the F-111A. She has until January to decide to place a firm contract, although the Americans would probably not regard this date as too rigid.

The RAF cannot publicly join in the great defence debate, but the air marshals are entitled to a big say in the defence policy that they must execute. They have made it quite clear to the politicians that, in their opinion, neither the "three-star" Buccaneer development nor even the Phantom has anything like the long-range strike ability that is at the very heart of air power. They are not talking about nuclear deterrence, which is another political question altogether, and one that is keyed to Polaris and the Royal Navy. It is long-range *conventional* strike, coupled with the ability to carry out instant reconnaissance at long range for political as well as military intelligence purposes, that is the essence of what the present controversy is all about.

. . . and the Mirage

Once defence policy is decided—and we have no doubt that the tentative position already taken by the Defence Minister will become a firm one—the problem resolves into a choice between aircraft. There is really only one alternative to the F-111A. This is the Mirage IV re-engined—as the F-111A would be—with the Rolls-Royce Spey.

The Mirage IV is in full production for the Armée de l'Air (which has 62 on order) as the delivery-system for France's nuclear weapon—the Force de Frappe. The Mirage was of course considered by the RAF as an alternative to TSR.2 before the F-111 option, but it was not felt to be of adequate range or capacity. Political pressures on the RAF have been strong indeed, as can be imagined. The French took a poor view of the fact that Britain, while preaching European collaboration, turned to America for her TSR.2 replacement.

Why not the Mirage? At Paris there were definite signs that the Air Staff are being urged to have another look at the Mirage. With Speys, and the "R" equipment from TSR.2, just how far short of the requirement does it fall? It would clearly have to fall short indeed to invalidate the political and industrial case for this aircraft.

It is the new dilemma of how far the interests of national defence can be compromised to the interests of European industrial collaboration.

At least there should be no doubt, whichever aircraft is commissioned—Mirage IV development or F-111A—that the RAF will remain in the long-range strike business.

WORLD NEWS

BEA's £1.3m PROFIT

A net profit of about £1.3m has been recorded by BEA for the 1964-65 financial year. The operating profit was about £5.5m, which represents a return of 6.3 per cent on capital and reserves. A total of £4.2m in interest goes to the Treasury. Total 1964-65 turnover was £66m.

The average utilization of BEA's fleet exceeded 2,000hr in 1964-65 for the first time, with the Comet 4Bs recording the highest average at 2,472hr per annum.

SHOW-TIME NEWS

During the Paris Show, but not at it, the German VJ 101C X2 prototype, with afterburning Rolls-Royce RB.145R engines, made two successful hovering flights at Manching on June 12.

The Potez 84 four-turboprop executive, powered alternatively by Turbomeca Astazou 10s or UAC PT6-As, received its French C of A on June 10.

The t.b.o. of all versions of the Turbomeca Astazou 2 was increased from 750hr to 1,000hr on June 11.

The possibility of an Israeli order for the Sud Super Frelon has been announced.

PARIS SHOW ACCIDENTS

The poignancy of a flying accident before thousands of spectators recurred at the Paris Show on June 15 (recalling a similar tragedy in 1961) when a USAF B-58 crashed and burned on the end of Runway 25, killing the pilot and injuring the other two crew members. The aircraft, from the 43rd Bomb Wing at Little Rock, Arkansas, had flown to Le Bourget from an air display at Torrejon AFB, near Madrid. At first it was thought that a collision had occurred, as there were two distinct fires and many aircraft were in the immediate vicinity; but it appears that the B-58 simply undershot the runway, struck the fairly steeply rising ground among the approach lights, bounced and broke in two. The USAF H-43B Huskie helicopter on guard duty was on the spot extremely quickly. It is not clear whether the two survivors used their ejection capsules, were ejected by the heat of the fire or were rescued from the flames.

Four days later, on June 19, the Italian Fiat G.91T, which had been giving spectacular aerobatic demonstrations throughout the week, crashed into a car park, apparently after a very tight second circuit following a baulked landing; nine spectators and the G.91's Italian Air Force test pilot, Capt Italo Donati, lost their lives.

BALPA VICE-PRESIDENTS

Lord Beswick (formerly Mr Frank Beswick, MP) and Air Cdre Sir Arthur Vere Harvey have accepted honorary appointments as vice-presidents of the British Air Line Pilots Association. For twenty years both men have been active in Parliament, from opposite sides of the House, whenever aviation matters have been discussed.

LAUNCHING THE ISLANDER

Three days and eight hours in the air after the private-venture Britten-Norman BN-2 first flew (*Flight* last week, page 947) it was granted a special-category C of A by the ARB. This outstanding achievement an unqualified tribute to the soundness of the design and of the organization behind it, came just nine months after metal was first cut and was the climax of an intensive effort to make a world debut at the Paris Salon. The BN-2 reached the Show and was displayed for the last four days. The first full description of the aircraft appears on page 1017-1021 of this issue.

At a Bembridge news conference on June 16, the day before the flight to Paris, Mr John Britten, technical director, and Mr Desmond Norman, commercial director and test pilot, launched the aircraft on its commercial career and announced the choice of a name—Islander. Deposits, it was said, had already been taken for 15 aircraft from the four operators who are B-N associates: Jonas Aircraft & Arms Corp of New York, ten; British Westpoint (with applications in for London inter-airport services), two; Cameroons Air Transport, two; and Ecuavia, one. Material is allocated for 17 aircraft and orders booked now could be satisfied in 14-15 months' time. Except for "one or two minor problems on the financial side" the production arrangements could be even more definite. Asked about the possibility of Government financial support, Mr Norman said "we have no reason to be pessimistic." The Transport Aircraft Requirements Committee had been given full details of the project and would soon be making its recommendations to the Minister of Aviation.

The news conference followed an impressive display of the Islander, flown by Mr Desmond Norman in discouraging conditions of low cloud and rain ("to check d.v. window location"). As rain beat heavily on the hangar doors, Mr Norman began his introduction to the aircraft: "God willing, we're going to take it to Paris and park it under that big Russian thing . . ." Of the specification he said "as far as we know there is no other aircraft in this category which has all the latest advances in light structures, engines, and equipment. Seat-mile costs will be low enough to enable the small man to make a darned good living out of small places. So many communities are left out of the airport system with the tendency of aircraft to get larger . . .

"Everyone in this company believes that this is a darned good industry . . . one of the most lucrative and expanding businesses you can get into if you do it right, with low overheads."

Mr Norman summed up the BN-2 as "an elegant solution to the problem of getting a lot of people into a small aircraft. It is as conventional as anything you can find. We have attempted no technical breakthroughs whatever."

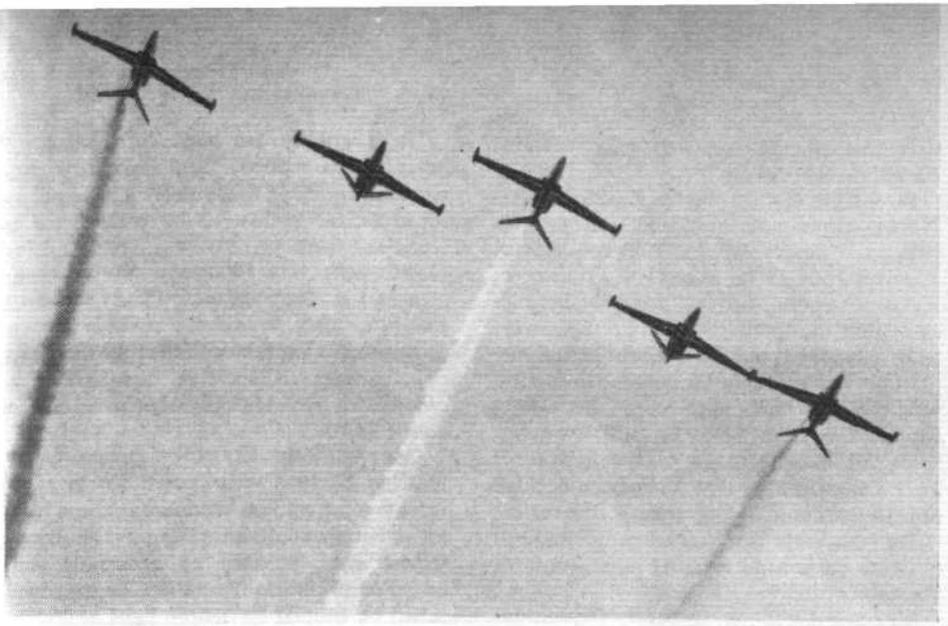
Speaking as the well pleased test pilot he remarked "I am dumbfounded at the way it flies . . . it leaps into the air like a cork out of a bottle . . . if special-category testing is anything to go by, there is every chance it will be certificated for public transport well before this time next year."

With a Beagle 242 *as background, Mr John Stonehouse, MP, Parliamentary Secretary MoA, is seen (left) during a recent visit to Beagle Aircraft at Shoreham. With him are Mr Peter Masefield, managing director, and Mr Tom Carroll, chief project engineer*

GERMAN "NO" TO CONCORDE PLAN
Air Transport, page 1009

TITAN 3 INTENTIONS
Spaceflight, page 1033

AIRCENT TACTICAL WEAPONS CONTEST
Defence, page 1030



Paris Virtuosos *were the five Magisters of the Patrouille de France, who flew the impressive partly inverted formation seen here. Our report on the flying displays, the new Russian aircraft and the space exhibits begin on page 997*

VC10 DOOR INCIDENT

During a C of A renewal test flight from London Heathrow Airport on June 20 the rear passenger entrance door of BOAC standard VC10 G-ARVK came open and was torn away. The incident occurred at 12,000ft over the Bristol Channel with the cabin unpressurized. The door struck the wing-root boundary-layer fence and the nacelle of the No 1 engine. A safe return was made to Heathrow with the engine shut down as a precaution.

This was the first C of A renewal test flight by a Standard VC10 and the aircraft was being flown by Mr D. Davies of the ARB, with a crew of nine ARB and BOAC personnel. All VC10 cabin doors are of the outward-opening plug variety, and the accidental opening is being investigated.

HONOURS IN AVIATION

As briefly reported in these pages last week, Mr James Martin of ejection-seat fame was among members of the aircraft industry named in the Queen's Birthday Honours announced on June 12; he receives a knighthood.

It is now possible to give the following more detailed list of names in the civil divisions of the various orders:—

Baron Sir Harold Roxbee-Cox, lately chairman of Council for Scientific and Industrial Research.

Knight Bachelor James Martin, managing director and chief designer, Martin-Baker Aircraft Co Ltd (for services to export and technology).

CB G. G. Macfarlane, Director, Royal Radar Establishment, MoA; J. A. Ratcliffe, Director, Radio and Space Research Station.

KBE Dr W. Cawood, Chief Scientist, MoA.

CBE N. Brearley (for services to civil aviation in W. Australia); B. Davidson, business director, Bristol Siddeley Engines Ltd (award as member of the Monopolies Commission); B. C. V. Oddie, Deputy Chief Scientific Officer, MoD (RAF); R. R. Law-Smith, vice-chairman, Qantas Empire Airways; W. D. Pugh, managing director, English Steel Corp; F. C. Wright, director, Standard Telephones & Cables (for services to export).

OBE Capt J. A. Cameron, general manager, BEA; J. L. Dell, chief test pilot, BAC Preston Division; A. L. Hall, assistant secretary, Department of Air, Canberra; Wg Cdr F. W. Hudson, lately holder of special appointment, MoD (RAF); W. H. Mercer, Chief Constable, AF Dept Const, MoD (Air); S. W. F. Palmer, Director of Civil Aviation, Malaysia; A. V. Rawson, chairman, No 103 (Doncaster) Sqn Committee, Air Training Corps; C. D. Waldron, commandant, Prestwick Airport; S. C. Wybrow, Director-General of Inspection's HQ, MoA.

MBE R. W. Alexander, superintendent instructor, HQ No 24 Gp, RAF; Obs Cdr W. G. Belton, commandant, No 14 Gp, ROC; S. Bentley, temporary executive officer, No 35 MU, RAF; S. C. A. Bowler, divisional administrative officer, MoA; G. C. Chouffot, senior flight operations inspector, Directorate of Aviation Safety; W. O. Davis, engineer, research dept., Smiths Aviation Division.

Mrs D. M. Fell, senior machine operator, maintenance, RAF Stafford; C. J. F. Gilmore, Chaplain's Branch, MoD (Air); Mrs G. M. Inglis, lately assistant secretary, RAF Benevolent Fund; G. Irons, higher executive officer, MoD (RAF); J. Kerr, DCA and senior pilot, Falkland Islands; M. W. May, No 11(F) Sqn committee, Air Training Corps; H. J. Rose, Royal Aircraft Establishment.

C. E. Sargeant, information officer, MoD (RAF); E. C. H. Smith, engineer II, MoA; J. E. Swinburn, departmental manager (armament forgings) and Service liaison officer, English Steel Corporation; Miss R. M. Thomas, senior executive officer, London Airport; R. C. Titman, engineer II, Atomic Weapons Division, MoA; Mrs D. Barnato Walker, for services to Air Transport Auxiliary and Girls Venture Corps; L. W. Wenman, chairman of examiners' panel, Guild of Air Pilots and Air Navigators; J. A. D. Whyte, liaison officer to RCAF, Scottish Aviation Ltd; Miss E. G. Young, higher executive officer, MoD (RAF).

Imperial Service Order J. A. Collopy, lately chief aircraft surveyor, DCA, Victoria, Australia; C. W. G. Daking, senior principal scientific officer, Meteorological Office.

MR WORCESTER, LECTURER

Mr Richard Worcester, aviation consultant and adviser to the Paymaster General, is to present a lecture entitled *The 100 Days, the 1965 Executive Actions and the 1965-75 Timeframe* before the Royal Aeronautical Society in London at 6 p.m. on Wednesday next, June 30. Visitors will be welcome and the lecture will be followed by a discussion.

CRANFIELD'S OPEN DAYS

The College of Aeronautics at Cranfield is holding two Open Days this week. On Friday, June 25, admittance is by invitation only; on Saturday the College is open to the general public from 11 a.m. Departments will be open for inspection, and there will be a flying display. Admission is free, but car parking will cost 2s 6d and detailed programmes 1s each.

SWANTON MORLEY RALLY

The Norfolk and Norwich Aero Club's rally and display at Swanton Morley is on Sunday, July 27, and not on Saturday 26th as noted in our diary of forthcoming events last week.

SENSOR

Reheat increases the thrust of the Spey at 38,000ft and Mach 2 by a factor of very nearly five. Rolls-Royce cannot confirm this figure, but it could be deduced from graphs published at Paris. The secret lies in the design of the gutters in the jetpipe. The Spey, which reverses the pattern of military first, then civil, promises to be one of the most successful jet engines ever built.

Three One-Elevens are almost certain to be ordered by the Spanish private airline Aviaco.

In its quest for an equatorial launch site the European Launcher Development Organization may choose the French base now being planned some 30 miles from Cayenne in French Guiana. France must give up the Hammaguir test range in the Sahara by 1967; the French Guiana site should become operational in 1968.

The brief success story of the TSR.2's flight development has been written by Wg Cdr Beamont, and may be published soon as a tribute to the team which did such an extremely fine technical job.

More than one foreign airline operating from London Heathrow has no criticisms of the airport management, which in their opinion gives quick and helpful answers to all reasonable requests. The problems begin when money is needed and Ministry approval has to be obtained by the airport management. The new Authority should change this, but there is no lack of good men in the present airport management.

Varig will resume the weekly Rio-London service—operated by Panair until it went bankrupt earlier this year—in August.

European Gliding Championships may soon be inaugurated. The idea, born at South Cerney during the recent World Championships, is for relatively modest contests which many of Europe's smaller countries could afford to organize. Accommodation would be in tents and expensive extras would be avoided. The European event could alternate year by year with the more lavish World Championships.

All ten of British United's One-Elevens, due to have been delivered by May, will be in service by the end of August. The airline has been having to charter expensively to fulfil its commitments, including Caravelles at £650/hr. A large number of protests are being received from passengers who were in good faith sold holidays by jet, but who have found themselves travelling in propeller aircraft—convincing evidence that jet travel has "arrived" in the charter market. BUA's One-Elevens, though late, are going like clockwork and BAC's export deliveries are on schedule.

parliament

KENNETH OWEN

Concern about the effects of the TSR.2 redundancies has not been evident among Conservative spokesmen in recent weeks. It was left to a Labour backbencher, Mrs Shirley Williams, a Member for Hitchin, to ask how many people had been made redundant by the cancellation, and how many were now in new jobs.

On Monday, June 14, Mr Richard Marsh, Joint Parliamentary Secretary to the Ministry of Labour, replied that 2,802 employees were so far redundant and 1,781 had registered with the Ministry. The Ministry's local offices had placed 582 in new jobs and 402 others were known to have found work.

It was interesting, Mr Marsh added, to note the way in which these workers had been redeployed. "The bulk of the placings have been of workers displaced at Preston and Weybridge. There were 303 placings at Preston and 82 at Weybridge. Placings and those known to have found work total 984. Of these 160 have remained in the aircraft industry; 500 have gone into associated, metal-using industries. Six hundred and fifty-three of them have remained in their own occupation. All the evidence is that this closure has had very valuable economic side-effects."

Sir Ian Orr-Ewing (Conservative, Hendon North) apparently has now assumed the role of Conservative TSR.2 spokesman. Also on June 14 he asked the Minister of Aviation whether he would issue instructions that the three TSR.2 prototypes were to be cocooned and not sold for scrap.

In his written reply Mr Jenkins thought it unlikely that cocooning would be worthwhile. "We are, however, still exploring what use can be made of the first three TSR.2 aircraft now that it has been decided not to continue flying them," he stated. "One possibility is a limited programme of research on ground running noise in aid of the Concorde."

Mr Eric Lubbock (Liberal, Orpington) asked the Minister if he would seek to amend the Air Navigation Order, 1960, to provide for "a points system of workload limitation for pilots," as used by BEA. The limitations on flight time, Mr Jenkins replied, were "drawn at least as tightly as those of other major aviation countries," although the matter was currently under review.

At their recent discussion meeting the graduates and students of the Royal Aeronautical Society voiced a bitter dissatisfaction at the present status in society of aircraft engineers and technologists. This feeling is not confined to the aircraft industry, and the general subject was raised in the House in questions to the Minister of Technology on Tuesday, June 15, by Mr Patrick Jenkin (Conservative, Wanstead and Woodford) and Mr David Walder (Conservative, High Peak).

"Many more engineers and technologists of high quality are needed in industry," Mr Cousins replied, "and there is a clear national need for many more young people of first-class ability to be encouraged to work for these professions." Mr Cousins' Department was following up the many aspects of the matter. (The Tavistock Institute, also, is making a study for the Government on factors affecting the status of engineers in society; this should be completed by mid-September at a cost of about £4,500.)

Cdr Anthony Courtney (Conservative, Harrow East) is well known as an active private pilot, and on Wednesday, June 16, he asked whether light aircraft might be allowed to use RAF stations at weekends. Duty officers and station fire parties, he suggested, could be trained to handle light aircraft.

Mr Bruce Millan, Under-Secretary of State for Defence for the RAF, said he did not think the proposed arrangements would be "consistent with the standards of safe and efficient operation of their stations which commanding officers of Royal Air Force stations are required to maintain." Declining a further suggestion by Cdr Courtney that radio messages might be accepted from light-aircraft pilots wishing to land at RAF airfields, Mr Millan said, "I regret that the operational commitments and flying programmes at RAF airfields . . . make it essential that longer notice of landings is given than would be possible under the arrangements proposed. There would, in any case, be technical and administrative difficulties."

In the concluding sentence of his reply the Under-Secretary said: "We are anxious to be as helpful as we can. . . ."

You could have fooled me, Mr Millan.

press

ROBERT BLACKBURN

London, June 16

For the record, and with respect to Messrs Mulchrone and Rodwell, I cannot recall—in 16 years of international travel—especially obnoxious behaviour on the part of British Customs officials. Like most people I have come across the odd pernickety one, and I have experienced occasional irritating delays: the longest wait was for about 40 minutes at Heathrow, but this was because of a choke in the baggage pipeline, not slow Customs.

In 1949, after landing at Northholt in an RAF Valetta, our press party was held up for about half an hour. Perhaps it was the Custom men's fault: I don't know. One of the older newsmen among us began to complain loudly and abusively. He mentioned his name, his paper and his close personal connection with important people—he would "speak to Sholto" about it. The Customs men apologized courteously, and blandly charged the party full duty on everything we had brought in. Much more recently I saw a reporter using bad language to an airline ticket clerk who was asking for an excess fare involved in switching flights. We journalists as a body are not all egotistical, drunken, loud-mouthed bullies, and I for one should resent any assumption that we are. By the same token, I wonder how much we'll achieve by making generalized criticisms of other groups of people on the basis of their occupation alone.

How many miles can an Antonov 22 fly in one hour? Answer: 350 (*Sun*), 370 (*Guardian*), 375 (*The Times*), 403 (*Express*), 410 (*Telegraph*), 420-460 (*Financial Times*). The *Mail* didn't hazard a guess, but Angus Macpherson's story on the "Red Giant" was enterprisingly illustrated by a retouched picture including a London Transport Routemaster bus to give scale to the great beast. Unfortunately, the artist put the bus in the wrong place and it came out looking smaller than a man walking across the tarmac on the other side of the picture.

Any discrepancy in published information about the Russian aircraft is the fault of the Russians and not of Fleet Street. I experienced the heat and shambles of the Le Bourget press room and the avasiveness of the Russians, and in my modest judgement the air correspondents' coverage was excellent. Few people at the show worked harder than these men, especially those with tight deadlines to meet. On these occasions Reg Turnill of the BBC probably has the toughest assignment of anyone, and his sheer endurance merits great admiration.

Talking of the Paris Show press room, I look back in sorrow at the contents of the pigeonholes adorning an entire wall—95 per cent of it waste paper. Why must PR departments devote so many thousands of expensive man-hours to the production of largely useless "press kits"—unless, perhaps, to persuade themselves in advance of the Show that they have done well by the Press, leaving them free to get on wtih the real work of enjoying the flying and the comfort of the chalets?

At Paris I encountered a truly classic case of inward-looking PR (no names, because this column is not for personal axe-grinding). A week before the Show I made a telephone call to a British company for three or four urgently needed photographs, and I confirmed my request in writing on the same day. The pictures were for publication in an internationally circulated magazine with a readership representing potential customers of the company concerned. No doubt they were too busy preparing for Paris to reply. Ten days later, my deadline now desperately close, I called at the company's chalet to ask for a copy of the picture illustrating their only new project. So help me, they had brought only six prints to Paris and these had all gone . . . but no doubt they had plenty of press kits and glossy brochures in the cupboard.

PARIS WEEK

ILLUSTRATED WITH "FLIGHT" PHOTOGRAPHS AND SKETCHES

Ungainly on the ground, the massive Mi-10 crane showed fine fuselage lines in flight. The Russian transport helicopter trio—the Mi-6 and Mi-8 also performed—was one of the most impressive items during the flying displays

THE AIRBORNE DAYS

THOUGH marred by an accident on Saturday, the two monster flying displays which concluded the Paris week were otherwise a memorable feast of flying served in an impeccable environment of gin-clear air, blue skies and scattered sun-dappled clouds. The menu was, however, one in which the choice of dishes was more impressive than the cooks' artistry; few of the demonstrations were distinguished by especial flair and the service was erratic.

Light aircraft were legion and their cavortings occupied both mornings. Memorable in this section were the fantastically steep climb of the Pilatus Turbo-Porter and the low-speed, low-level demonstration of Czech Z.37 Cmelak agricultural aircraft. Mitchell displayed the Beagle B.242 to very good effect. The Matra Moynet Jupiter tandem-twin business transport was proved to be a spritely performer, both when being pushed or pulled, for it landed with the front engine stopped. In nearly every instance the French backed quality with quantity in the flying displays; one triplicated show was that of the Sud Horizon.

Moving into the more expensive categories—those splendidly named *avions d'affaires*—the whole gamut of pure-jet aircraft available, from the MS Paris III up, performed. The Lear Jet looked absolutely superb as it made its high-speed runs piloted by Bill Lear Jnr. This, surely, is the nearest thing to a rich man's fighter (though a civil Mustang was seen on Sunday). The Jet Commander made its European début, still looking Aero Commanderish despite its mid-wing. Dassault went for quantity with three elegant Mystère 20s, which variously and simultaneously displayed high- and low-speed capabilities. Take off and climb honours went indisputably to the HS.125, flown by Sowray. In little more than two-thirds of the distance used by the opposition, he drew audible gasps from the crowd with the climb, making a strong impression in an unfairly short "spot." The military-roundelled Piaggio PD-808 streamed tip-tank vortices and braked by courtesy of a ring-slot 'chute.

The finest stylist among the big-twin pilots was surely Balado in the Argentine twin-Bastan Dinfia Guarani II. This was flown with real style, an almost instantaneous undercarriage retraction being followed by a rocketing climb. Plan-form, abundantly displayed in steep one-engine turns, was disturbingly reminiscent of the Junkers Ju86. Twenty have been ordered; performance

The An-24 feedliner, below, is the turboprop partner of the new rear-engined Tupolev Tu-134 at right. Relocation of the engines, formerly in the wing roots, has greatly improved wing area and efficiency, though the external undercarriage housings remain

The RAF Red Arrows, flying their Gnat Trainers, were one component in a warmly applauded unified RAF display on Sunday

The prototype Wessex 3 ASW helicopter, with dorsal growths new to the type, was prime smoke-maker in Westland's well integrated display

Paris Week . . .

Three Franco-German Transall C-160s took part in the flying show. Airbrakes are extended for this short-field approach

The An-12, in Aeroflot colours, is now completely civilianized; the blind tail turret seen on early airline models is now removed

The prototype Sud SA.330 tactical helicopter, which could become an Anglo-French project, was part of a large Sud-ALAT helicopter display

quoted was 298 m.p.h. cruise and a 2,650ft/min rate of climb.

Rare bird among the choppers was the Lockheed XH-51A rigid-rotor experimental machine, which was impressively fast but oddly asymmetric with its off-centre J69 auxiliary propulsion turbojet. Sud—maintaining its record of a *new* helicopter at every Salon for the last 15 years—filled the sky with two Super Frelons, in their operational ASW form, the SA.330 tactical helicopter, and gaggles of varied Alouettes.

Maritime patrollers were represented by a Canadair Argus 2 and a Lockheed P-3A Orion, and the home-grown Breguet Atlantic. Two of the latter flew in from the north as the third performed and all appeared most stately but highly operational. "Watch now for the fly-past of two Breguets on one engine" said the English commentator, who unconsciously but engagingly leavened his fixation on undercarriages and " heelycopters."

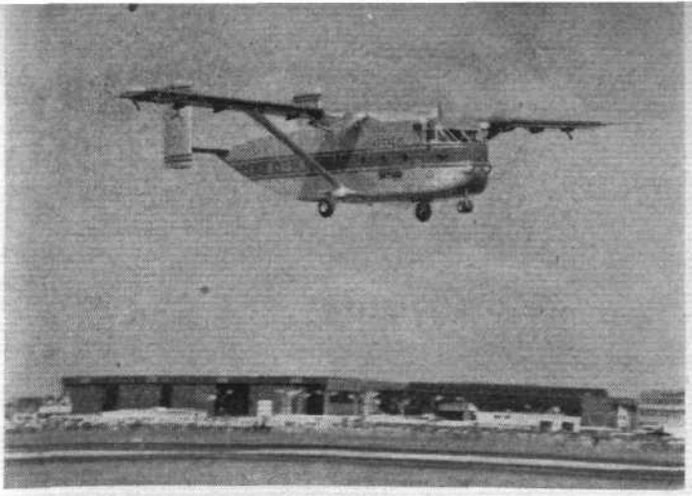
Transport makers (of the West) virtually ignored the Paris Show, although BAC did excuse the disappointing non-appearance of the VC10 as being caused by Ghana Airways' pressing requirements. Sole western civil airliner displayed was the Super Caravelle, flown by André Turcat, who showed that the years, and much development, have impaired not one iota the Caravelle's purity of line.

The USSR, stealing the static thunder with the monstrous An-22 which loomed over all, flew three transports—the An-12, the An-24 and the new Tu-134 short-haul rear-engined jet. The two Antonov machines show a strong family likeness, particularly when seen head-on, and the rear-engined Tu-134 still resembles its predecessor. Its take-off and landing distances were well inside those of the Jet Commander and notable on landing was the large under-fuselage airbrake, extended before touch-down. The massive helicopters, the Mi-6, Mi-8 and Mi-10, fascinated all and were most elegant in flight, the 120-passenger Mi-6 particularly so.

"Attention, décollage du Buffalo," boomed the amplified narrator. "Attention, Buffalo taking off," his faithful English echo said on Saturday, when the commentary was bilingual. The imperative is justified; a few seconds' inattention and this remarkable machine has gone. The de Havilland Canada pilot Fairbanks scorned the early reaches of the runway, taxied up to the official grandstand and was off in, perhaps, five lengths. The Buffalo (and Caribou on Sunday) descended in tight spirals before making an incredibly breath-catching flypast, when it seemed just to hang upon the air. This was a difficult show to follow for Hawker Siddeley pilot Harrison in the competitive 748MF Andover, and probably the happiest people around during this tangible contest were Hawker Siddeley shareholders, who thrive which ever wins. Despite its less workaday appearance—surely the glamorous airline-style civil livery is a mistake for demonstrating this forward-airstrips aeroplane—the Andover displayed equally impressive powers of rapid levitation and steep descent and an equal contempt of the runway's length, though its demonstration was not so well placed in the sky as was the Buffalo's.

As the Andover landed, the Breguet 941 ran in from Villacoublay with 60 Commando troops aboard and its rear door open. This other remarkable hanger-on-the-air touched down before the stand, rolled a few yards, disembarked its well-armed load, and was away in 42 seconds, flown by Witt.

Three Franco-German Transalls performed adequately, and the impressive Lockheed StarLifter took the air, displaying a veritable



Shorts sent along the short and the long of British freight aeroplanes—the Skyvan, seen here with its newly lowered tail unit, and the Belfast

sheet of wing as it pulled away into a steep climb. It rather stole the thunder of the Short Belfast, which needed the companionship of its Skyvan stablemate to cut it up to size.

A trump hand of US military hardware was displayed; the F-5 Freedom Fighter, the A-4 Skyhawk ("Sky-oak" to the commentator) and the Phantom all impressed.

There was nothing illusory about all the Mirages Dassault had to fly: the Mirage IIIC-2, which has the same Atar 9K engine as the Mirage IV, the IIIR recce machine, the IIIT test-bed for the TF-106, and a Mirage IV.

From the far side the Balzac VTOL machine took off noisily to join the Dassault throng; the IV did a high-speed run and climbed vertically into cloud; the Balzac hovered over the runway and was almost clobbered by a high-speed-running III, which hauled up and seemed to miss it only by a hair; and the VTOL machine showed its own sleek heels with a low run in from the right while the IV came in higher from the left. The Balzac then settled, with clouds of dust, on a pad on the further runway-side. In distinct contrast with the Kestrel's nose-down-and-then-flare approach technique, the Balzac rides down the slope nose-high.

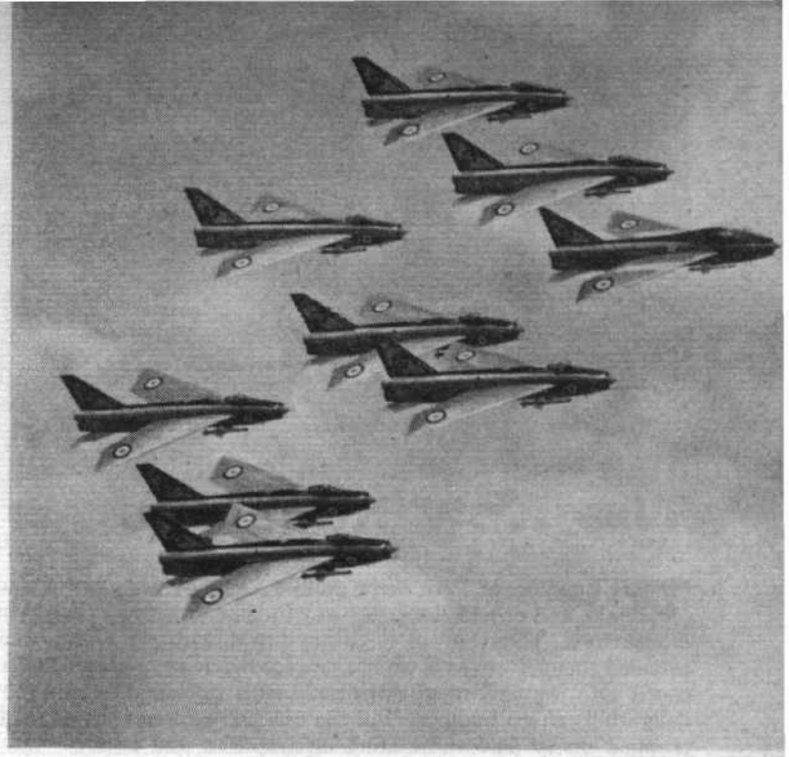
A keen display "battle" was that flown by the trainers, beginning with the Potez 94 armed development of the well-known Magister. Saturday's tragic accident to the Fiat G-91T came at the end of a brilliantly flown display by Capt Italo Donati, who was forced to overshoot by the presence of the Tutor on the runway. Donati pulled up, rolled during the climb, flew some of the downward leg inverted and was hauling round in a tight curving approach when he crashed into a car park.

All honour to the RCAF Canadair Tutor pilot, who flew his largely unwatched display while rescue helicopters and crash tenders raced to the scene, and particularly to Macchi chief test pilot Carestiato, who brilliantly displayed the MB.326 only minutes after the crash. His display included inverted flight with flaps and undercarriage out, an inverted spin and a deliberately widely yawing approach. In the Hispano Saeta, the Spanish trainer, Santa Cruz went even better on landing and really fish-tailed his way all down the glide-slope.

The Armée de l'Air flew over 80 assorted Mirage IIIs and IVs, Super Mystère B.2s and Vautours and on Sunday the impeccable Patrouille de France, Magister-mounted, laid its tricolour smoke and flew its drills with some members upright and some inverted. Sunday was jazz-piano accompaniment day and the HS.125, with its stimulating climb, drew what some thought was an unfairly soporific *Greensleeves* from pianist M Codolban. *Roll Out the Barrel* accompanied, rather vainly, the beautifully conceived and unified display of the CFS Red Arrows, on Gnat Trainers, and Treble One Sqn with its new Lightning F.3s. The shattering climax came as the seven Gnats streamed in for their *atterrissage*, the last two trailing smoke, when the Lightnings, which had been lost to sight, streaked in low and very fast, in well-spread line astern, between the runway and the crowd.

Immediately after the RAF display *Flight* left for the nerve-racking thrombosis of Sunday's Paris traffic, a BEA Trident (temporarily operating from Orly) and a waiting printer. Paris '65 ended for us with the distant sight of the RSAF Draken team performing in two formations of four, as we sat stuck in a jam. There were further joys to come, including the Aeronautica Militaire Frecce Tricolori team, on their modified G.91s, the USAF Thunderbirds and the USN Blue Angels in their F11Fs.

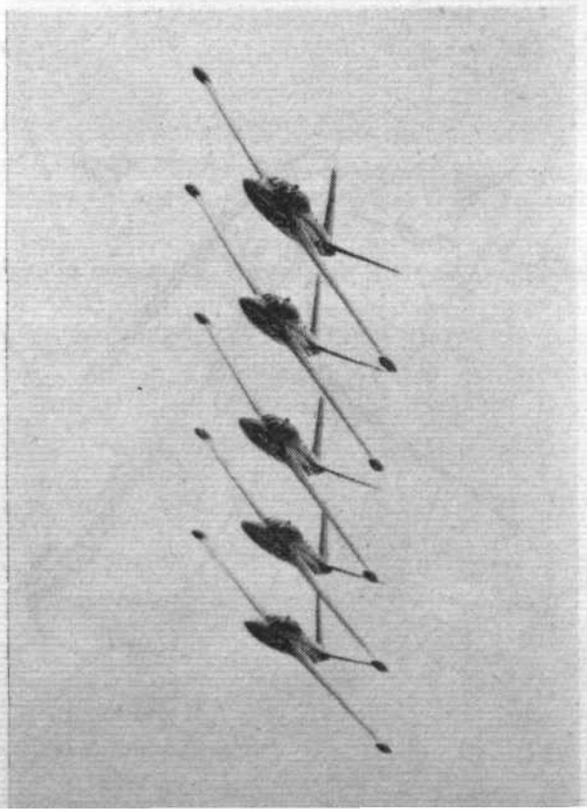
We never did find out what M Codolban had in store for them.

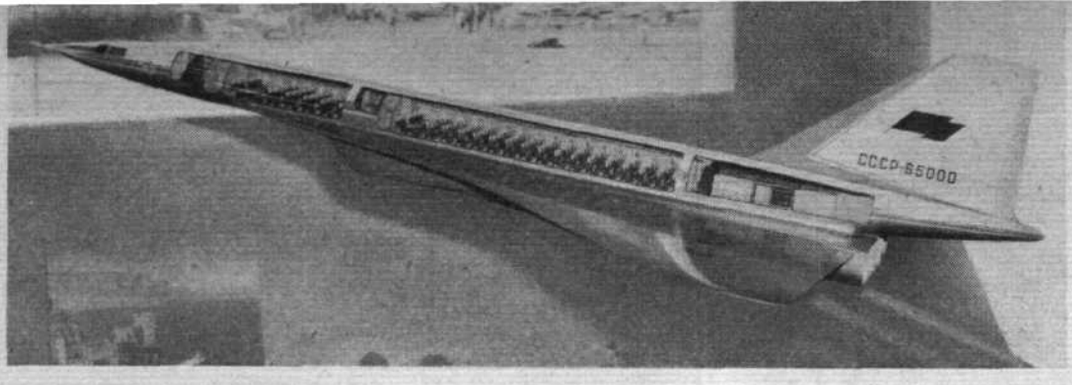


Treble One Sqn, RAF, came back into the international display scene in its new black-and-gold-finned Lightning F.3s, combining with the Red Arrows for the RAF's major "spot"

With short wings partially unloading the rotor in cruising flight, the Mi-6 transport helicopter—the world's largest—was a stately sight in flight. The powerplant/transmission/rotor combination appears to be used virtually unchanged for the Mi-10 flying crane

"Flight's" photographer caught the Patrouille de France's five Magisters, unusually, all the same way up. Generous use of tricolour smoke was made in their display





Paris Week . . .

This model, which arrived too late for mention in our report last week, showed the main features of the Russian Tu-144 SST project, the prototype of which is to fly in 1968

The New Russians

THE Russians at Paris were quite evidently given clearance to talk, and provided themselves with an ample staff of excellent interpreters. Thus put in linguistic touch with the West, they revealed themselves (as if we had not known it anyway) as experienced and well-informed engineers, with occasional flashes of delightfully sharp humour. But the old side-stepping answers still cropped up to leave infuriating uncertainties and doubts. Only Mr Tupolev and Mr Antonov themselves, gracious and commanding doyens of the industry, talked with the assurance and certitude of the oracle.

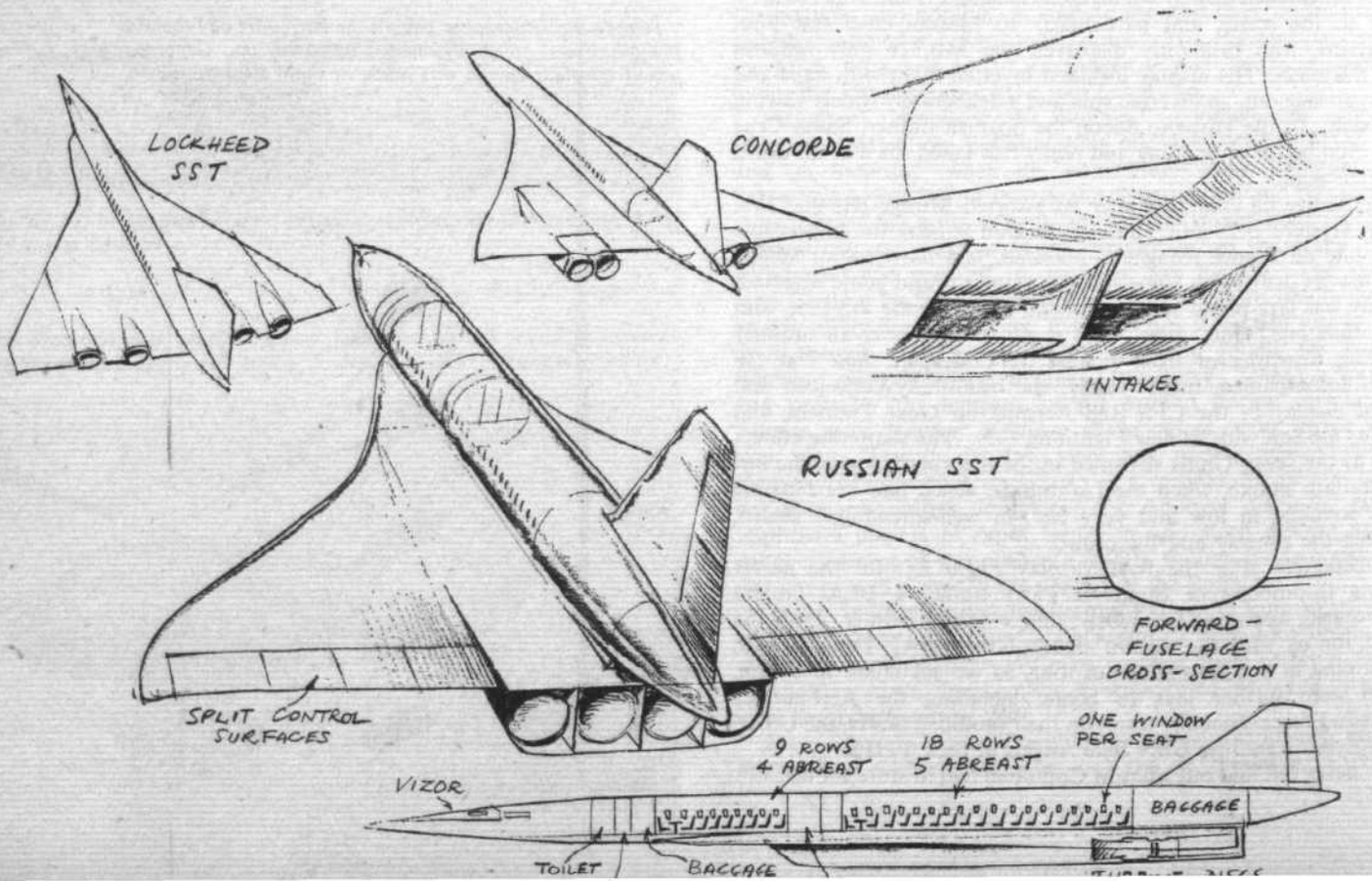
So the model of the Tu-144 SST remains a bit of an enigma, for no 4ft-long model of a claimed 121-seater (the model, incidentally, contained 126 seats) can reveal many essential details of the actual design and *might* be very misleading. The registration it bears, CCCP 65000, is, we were told, an artist's whimsy indicating Paris 1965 and not project 1965.

The notice board said simply "Tu-144: cruising speed, 2,500km/hr (1,552 m.p.h., Mach 2.35 we were told); range, 6,500km (4,030 miles); gross weight, 130 tonnes (286,000lb); take-off run 1,900m (6,240ft); passengers, 121." Our first casual conversation through the interpreter then went something like this.

Flight: "Might you not encounter sonic fatique on the rear underfuselage close to the engine effluxes?"
Pause for machining from our French into Russian: Russian reply: machined back into French (this for each question).
Russian: "We will avoid this problem."
Flight: "I see you have split control surfaces."
Russian: "Yes, they both operate together."
Flight: "Was this aeroplane ordered by Aeroflot, or is it a national venture?"
Russian: "It is requested by Aeroflot."
Flight: "On what routes will this aeroplane be used?"
Russian: "Russia is a very large country. The aeroplane will fly internal routes and to the West, to Paris, etc."
Flight: "These are overland routes. What about sonic booms?"
Russian: "It is a problem."
Flight: "Have you read the results of the Oklahoma boom trials?"
[Machine: "Tilt."]
Flight: "Trials of booms."
Russian: "Yes."
Flight: "At OK-LA-HO-MA."
[Machine: "Tilt."]
Flight: "OklaHOma."
[Machine: "Tilt."]
Flight: "OklaGOma" (our idea of Russian H = G).
Machine: Pause, mumble, flash "'klAg'ma!"
Flight: "Yes, have you seen it?"
Russian: "Yes, we are aware of it" (loss of interest in project: end of interview).

Next day we returned with a Russian-speaking French chum and a battery of questions. The model was still like Michelangelo's Pieta in St Peter's at Rome—surrounded by murmured commentaries in German, French and English between knots of onlookers, some pure inanity, the rest penetrating technicalities from Western technicians. All gather round when they see someone make effective contact with the duty Russian.

The general similarity between US, Anglo-French and Russian SST projects, and some of the features of the new Russian venture, are illustrated in these drawings by "Flight" artist Arthur Bowbeer



Russia's second Paris surprise, also a late arrival, was the monster An-22 transport

We synthesize now the information elicited, with the full realization that much of it was in the tradition of the "according to the pre-determined programme" answers given so often during questioning of Russian space technicians, only the theme was "it is of the nature of the solutions applied by designers of other SSTs." After being gently chided at these stilted replies, the Russian smiled apologetically when he thus replied again. He was, he reminded us, only an Aeroflot operations man.

"On what reserves, then, do you base your stated range of 6,500km?" Answer: "Most of our routes are much shorter, say, 3,500km to 4,500km." Finally someone needled him into exclaiming "We would guarantee Paris to New York non-stop."

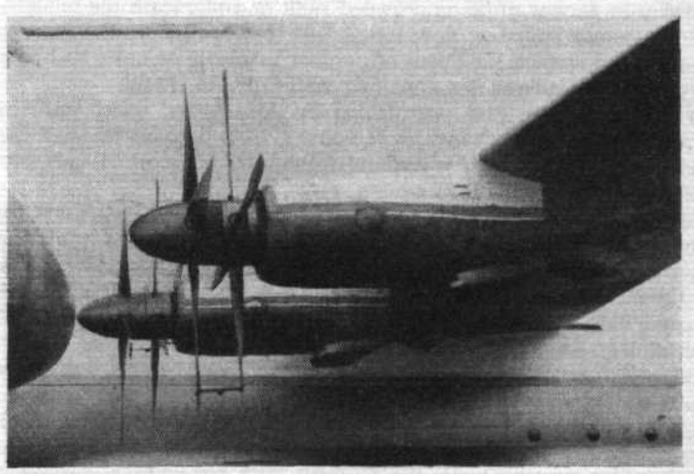
We gathered that the Tu-144 prototype should fly in 1968, about the same time as the Concorde. The Russians are developing several SST engines, some with and some without afterburner, but all intended to have reverse thrust for landing. The four engine bays are in a single box with two intake ducts directly beneath the fuselage, but the engines themselves are aft of the cabin and the wing carry-through separates the two, so that noise and vibration may be better than with more distant locations. Airport noise is not expected to be a problem and acceleration profiles will be chosen to minimize noise during climb. Booms are not expected to be a problem. The cruising height is "of a value to be expected of such an aircraft." Ozone is not expected to be a problem because it decomposes in the (cabin air) compressors. Experience with other Russian aircraft operating in these regions has been good.

There is an inner, nearly perpendicular windscreen and secondary "peep-panels" in the covering nose fairing. The nose is said to droop for landing, but the top deck must also retract or the necessary droop would be excessive. Baggage is stowed in panniers in a chamber aft of the main cabin, and is unloaded by rolling back through the pressure bulkhead and down out of the tail, aft of the jetpipes. No underfloor stowage is evident.

The main undercarriage is of six-wheel bogies retracting inwards, but possibly not into the engine boxes. Nosewheel location is not precisely known, but is aft of the engine intakes and might be offset in the port-side forward wing-root.

Both short (Concorde-type by implication) and long intake ducts present problems, and the Russians have chosen very long

With gantry rails extended under the upper loading door, a relatively long load could be carried well clear of the An-22's cargo floor. The bullets on top of the fins are not part of the rudders



The An-22's four Kuznetsov free-turbine powerplants, with independently turning contra-props, deliver no less than 15,000 h.p. each

Tucked into the Russian enclave in the static park, the mighty An-22 dwarfs all its compatriots. The tailplane of the Il-62 can be seen beyond the An-22's engines. The Mi-10 is on the right

The flight deck of the Mi-8 is remarkably roomy and well windowed by Mi-6 standards. The two dials at top right serve the astro-compass system

Paris Week . . .

ducts with adjustable ramps, which probably explain why the engines are under the fuselage and not under the wing.

The navigation system will be automatic ("of the kind logically adopted for any SST project"), but a question about inertial, stellar, Doppler or radio aids was dodged. So was a question about autopilot ("there will be one") and automatic landing ("it will be available when this aircraft is ready and will therefore probably be incorporated"). The split control surfaces in all three axes are powered and have some mechanical and some electrical signalling.

Airframe materials are "chosen appropriately so that at stagnation temperature they have the strength required."

As all parties concerned were now exhausted by additional multiple translation for more recently arrived onlookers—and were in danger of being crowded right in underneath the model—the second interview now terminated, but not before the Russian observed that his judgment of popular tolerance of noise had been completely altered by appalling traffic din in Paris!

The Russian team was fielded by Aviaexport, which gave its address in all brochures as Moscow G-200, Smolenskaia-Sennaia Square 32/34, V/O Aviaexport: telegrams, Moscow Aviaexport: Telex, Moscow 1279: telephone, 44-26-86.

A sales representative gave some prices and delivery times for most of the types on show, all to include full equipment, tools and one year's supply of consumable spares, as follows: Mi-6, $2m (about £713,000) and six months; Mi-8, $0.6m (about £214,000) and nine to 12 months; Mi-10, $1.8m (about £643,000) and 12 months; An-24, $0.85m (about £315,000) and six months; Tu-124, $1.450m (about £517,000). Little market analysis had been done in the West and export potential of Russian aircraft there was accordingly unknown. The exact details of, for instance, ARB certification requirements were not known and no comparison was therefore possible with the Russian civil air board's standards. The days of very short TBOs for Russian engines were now over. The Il-18's turboprops, for instance, were now cleared for 4,000hr.

The An-22 To the surprise of most people, but to the enraptured delight of Mr Antonov himself, the mighty An-22 prototype, which first flew in February and is apparently a military aircraft, reached Paris non-stop from Moscow on June 16. Flight time was reported as 5hr 5min, which made the block speed little better than 350 m.p.h. Maximum speed was given as 422 m.p.h.

Though hugely impressive, the An-22 makes little sense by Western commercial airline standards, unless one accepts as a basic requirement operation from relatively small and rough fields, i.e., that the An-22 carries unprecedented loads in underdeveloped areas without major airports. Both the tremendous 12-wheel, levered-suspension main undercarriage and the twin overhead gantries for handling large unpalleted loads support this theory. In its possible military application the An-22 becomes a very tactical C-5A, probably able to transport big cross-country vehicles and missile batteries. Its payload-range was stated to be 80 tonnes for 5,000km (176,000lb for 3,100 miles). Another version expected next year is reported to have a slimmer fuselage and two passenger decks, each with two aisles, to accommodate 720 passengers.

The prototype at Paris nevertheless carried the civil registration CCCP-46191 and Aeroflot markings, together with the name Anten. The provision of oxygen replenishment points with pressure gauges marked in English suggests need for oxygen filling in the west and therefore for unpressurized cruising at above 10,000ft. Pressurization is undoubtedly intended at a later stage, and the ramp doors have rubber edge-seals. Pressurization equipment occupies the forward portion of the very large undercarriage blister on the right. A turbine a.p.u. in this area was several times started in the crowded static-display area at Le Bourget and emitted 4ft-long tongues of flame quite near passing spectators.

The An-22 looks very large at a distance, but the feature which finally brings its huge size home is the very large personnel entrance door in each undercarriage fairing. From this a passage leads uphill and slightly forwards into the cathedral-like cabin. Side turnings lead forward to the a.p.u. and aft to the undercarriage. Main fuselage structure is based on three strong fuselage ring frames picking up the three spars of the wing torsion box at the top and the three main undercarriage units at the bottom. A third large ring frame picks up the nosewheel undercarriage and forms the forward cabin wall, dividing the remainder of the nose for crew quarters. The upward-retracting rear freight door and the downward-moving vehicle ramp form the pressure retainers in the rear together with a small bulkhead in the tailcone.

A normal-sized flight deck fairs like an insignificant pimple into the tapered nose section and a traditional Russian bomb-aimer's position for a navigator completes the nose. There is a small plastic dome beneath the navigator's compartment, probably housing something like a drift sight. The main navigation radar, much larger than the dome on, say, a Tu-104, is mounted beneath the starboard undercarriage fairing. There are several smaller aerial domes nearby.

The wing is relatively thin and, from above, can be seen to have equal taper on both leading- and trailing-edges with fairly high aspect ratio. On landing, the flaps appeared to be a normal single-slotted arrangement, but published figures claiming a take-off run of 4,260ft and a landing run of only 2,620ft indicate provision of advanced high-lift devices. The four engines are Kuznetsov NK-12MBs of 15,000 h.p. each driving eight-blade contraprops. Front faces of the blades are painted black and rear faces hand-buffed with the distinctive circular whirls noted two years ago on the similar propellers of the Tu-114.

The An-22 was not open for public inspection during the Show—unlike nearly all the other Russian aircraft—except during one rather hectic Press conference on June 18, but *Flight's* chief artist Arthur Bowbeer was able to gain access and make the sketches reproduced on page 1004. There was no indication of attachments for a second deck, but a notable feature was that long strakes beneath the rear freight door, which retracts upwards, turned out to be extension rails for the two travelling gantries. By this means loads, presumably not palleted, could be run right out of the cabin, clear of the vehicle ramp, and deposited on lorries. The floor itself is metal and covered with sharp metal studs at a few inches' pitch to form a non-slip surface. There are only six round windows on each side of the main cabin, set at about mid-height. Three further portholes, one at "first storey" level are in the crew quarters forward of the bulkhead. The cabin measurements were given as 4.4m × 4.4m × 32m (14ft 5in × 14ft 5 in × 104ft 10in). Considering that the fuselage outside diameter is probably at least 22ft, the internal measurements are not over-generous and compare with an uninterrupted minimum square envelope of 12ft × 12ft in the Belfast, which also has a maximum internal width of 16ft 1in. The Belfast's maximum floor-to-ceiling height is 13ft 4in. On the other hand, the An-22 can carry nearly four times the Belfast payload for 3,000 miles, probably with better field performance. But it is extremely doubtful that any Western manufacturer with operating costs to consider would indulge nowadays in a slow turboprop design.

A Flight in the Mi-8 Though the Mi-6 and Mi-10 monsters made the headlines, the smaller Mi-8 was obviously a much more recent conception, showing considerable advances in interior arrangement and equipment. Last year it set world records for distance in closed circuit and speed over a 2,000km circuit. The brochure indicates that the Mi-8 is intended to replace the Mi-4

The Mi-8, seen here flying during the display, is a modern and handsome replacement for the Mi-4. It gives a very comfortable ride

which is widely used all over the world, and the new machine offers twice the payload and a high cruising speed of 143 m.p.h. The five-blade rotor system is to some extent interchangeable with that of the Mi-4, because the rotor blades at Paris were in fact Mi-4 units hastily mounted because of last-minute difficulties. This temporarily deprived the Mi-8 of its de-icing, which is liquid in the Mi-4 and electric in the Mi-8. Electrical heating is also used for de-icing the tail rotor, windscreen and engine intakes.

Powerplant is two unspecified 1,500 h.p. free turbines, probably derated for normal use, because the Russians report that take-off power can be maintained at up to 5,260ft. Rotor r.p.m. are governed and the good engine automatically increases power if one fails. The Mi-8 can hover at full load on one engine.

It is noteworthy that the cabin volume aft of the roomy and large-windowed flight deck is entirely given up to payload. All normal fuel is carried in external streamlined tanks; and the starboard fairing is extended forward to house an air-conditioning system for both heating and cooling the cabin. Long-range tanks can be fitted inside the cabin when needed. There are floor-level hot air ducts in the passenger cabin.

Freight, ambulance and passenger versions of the Mi-8 are offered, together with a controllable winch and underside cargo hook for lifting slung loads up to 5,500lb. The aircraft at Paris was an airline one with brand-new and excellent cabin furnishing—alternate grey and red seat-rows, four abreast with aisle, and blue carpet. The seats were mounted on tracks. The flight deck, by contrast, had a rather jazzy carpet and acid green paint on sides and windscreen pillars. This last may have been to make a dark grey background against red cockpit lighting at night. Access to the passenger cabin was either through a sliding door well forward to port, or through a small door formed in the main clamshell cargo doors at the back. The cargo version offers direct rear loading suitable for fairly large cars. Maximum internal load is 8,800lb. Payload range is 6,600lb for 250 miles or 8,800lb for 62 miles. Seating capacity is 28 at 27in pitch with an 11.4in aisle between arm rests. The freight compartment is 28ft 10in long, 7ft 3in wide and 6ft high, though there is just not standing room for a normal person at the forward end of the furnished passenger cabin. Total cabin volume is 777 cu ft.

Though the scale of the two rotors is obviously vastly different, there is otherwise little difference between the Mi-6 and Mi-8 rotors. Both have quite conventional controls and articulation. The very large welded swashplate of the Mi-6—rather daring by Western standards of faith in welding—is replaced in the Mi-8 by a machined spider. The tubular-bladed spars of the Mi-6 are also replaced by flat torsion boxes forming the leading-edge in the Mi-8. Drag and flap pivots are coincident in the Mi-6 and a few inches apart in the Mi-8, but the Russians say that this is incidental rather than a change in basic design. Both kinds of blade are in the classic Sikorsky tradition of multiple trailing-edge pockets, though they droop very considerably when the rotor is stopped.

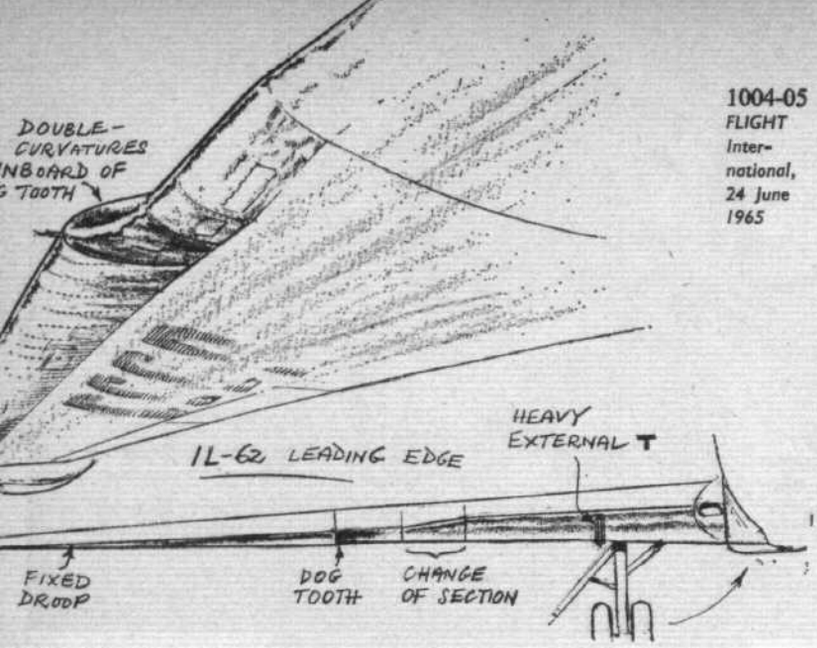
The Mi-8's controls are hydraulically powered in both cyclic and collective channels and an apparently more advanced autopilot with barometric height lock is fitted. The Russians report that it can control all flight modes, including transition. It is certainly used for stabilization. Sperry-like trim indicators show rather better trimming capability than in the Mi-6, which must first be trimmed by hand before the autopilot is engaged to hold attitude. The Mi-6 is steered in automatic flight by a rocking stick beside the pilot's seat, but the controller in the Mi-8 is on a separate pedestal in the centre of the floor rather far from either pilot, so that stick-steering is probably used for manœuvring.

Most electrical switches are in the roof of the Mi-8 flight deck and many are operated together by gang bars covering six or more switches. Engine starting seems to be automatic, though fairly noisy out-of-phase beating between engines indicates that automatic speed control is not brought in until high powers are reached just before take-off. Radio complement is of the rather more modern Russian kind with digital frequency selection for VHF sets. Radio compass is carried, as is a radio altimeter. An intriguing device is an astro-compass for use in Polar regions and having a star-, Moon- or Sun-seeker mounted above the rear fuselage. This is associated with a speed dial with secondary manual target-speed selector, the function of which we could not elicit with the limited interpretation available.

Without much difficulty, *Flight* obtained a ride in the Mi-8. The Russians were using the standard crew of three, the engineer sitting on a jump seat immediately inside the flight-deck door. The flight lasted only ten minutes or so, but was noticeably smooth and comfortable, with a very acceptably low noise level. It was only noticeable that a little roughness occurred whenever the pilot departed from his trimmed attitude. This was subsequently understood to be attributable either to the non-standard blades or to slightly rough handling. Highest vibration, as might be expected, occurred during the slowing transition into the hover, but even here it was not in the least unpleasant—as it can certainly be, for instance, in a piston-engined S-58. Certainly, the average inexperienced passenger would find nothing unacceptable.

Putting an intake bung in one of the 1,500 h.p. turbine intakes, a Russian mechanic gives scale to the Mi-8 rotor head, which is smaller, but similar to those of the mighty Mi-6 and Mi-10

1004-05
FLIGHT
International,
24 June
1965

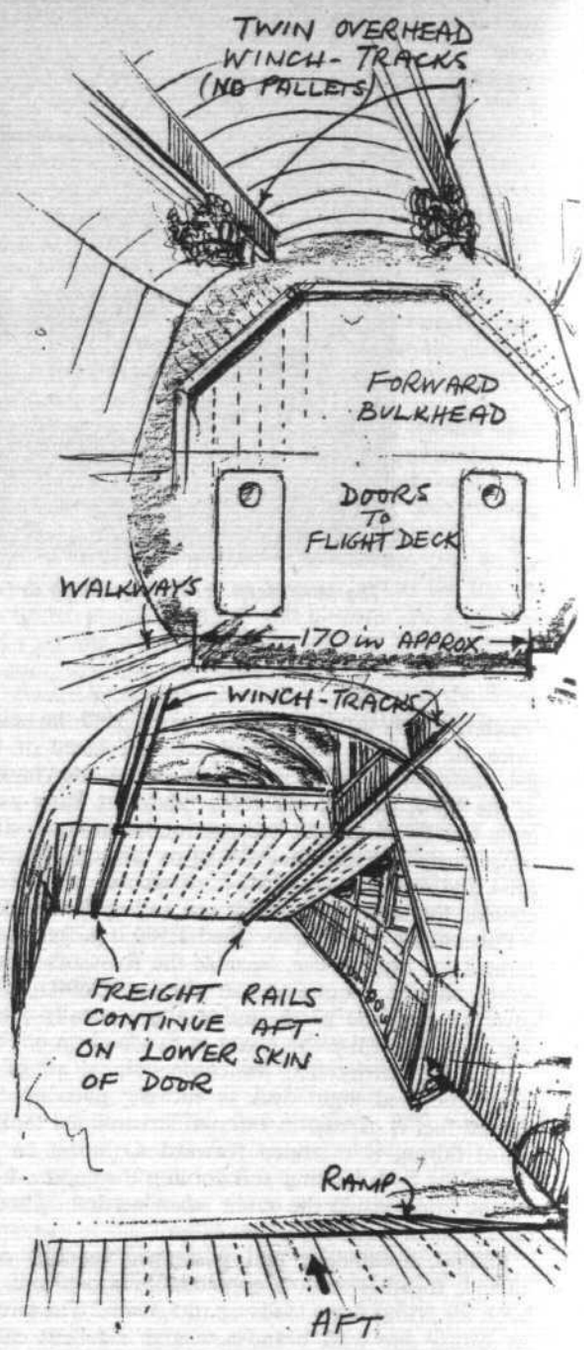


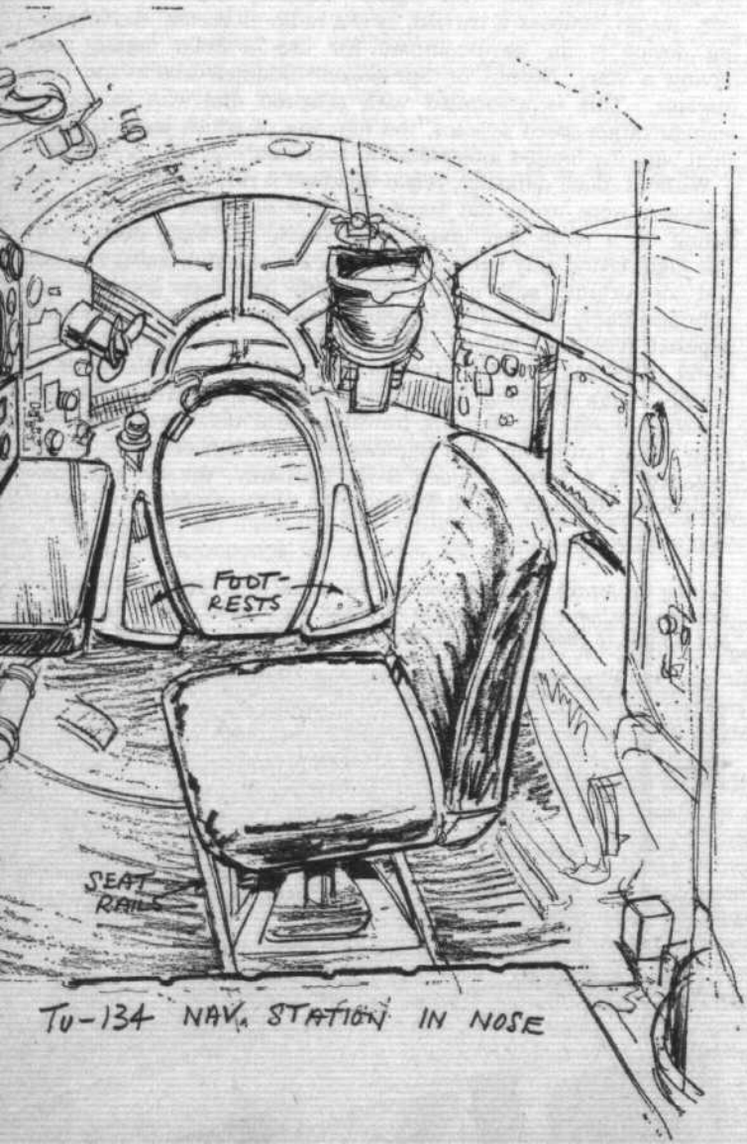
Paris Week . . .

SHOW SKETCHBOOK:

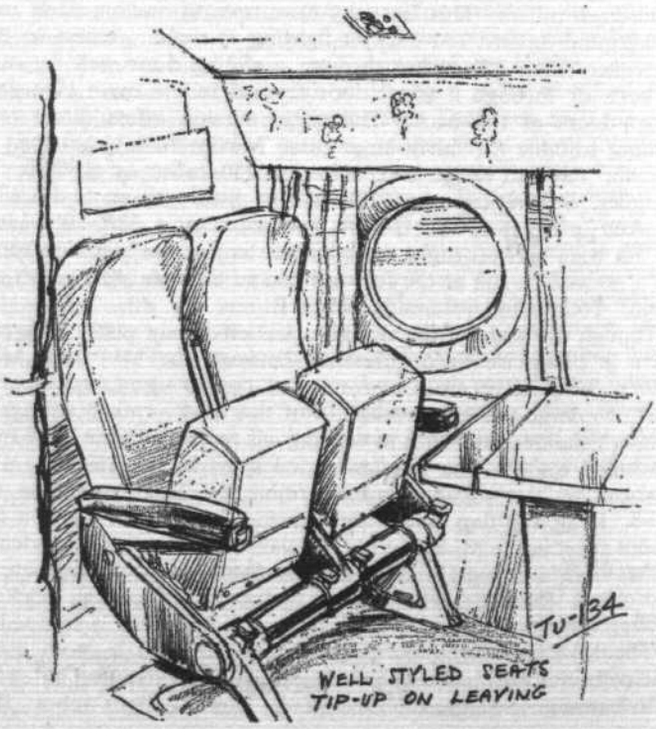
An-22 AND OTHERS

"FLIGHT" COPYRIGHT SKETCHES

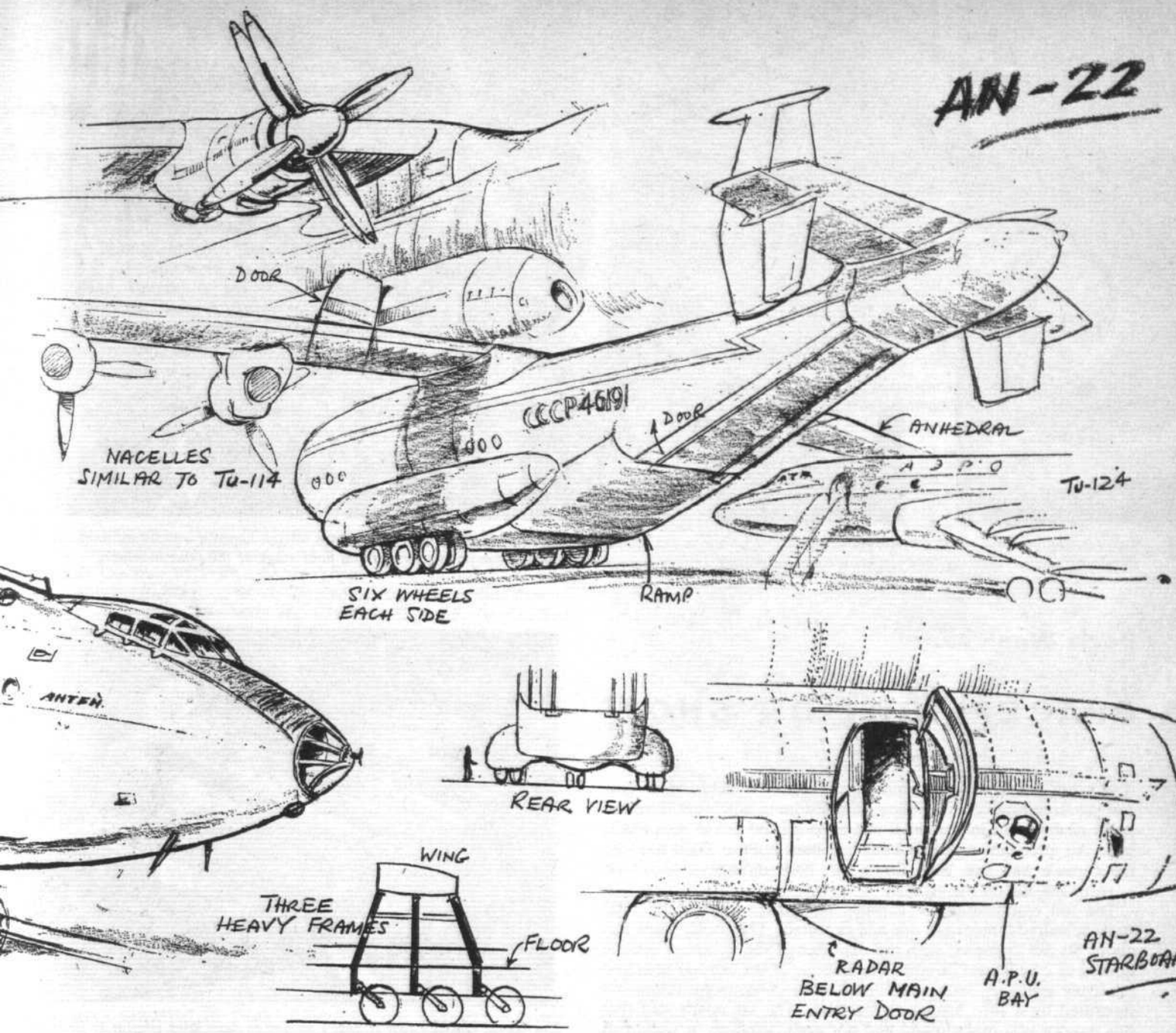


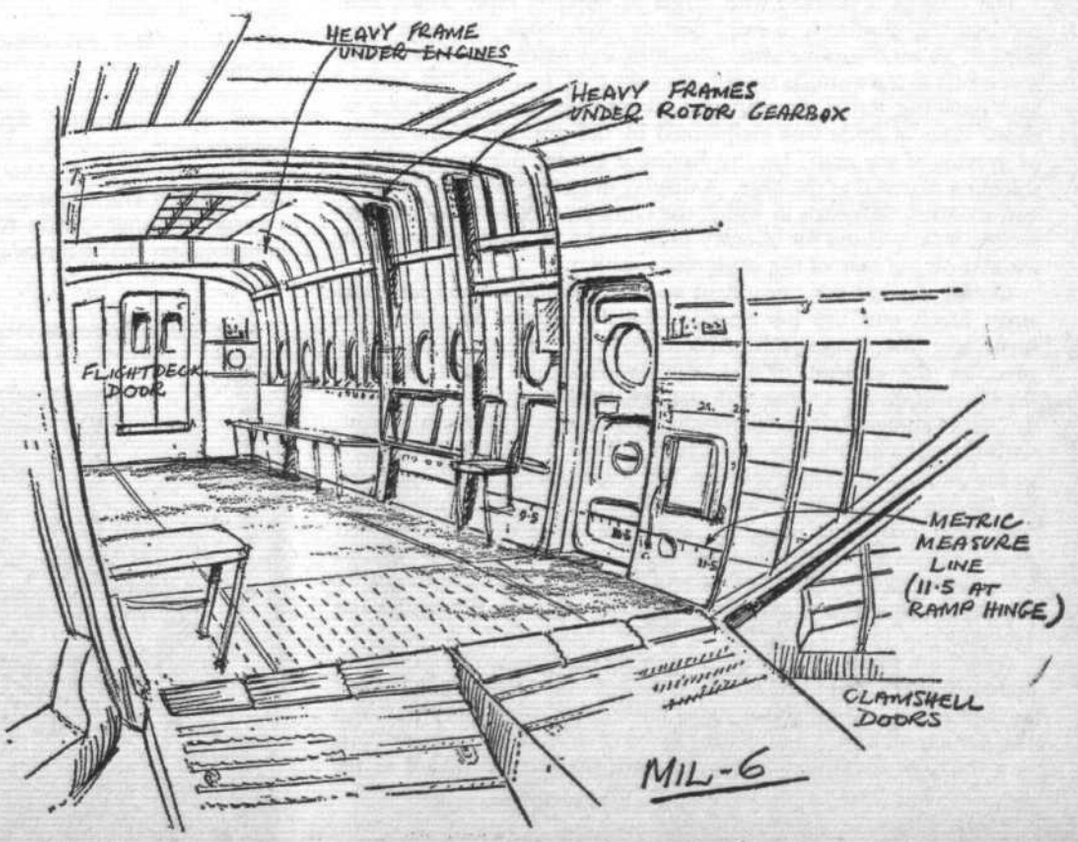


Tu-134 NAV. STATION IN NOSE

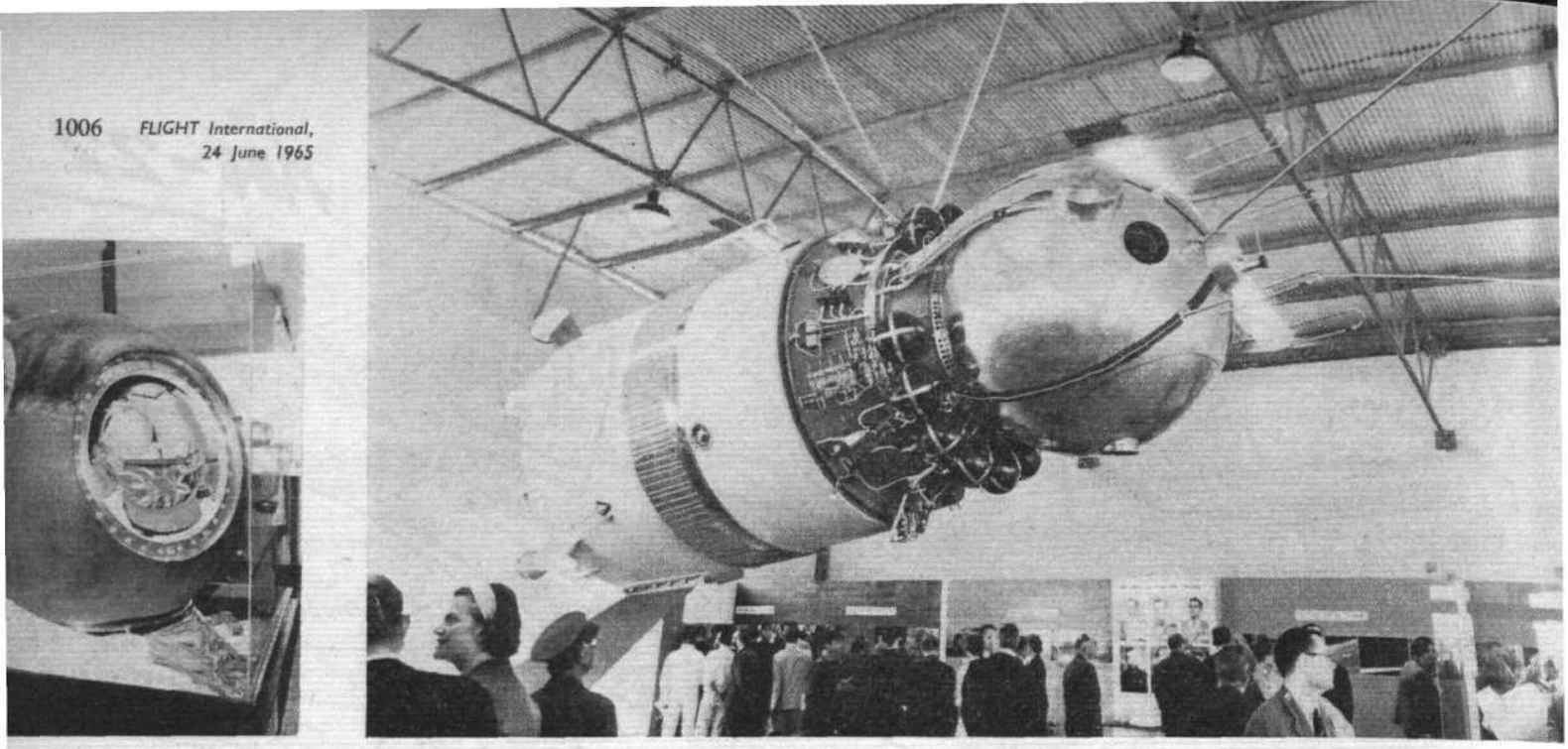


WELL STYLED SEATS
TIP-UP ON LEAVING





Without question the show-stealers at Le Bourget were the model of the proposed Russian SST, which is described and illustrated elsewhere in this issue, and the mighty An-22 featured above. These sketches were made by "Flight's" chief artist Arthur Bowbeer and indicate the major features of interest of the aircraft, including the parallel load-handling gantries, whose rails are continued in the underside of the rear freight door, so that loads can be carried right aft and deposited directly on to trucks. The 720-seat passenger-carrying version of the An-22, to appear next year, will have a slimmer fuselage and two decks. The lower three drawings, from left to right, are the Tu-134 navigator's compartment, cabin seating and the freight hold of the Mi-6 helicopter. At top left is the leading-edge of the Il-62.



Main spaceflight interest at Le Bourget was centred on the Soviet space pavilion. The exhibits included (left) a Vostok capsule which had undergone simulated re-entry heating, and (right) a complete Vostok vehicle comprising capsule, equipment section and final stage of the launch vehicle

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SPACEFLIGHT ON SHOW

SO this was Vostok. A shiny, new Vostok vehicle and a Vostok capsule showing signs of exposure to heat were the main items of attention in the small but close-packed Soviet spaceflight hall. An attendant said that both had been built as flight models; the capsule had not been flown but had undergone simulated re-entry heating on the ground.

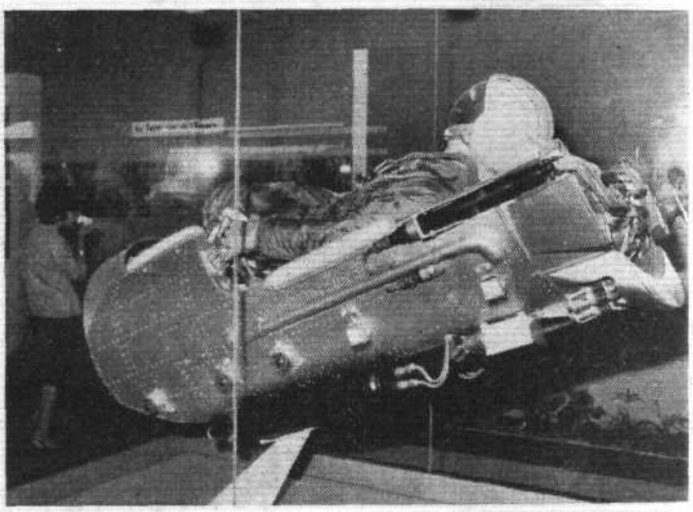
The full combination of capsule, equipment section and final stage appeared larger than one had expected. The rocket stage was about 8ft 8in diameter, with the diameter of the spherical capsule quoted as 2.3 metres (7ft 6in). The interior of the capsule appeared relatively spacious, with main items of wall-mounted equipment separated by a soft, insulating material. The attendant said that this interior was realistic and had not been tidied-up or simplified for display.

The capsule is skinned with strips of metallic tape, which had survived the simulated re-entry heating over about the upper one-third of its total surface area. Re-entry was made always with the spacecraft in the attitude shown, we were told, i.e., with the cosmonaut reclining across the craft and taking the g-loads from back to chest. This attitude was maintained by the position of the centre of gravity of the craft, i.e., by having a greater thickness of heat-shielding material at the base. A display diagram showed a re-entry and recovery sequence in which the combined capsule/equipment-section was oriented for re-entry prior to the firing of retro-rockets located on the rear of the equipment section.

During descent the cosmonaut normally would jettison his main entry hatch and use his ejection seat to descend by parachute separately from the capsule. According to the diagram his ejection precedes the jettison of the capsule parachute hatch and the deployment of the drogue and main parachutes.

The cosmonaut's main entry hatch is directly above his head, with the parachute hatch—now seen to be of the same diameter—to the pilot's left. Looking down over his knees the cosmonaut can see through the optical orientation device, a circular window with four reference sights mounted outside. Level with his head at about 45° to the right is another small circular window. Next to this, to the right of the pilot's shoulder, is a panel of 16 multi-pin electrical connectors used to link the capsule with the equipment section.

There is a small circular transparency in the parachute bay which comes through behind an instrument/electronics panel on the pilot's left. There also appears to be an emergency cabin-entry hatch in the parachute bay. Outlined on the skin of both capsules at Paris is a third large circular hatch or panel, the same diameter as the main entry and parachute hatches and containing the optical orientation device.

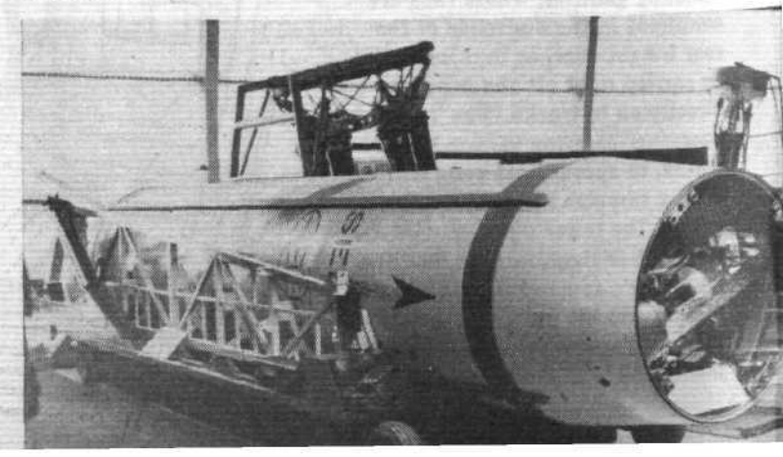


The Vostok ejection seat is based on design principles similar to those of current aircraft ejection seats, and is propelled by two rocket motors

Also on display was a Vostok rocket-powered ejection seat, and items of cosmonauts' flying clothing and emergency survival equipment.

France The space pavilion sponsored at Le Bourget by the French National Centre for Space Studies provided the clearest confirmation that France is dedicated to pursuing a widely based

The first stage (below) of the French Diamant satellite launcher consists of SEREB's liquid-propellant propulsion stage of the Emeraude sounding rocket . . .



programme of space research and exploration with enthusiasm and drive. Most elements of the French programme are already known, but here they were tied together and detailed in a comprehensive and well planned exhibition which had attracted the support of industry, universities and independent research establishments as well as of government departments. The European Space Research Organization also contributed a display which outlined current ESRO progress.

In a separate pavilion showing the work of government defence research establishments, the three stages of the French satellite-launcher Diamant were on display. These comprise (1) the liquid-propellant Emeraude propulsion stage, (2) the Topaze solid-propellant engine and (3) the second (solid-propellant) stage of the Rubis rocket. Matra's A-1 test satellite will be used to verify the performance of the rocket. Also on view was a four-chamber solid-propellant stage said to develop a thrust of 13,200lb for use in both military and scientific programmes.

Individual companies exhibited space hardware also in the main halls of the salon. Models of the forthcoming D-1 and FR-1 satellites, sounding rockets, and French proposals to meet ESRO requirements were included by companies such as Nord, Sud, Matra and SEPR.

The D-1 satellite is to be launched next year by Diamant vehicle from Hammaguir. It will be followed by the D-2, which is expected to be launched from the new French launch site near Cayenne, in French Guiana, in 1968. As described at Le Bourget the D-2 craft will weigh 80kg, of which 25kg will comprise scientific experiments. Measuring 24in long and 27.5in in diameter, the satellite will be placed in an orbit at 450-900km and an inclination of 30-45°.

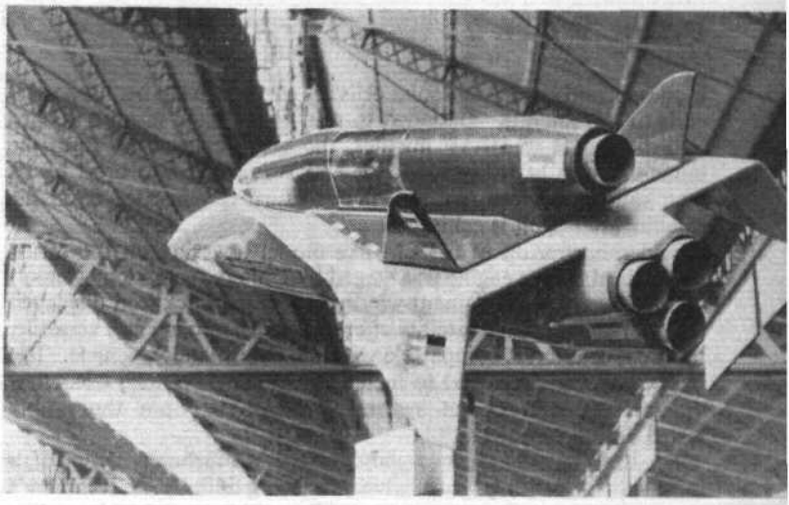
The French National Centre for Space Studies (CNES) is at present setting up a network of ground stations for satellite tracking, telemetry and command. The chosen sites are at Brétigny, Hammaguir, Ouagadougou (Upper Volta), Brazzaville and Pretoria. All five will have telemetry and command facilities, and those at Hammaguir and Pretoria will in addition be capable of accurate orbit determination. Main operations and computing centre is at Brétigny.

Compagnie Française Thomson-Houston is building the DIANE interferometers for tracking, with aerials subcontracted to STAREC. The IRIS telemetry/command equipment is made by Compagnie Générale de Télégraphie Sans Fil, with aerials subcontracted to ELECMA, the electronic division of SNECMA. Other equipment has been developed by Nord. The complete network should be ready by the end of this year.

West Germany As usual, there was no shortage of space proposals displayed in model form on West German company stands. Junkers and Bölkow showed a model of their RT-8 space transporter which has been the subject of a Project 623 study contract for the Federal Ministry of Scientific Research. Models of the 625A-1 and 625A-2 scientific satellites were on display, together with possible high-energy (liquid hydrogen) rocket engines intended for future ELDO programmes.

USA The immense US space effort was poorly represented at Paris. Individual companies showed various pieces of hardware, models and films, but the overall impression was fragmented and weaker than it should have been. A film of the Gemini 4 flight was included in the programme at the French space pavilion, but only towards the end of the salon did the US Government decide to send the two astronauts, Maj McDivitt and Maj White.

This model of the RT-8 aerospace transporter was shown by Junkers and Bölkow; it was designed under a study contract from the Federal German Ministry of Scientific Research

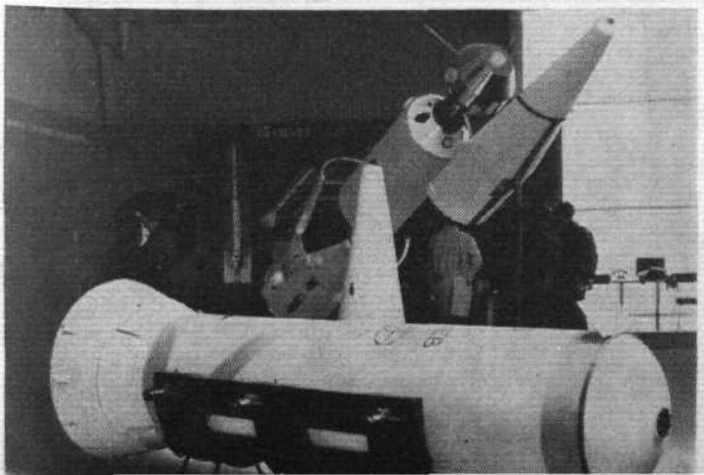


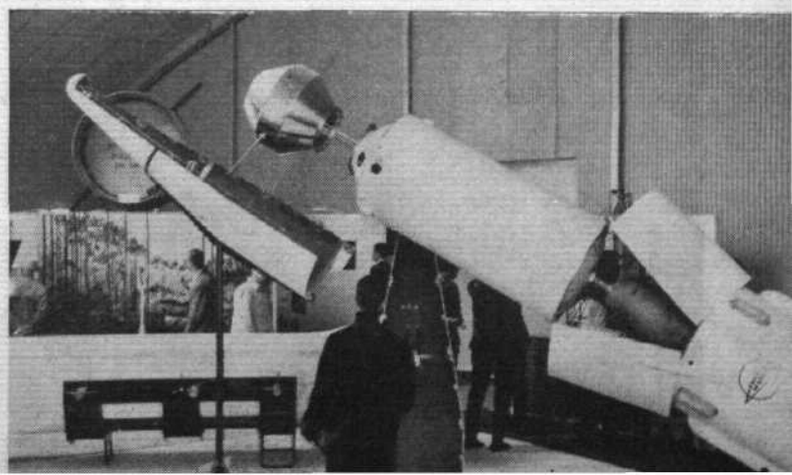
UNITED STATES AIR FORCE AEROSPACE POWER FOR PEACE, proclaimed an inscription alongside two intercontinental ballistic missiles. The Atlas formed a vertical feature, while the Titan was horizontal and attracted a queue of people waiting to get inside. Nearby was a USAF Agena B stage, appropriately tidied up and made suitable for public inspection.

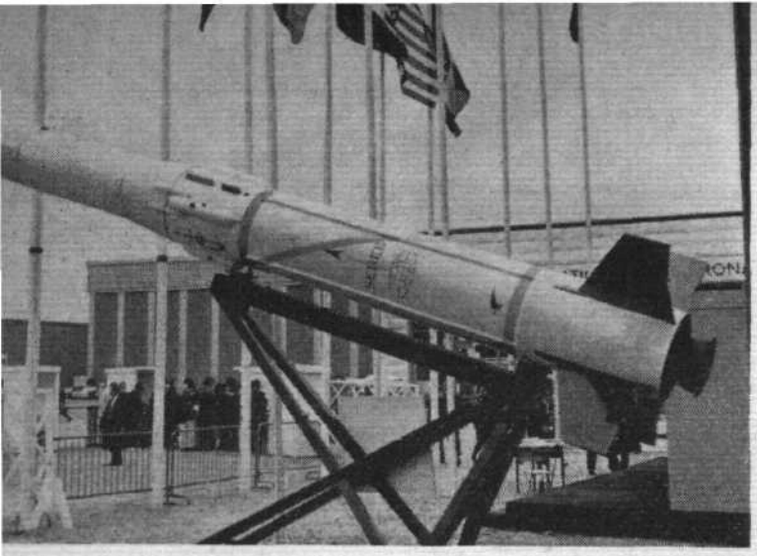
"The Aerospace Research Satellite consists of three sections—propulsion module, the satellite itself (which is displayed here) and a special cradle attached to the launch vehicle . . ." The General Dynamics description was informative but the satellite was *not* displayed there, apparently because security clearance had been refused.

Among the details quoted for the standard ARS craft were an approximate weight of 100lb, a length of 54in and a diameter of 27in. Up to 200lb and 8.4 cu ft of instrumentation can be accom-

. . . while the second stage (below, left) of Diamant is the solid-propellant Topaze, also built by SEREB. Below right, the third stage of Diamant consists of the solid-propellent second stage of the Rubis vehicle, proving trials of which have recently been completed. The satellite is Matra's A-1







Near the entrance to the French space pavilion was this two-stage SEREB/Matra Rubis sounding rocket

Paris Week . . .

modated, and some 2,500 solar cells are carried on the hemispherical ends of the satellite. Designed to ride pick-a-back fashion aboard ballistic flights of USAF missiles, the satellite separates from the launch vehicle at ballistic apogee and is injected into orbit by its own solid-propellant motor (which in turn is separated from the satellite after orbit is achieved).

A demonstration of a LEM-like model hovering on the thrust of a hybrid rocket engine was staged by United Technology Center, who showed also a filament-winding process. Lockheed displayed a model of a scientific satellite offered by the company as a versatile, low-cost spacecraft compatible with the Scout launch vehicle. The basic spacecraft was said to include "command, power, telemetry, data-storage and design systems which have been thoroughly tested and flight-proven."

On the General Electric stand was a see-through model of a biosatellite spacecraft, six of which are being built by the company's re-entry systems department for NASA. Object of the biosatellite programme is to study the effects of extended exposure to weightlessness and radiation on a variety of biological specimens; a toy primate (zoological, not ecclesiastical) was aboard the display model. Also featured by GE was the company's work on gravity-gradient stabilization for satellites.

Britain Modestly present in the Westland chalet at Le Bourget was a model of the proposed all-British satellite launch vehicle known as Black Arrow. First mentioned on the occasion of last year's SBAC Show at Farnborough by Mr Julian Amery, at that time Minister of Aviation, the project has seemingly been on ice since the change of government. No contract for the vehicle has been signed, although work has ticked over at Westland and at Bristol Siddeley, and its future reportedly is dependent on the recommendations of the Bondi Committee on defence space interests. The vehicle would be based largely on Black Knight technology.

Models of the rocket engines which would be used in the Black Arrow vehicle were displayed but not identified as such on the Bristol Siddeley stand. The first stage would be powered by an eight-chamber BS606 motor, using HTP and kerosine and developing a thrust of 50,000lb. A BS625 single-chamber engine using the same propellants and developing 14,400lb thrust would form the second stage.

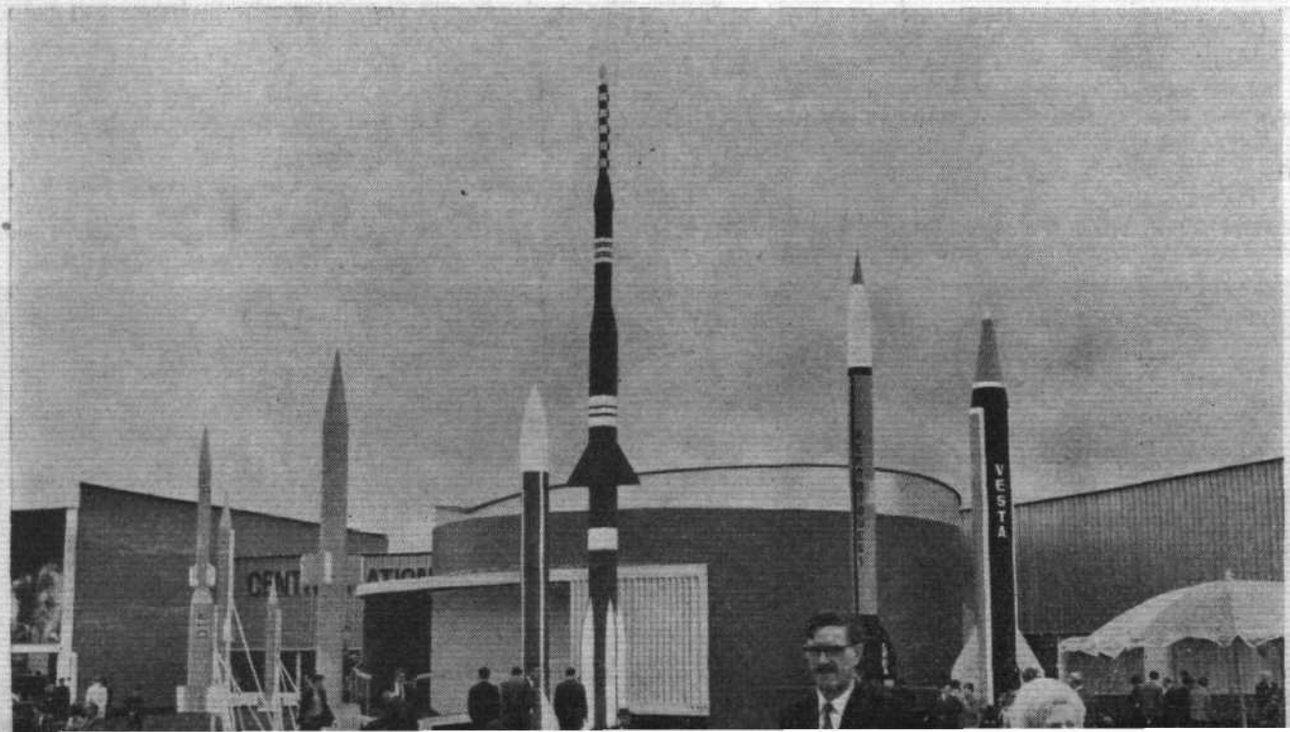
Other Bristol Siddeley rocket engine projects shown in model form included the PR27, a possible first-stage for a small satellite launcher, producing 90,000lb thrust; and a 3,000lb thrust upper-stage unit designated PR38. The company's work leading to hypersonic propulsion also was illustrated, and a wind-tunnel model of a variable-geometry intake for a turboramjet application was attracting great interest from a group of Russian visitors.

Rolls-Royce exhibited an RZ.2 rocket motor as used in Blue Streak, whose successful trio of test flights was portrayed in a film shown by the European Launcher Development Organization. Good news for British Aircraft Corporation, agents for the Skylark sounding rocket, was conveyed in a notice concerning the use of the vehicle by the European Space Research Organization: "ESRO intends launching about 160 Skylarks from the Kiruna and Sardinia ranges." This number will presumably be spread over the eight-year period of ESRO's initial programme.

European Organizations Both the European Launcher Development Organization and the European Space Research Organization had progress to report at Paris. Outside the ELDO building, the half-scale model of Europa I was flanked by a four-chamber, second-stage Coralie motor and by a half-section of the Italian nose fairing for the vehicle. Inside the building recent progress was illustrated in models, films, photographs and hardware.

Full-scale models of the ESRO 1 and ESRO 2 satellites were shown in the French space pavilion. Prime contractors for these spacecraft are Laboratoire Central de Télécommunications and Hawker Siddeley Dynamics respectively. Other ESRO exhibits detailed specific experiments and reported progress on ESRO establishments including the space technology centre at Noordwijk, the rocket firing range at Kiruna and tracking stations on the island of Spitsbergen and near Fairbanks, Alaska.

Other French sounding rockets at the Show included (from the left) Centaur, Dragon, Belier and Eridan (Sud); Tacite and Berenice (ONERA); and Veronique 61 and Vesta (LRBA). At one end of the performance scale the Belier can lift a 30kg payload to a height of 85km; at the other, Vesta can launch 400kg to 400km or 1,000kg to 210km



AIR TRANSPORT

GERMAN "NO" TO CONCORDE PLAN

THE suggestion that Italy and Germany might share in the production of the BAC/Sud Concorde (see last week's issue, page 944) on the understanding that orders might also be placed, has received short shrift from Lufthansa. The airline's technical director, Herr Gerhard Hoeltje, said last week that Lufthansa had studied the Concorde and had decided against it. He added that the West German Government had not made an approach to Lufthansa since a team of Anglo-French officials had visited Bonn early this month to offer Germany a share in the project. Of the offer he said that "it looks, in the main, like an attempt to get someone to share the development costs."

GOOD ONE-ELEVEN RESULTS

FIRST BAC One-Eleven services by Mohawk Airlines, the US local-service carrier, will start on July 15 over routes between ten north-eastern cities including New York, Boston and Cleveland. By June 10 Mohawk, who took delivery of their first One-Eleven on May 17, had completed 100hr of flight training on a round-the-clock basis.

By the end of May, when ten had been delivered, the One-Eleven had flown a total of 2,285hr and had made 3,016 landings during crew training and scheduled operations by British United Airways (services from April 9) and Braniff International (from April 25).

Last Tuesday, June 22, was to be an "open day" at Gatwick Airport, with the Minister of Aviation present, to mark the completion of the modernization plan for the airport. This new picture was taken from the "Flight" Beech Baron on Wednesday of last week

Average utilization during the period April 25 to May 31 was about 6.5hr a day on short-haul operations and crew training. During May, the first full month of One-Eleven operation, Braniff achieved a load factor of more than 73 per cent and during the first part of June the factor was nearly 70 per cent.

Braniff's executive vice-president, Mr R. V. Carleton, said recently that the service completion factor for the One-Eleven had, up to June 10, been 98.8 per cent with no more than "minor" mechanical problems. Utilization, he said, is 7.6hr daily, with the expectation of an increase to 8.5-9hr. Operating costs "look good" and the break-even load factor had worked out at 48.7 per cent with the expectation of a reduction to 42 per cent and better as more aircraft entered service with the airline, whose shortest stage is 67 st. miles. Braniff now has four One-Elevens in service—the fourth was delivered last week.

FOURTH DC-9 FLIES

ANOTHER DC-9, the fourth, has joined the test programme on which the other three DC-9s have now completed 200 hours flying. The fifth is due to fly before the end of this month. No 4 will be used to test the anti-icing, electrical, pneumatic, communications, navigation, air-conditioning and pressurization systems.

The DC-9 has so far been taken up to 38,000ft, and has flown at Mach 0.89, taken off at 90,000lb gross weight and landed at 81,000lb. It has also accomplished single-engined take-offs and landings. The five DC-9s should complete the FAA test certification by the end of the year. Sixteen airlines have ordered the DC-9—Air Canada (8), Allegheny (4), Ansett-ANA (2), Bonanza (3), Continental (12), Delta (15), Eastern (24), Hawaiian (2), Iberia (3), KLM (6), Ozark (3), Saudi Arabian (3), Swissair (12), TAA (6), TWA (20) and West Coast (3).

EVASIVE-ACTION INCIDENT

FOLLOWING a near-miss evasive-action incident which closely resembled that which may have led to the Eastern DC-7B crash on February 8, the Federal Aviation Agency has changed ATC procedures to increase the vertical separation of aircraft on converging tracks from 1,000 to 2,000ft. The aircraft concerned in this latest incident were a TWA 707 outbound from J. F. Kennedy Airport and an American Airlines DC-6 inbound. The pilots concerned filed near-miss reports with the FAA and have been interrogated by the CAB, which has, according to *Aviation Daily*, taken the flight recorder of the 707. Reports say that one of the pilots, assuming that the two aircraft were at the same altitude, took evasive action by diving down in front of the other aircraft.

The Eastern DC-7B which crashed on February 8 was outbound from J. F. Kennedy and the PAA 707 was inbound. The Eastern crew, it is believed, took evasive action to avoid the 707 and the pilot of the DC-7 is presumed to have lost control. The two aircraft were at a height of approximately 3,500ft at the time. In the latest incident the TWA and American aircraft were, according to the FAA, at 5,000 and 6,000ft respectively. The Agency has continued to say that the reports of a near-miss on February 8 were not correct, despite evidence brought out at the CAB public hearing by traffic controllers and pilots. The Pan American crew, in fact, reported a near-miss and one crew member said that he could hear the DC-7B's engines.

The latest incident occurred at 10.35 p.m. EST, at a point very close to that of the February 8 incident. The TWA 707 was outbound for Madrid and American's flight, which had been holding, was being vectored into J. F. Kennedy Airport from 6,000ft. A CAB spokesman said that information about the present investigation will be turned over to the investigators of the Eastern accident.

There is, according to *Aviation Daily*, a growing feeling, among

AIR TRANSPORT...

those working on the February accident and the recent incident, that research will need to be done on the problem of optical illusions at night. If FAA statements and the TWA flight recorder read-out (which showed that the aircraft was at its assigned altitude) are to be believed, pilots are seeing near-misses when there may have been no cause for anxiety. The illusion of a near-miss may thus turn out to be more dangerous than the real thing.

ANYONE FOR A SHUTTLE?

ON April 18, 1966, the new electrified railway system from London to Liverpool and Manchester will become fully operational. The timetables show respectively eight and ten daily expresses in each direction, with a best time of 2hr 35min and most trains scheduled to take under 2hr 45min.

It is to be hoped that the airlines, BEA and British Eagle, will respond to this challenge, and not take a fast parallel rail service as an excuse for minimizing capacity, as BEA has done on the London to Birmingham route. The captive market of connecting passengers is not very rewarding, as only in the special case where BEA is the carrier throughout does an airline receive the full fare for the domestic sector. Even now, on the London to Manchester route during the economically critical summer peak, 30 per cent of the traffic yields sub-standard revenues.

How then to retain the purely domestic passengers in the face of this competition? In the first place, a smoother ride can be promised by air. When averaging 74 m.p.h., the trains can be expected to ride badly (basically because the total flange-to-rail clearance on British railways is $\frac{5}{8}$in against the $\frac{1}{4}$in achieved elsewhere).

Secondly, this is the signal to introduce "air shuttle" service on these two routes. Each year full-scale business air travel restarts after the winter in early March. This gives six weeks to sell the service before the railways swing into action.

The M4 motorway enables everyone to enjoy the thrills of Le Mans en route to Hammersmith. Limousine drivers have set a standard time of 15min from Heathrow—reduced to 13 if a chance is taken with the "Big Brother" television system which monitors the narrow, twisting section culminating in the sharp right-hander at Wimpey's. Thus, a passenger carrying all his baggage, and joining a shuttle flight at Manchester 1min before the doors close, can be at Hammersmith an hour later if the organization is slick enough. Thence, using the tube, he can reach many West End or City offices as quickly as a man detraining at Euston, even during the rush hour.

A valuable shuttle can be provided, even if the operating times have to be restricted. As long as back-up aircraft are available from 07.45 to 09.30 and between 17.30 and 20.00, guaranteed seats can be offered at the most critical times on these short routes. The main need is a little commercial vitality. If the shuttle costs more, increase the fare. The public will pay a premium for instant air transport—as Eastern's experience attests.

No BUA Brussels Service The ATLB has refused British United Airways' application for a service to Brussels from London (Gatwick).

New KLM President Dr Gerhard van der Wal has now been officially appointed president of KLM in succession to Dr Horatius Albarda who lost his life in an air crash in Switzerland on May 17.

Cathay Buys Third 880 Last week Cathay Pacific Airways confirmed its purchase of a third Convair 880-22M for delivery to Hong Kong next November (see *Flight*, June 17, page 978).

New Director-general for CSA The Czechoslovak Ministry of Transport have announced the appointment of Mr Josef Karlik as director-general of Czechoslovak Airlines.

Skyvans for Alaska? Mr Ray Peterson, president of Northern Consolidated Airlines of Alaska, said at the Paris Show that he was considering "an initial purchase" of three Short Skyvans. He also said that he foresaw a potential world sale of 2,000 Skyvans because "there is just nothing else like it."

Heralds for Formosa... Far Eastern Air Transport, Formosa (Republic of China), has ordered two 50-passenger Handley Page Heralds for domestic services and charter operations. The first will be delivered this year and the second in 1966.

...And Another for Arkia A third Handley Page Herald is to be ordered by Arkia, Israel's domestic airline, for delivery by the end of this year. Arkia already has two Heralds in operation.

Plessey Recorders for Cambrian Flight-data and monitoring recorders by Plessey have been ordered by Cambrian Airways for their Viscount fleet. These recorders provide an indestructible record of aircraft performance and meet the MoA crash-proof requirements. BEA have already placed a £500,000 order for these recorders, with which their whole fleet will be equipped.

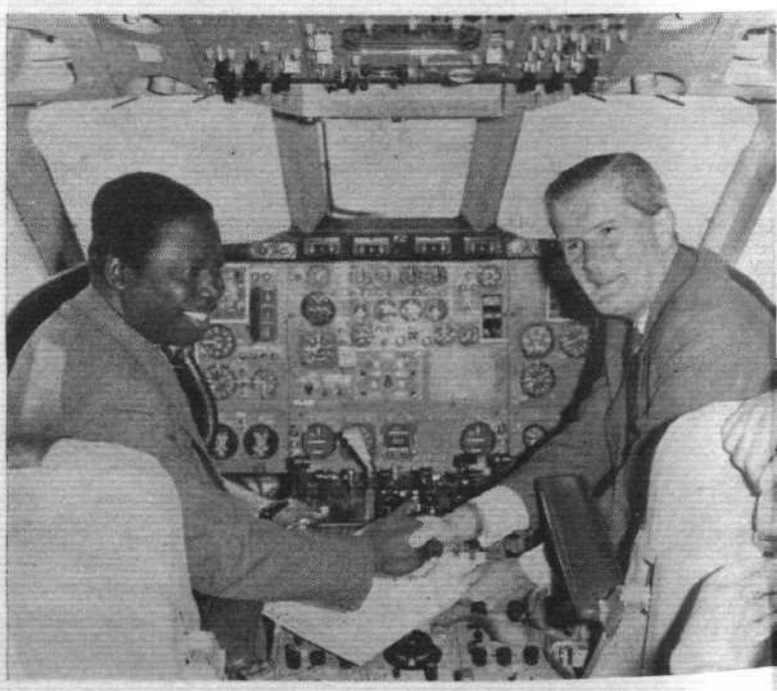
Early Bird Demonstration Pan American recently conducted a 90min demonstration of the use the COMSAT-operated Early Bird satellite for voice-data communications on scheduled London - New York services. Simulated airline and hotel reservations between the two points were initiated and confirmed via the satellite.

IFALPA Symposium The next symposium to be organized by IFALPA will be on all-weather operation (with special reference to head-up displays) and navigational aids (with emphasis on long-range aids). The date will be October 13-16, 1965, inclusive and the meeting will be in the Hilton Hotel, Rotterdam.

PIA's New Commercial Director Mr M. M. Salim has been appointed commercial director of Pakistan International Airlines. Previously the airline's planning director, Mr Salim entered aviation as an engineer in 1938 and was with PIA's predecessor, Orient Airways, before becoming chief administrative officer when Orient was merged with PIA in 1955.

Loftleidir's Stretched CL-44s News that Icelandic Airlines, Loftleidir, have received their first stretched 189-passenger, Rolls-Royce 400 (last week's issue, page 976) was premature. Delivery dates and registrations of these modified CL-44s for Icelandic are March 1 (TS-LLS), and May 1 (-LLG), 1966, and February 1 (S-LLH) and March 1 (-LLI), 1967. Canadair, as explained last week in the first Paris Show report (page 956), hopes that orders for the 400 will be obtained and that production will be restarted.

The second VC10 for Ghana Airways was handed over by BAC at Wisley on June 2. On the flight deck are Mr Dowuona-Hammond, Ghana's Minister of Communications, who signed the documents, and Air Marshal Sir Geoffrey Tuttle of BAC. This VC10, 9G-ABP, has large freight doors. It will normally operate over the Accra - Beirut route. A third VC10 is on firm order for 1967 delivery, but may be exchanged for two BAC One-Elevens



TWIN TRACKS TO BERLIN

BY JOHN BENTLEY*

CIVIL pilots from Britain, the USA, Holland, Germany, Finland, Mexico and Switzerland took part recently in demonstrations of the use of Decca navigation systems in the Berlin corridors. The company's Ambassador (G-ALZP) operated between Frankfurt, Berlin and Hanover in a practical demonstration of the latest equipment developments, showing in particular the accuracy and pictorial presentation of the Decca system for precise track keeping.

There are three 18-mile-wide corridors connecting Berlin with West Germany. The northernmost, and at 85 miles the shortest, is the Hamburg/Berlin corridor; the central (Buckeburg/Berlin) corridor is 100 miles long; and the southern corridor from Frankfurt to Berlin is some 200 miles long. The approximate inbound tracks are respectively 120°, 090° and 055°.

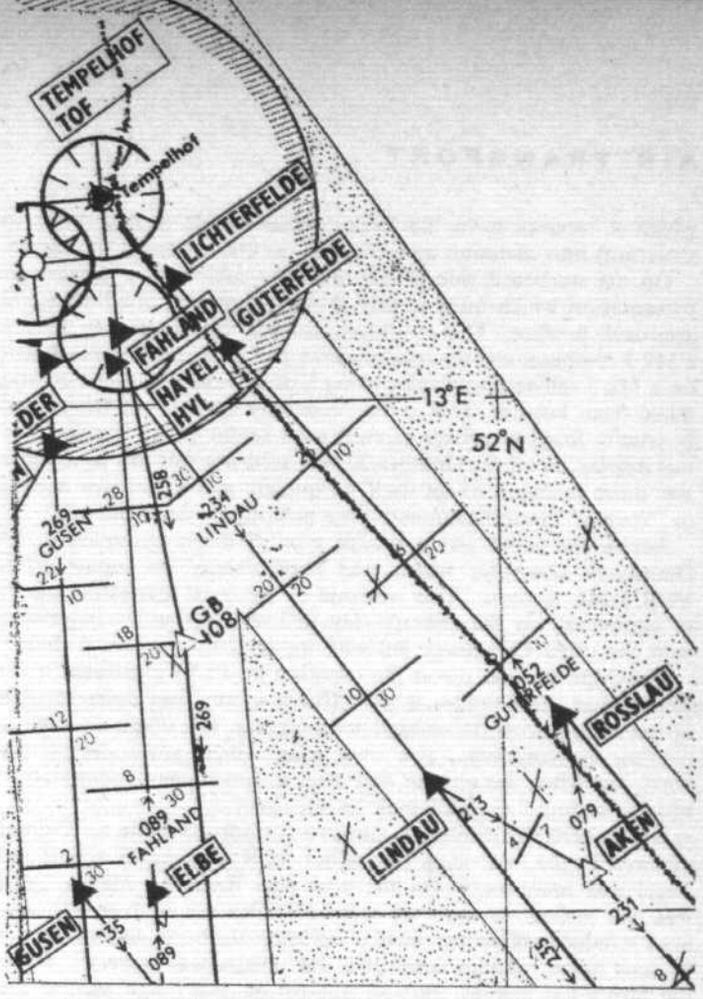
The corridors provide a good, if not unique, example of the need for an accurate, flexible navigation aid to assist in both the pilots' and the controllers' problems. The upper limit, for all practical purposes, of FL95 restricts the capacity of the corridors and so does the single centreline track which is used most of the way along the corridors. This single track also poses ATC problems when aircraft need to climb or descend through the levels of opposing traffic.

Both the radar and the VORs which are available to users of the corridors give inadequate coverage. An FAA calibration aircraft went to Berlin early this year and found Tegel VOR unreliable beyond 20 miles and Hehlingen VOR unreliable at the lowest flight level (FL35) beyond 20 miles. The situation is further complicated by the gradual increases in traffic which are taking place—BEA alone operates 80 flights daily through the corridors. When Pan American starts to use the Boeing 727 into Berlin the position may well become intolerable as overtaking will be virtually essential but at the same time impracticable while using the single-track system.

Given the airborne capability of accurate track keeping, the Decca Navigator Co claims, it would be entirely feasible to have a twin-track structure in each corridor—that is, to fly inbound to Berlin along a track approximately 3½ miles inside the southern boundary and outbound along a similar track inside the northern boundary. Lateral separation between opposing traffic would then be 11 miles. Such a system would obviously increase the corridors' traffic capacity and at the same time help to solve the ATC climb/descent problems.

The crux of the matter is the aircraft's capacity for *accurate* self-navigation; a diversion off track in one direction increases the risk of collision, while in the other direction the aircraft would quickly stray outside the corridor boundary into the Russian zone. Which fate is the worst will depend on the reader's experience and political inclinations! However, accurate navigation would also substantially reduce the dependence of the aircraft on guidance from ground radar control, leaving the latter free to exercise an overall safety monitoring role, to provide navigation in emergencies and to sequence the traffic when entering and leaving the terminal areas.

The Demonstrations After a briefing, the party, 16 strong, took off from Frankfurt in G-ALZP en route for Tempelhof via the southern Berlin corridor. Flight level was 95 and the weather was 5/8 cumulus between 3,500 and 9,000ft. The normal route would be to leave Fulda VOR on a track of 046° to Mansbach VAR, 17 miles away, and thence on 054° to Konnern (88 miles). A further 18 miles and the track splits at Aken, where normal inbound traffic turns right and flies the right-hand side of the corridor through Rosslau and Guterfelde to Tempelhof, while the outbound traffic takes a route through Havel and Lindau for the first 50 miles.



Ground-based data-link trace of the Ambassador tracking to one side of the Frankfurt - Berlin corridor

The Ambassador left Fulda on a track of 060° for a point five miles south of the Mansbach VAR, where it established itself on a track of 054° parallel to and approximately four miles inside the southern boundary of the corridor. This track was maintained as far as Rosslau, 117 miles away, where the aircraft joined the normal split track through Guterfelde and Lichterfelde to Tempelhof.

Flying throughout the trip was done on the autopilot to which the pilot made manual corrections as necessary. Navigation was entirely by Decca, for which, needless to say, G-ALZP is well fitted. In front of the captain was a Mk 4 miniature display driven off a Mk 10 receiver and an Omnitrack 2 computer. The co-pilot had another Mk 4 miniature display driven by a Mk 8 receiver and a Mk 3 computer. Above the centre of the windscreen was a third display, this time the 331—a paper chart distorted presentation driven by a Mk 10 receiver and an 830 computer, which is an installation similar to that used by BEA in their Viscounts, Comets and Argosies. On the paper charts the track is marked by a pen which moves over the paper, while the Mk 4 displays employ transparent plastic charts, illuminated from the inside. These charts are undistorted, the aircraft position being shown as a small circle of light in the centre of which is a stylus which inks in the track as a continuous series of dots.

As a check on the pictorial display the captain used the decometers for lane identification, VOR readings from the conventional dial display, and a facility, which is available to Decca Omnitrack users, known as the "ghost beacon" about which more will be said later.

In the aft compartment a Mk 3 undistorted plastic-chart display driven by a Mk 8 receiver and an Omnitrack 1A computer were fitted for the Berlin demonstrations. During the trials this equipment was giving track-keeping accuracies of a ¼-mile within 200 miles of the master station. It was a simple matter to set the equipment up before starting and to change charts. All one needed to do was press a button to make the chart wind forward or back so that it could "read" its instructions from the appropriate part of the margin and it would then position itself automatically on the correct spot within approximately 10sec. Once set, no alterations were required. The use of the Omnitrack computer permits the pilot to have an orthomorphic (undistorted) display which greatly simplifies map reading and the identification of reporting points. The Omnitrack achieves this by converting the hyperbolic inputs

*Editor, "The Log," BALPA.

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which it receives from the Decca chain (which is hyperbolic in structure) into cartesian co-ordinates—so straightening the curves.

On the starboard side of the midships cabin was a large-scale presentation which quite clearly showed runways, taxi-tracks and approach profiles. This employed another Mk 8 receiver driving a Mk 3 computer and the resulting distorted presentation was shown on a Mk 3 self-setting display using a plastic chart illuminated and inked from behind. This is the "economy version" of Decca and is usually fitted to private aircraft on a rental basis. Tracking on this display, as on the Omnitrack, was accurate, but this equipment was more reluctant to set itself up quickly and sometimes needed to "re-read" its instructions before positioning itself initially.

Across the cabin was a similar type of display coupled to an Omnitrack computer which was itself driven' by inputs from VOR/DME stations. This was one of the most interesting pieces of equipment on the aircraft—not in itself, but as a comparison with the other Omnitrack fed with inputs from the Decca chain.

The flight up and down the corridor at FL95 illustrated quite clearly that the Omnitrack with Decca inputs was quite capable of providing accurate enough tracking for safe flight in such a limiting environment. The only snag which arose during the flight was when the aircraft flew over a government radio station which produced a small kink in the trace.

Using VOR/DME inputs, however, produced quite a different picture. In the first place Tempelhof VOR was out of action and Tegel was inaccurate. On the way into Berlin at 9,000ft Tegel was not picked up until we were 25 miles out and on the way back it faded at 60 miles; at 40 miles range the beam was inaccurate by four miles. (Radar confirmed that Decca was correct.) While the Decca-fed display tracked stolidly on every half second the VOR/DME-fed equipment was constantly being cross-checked and retuned in an effort to get better results.

Versatile Computer

The Omnitrack computer is an extremely versatile piece of equipment. As a digital computer it can take any kind of inputs such as Doppler and VOR/DME, but another of its functions is possibly of even more use to the pilot. This is its "ghost beacon" facility. A pilot can select any point within 500 miles of his present position, feed the co-ordinates of that point into the computer by means of a turret switch and the computer will give him his range and magnetic bearing to that point within one-sixty-fourth of a mile. The computer does this by solving the triangle formed by the cartesian co-ordinates of the chart which it is at present using, the aircraft's position and the point which the pilot has selected. The point selected can be anywhere—a reporting point, an airways intersection, a coastline—and, if this is on the chart being used, the pilot can simply stop the normal drive and place the stylus over the point selected instead of using his turret switch.

The ghost beacon facility can be shown as a range and bearing, or can be coupled to the autopilot or to a fly left/right indicator. It can also exchange distance-to-go information for time so that one has an "ETA meter." Another application which would benefit the controller more than the pilot is the computer's ability to select an optimum-slant track to position an aircraft at a specific height at a certain time. This could be presented as a mythical glide/climb slope or as a rate of descent/climb which has to be used.

As a demonstration of the facility the captain of G-ALZP used Tempelhof as a ghost-beacon check on the tracking on the corridor. On our return to Frankfurt we were asked to join the glideslope at a point 12 miles out. This was done simply by placing the pen 12 miles out on the approach and tracking towards it. The chart traces on the demonstration equipment showed the aircraft's progress and the ease with which the pilot made good his requested joining position.

Altogether the day was a triumph for Decca, whose equipment is achieving excellent reliability with BEA (besides the equipment previously mentioned, the Trident carries Decca pictorial undistorted charting fed by a Doppler input). The civil pilots on the flight, some of whom had been sceptical before setting out, were unanimously impressed by the possibilities of using the equipment to solve the problems of the Berlin corridors. The accuracy of the equipment was up to the required Eurocontrol standard of ± 2 miles (95 per cent probability)—and this using the German Decca Mk 8 chain, the only one in Europe; the others are Mk 10.

Data Link While the party was on the ground at Tempelhof a short visit was made to the Decca data link van, which had been positioned there specially to record the demonstration flights. Data link is really an ATC tool with two main roles—data-gathering and as an alternative link between the controller and the pilot.

Data gathering would be the normal function of the equipment. This is achieved by feeding in the call-signs of any aircraft in the area; data link will then carry out a roll-call of each aircraft individually at a rate of five aircraft per second. On hearing its call-sign the aircraft will automatically transmit its position (as XY co-ordinates), height and identity. There is no limit to the number of aircraft which can be accommodated and the controller can, if he wishes, interrupt the roll-call sequence and select any specific aircraft about which he may need special information (e.g., two aircraft approaching the same reporting point).

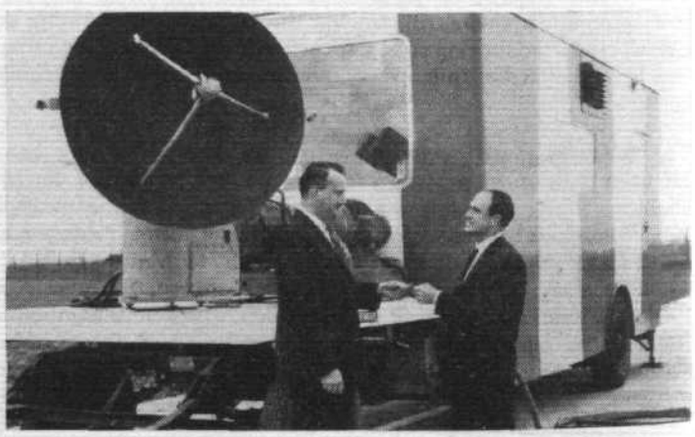
The information is transferred in digital form and would therefore be compatible with the type of computer used to handle ATC data. When the information is received it can be used in a number of ways: either for direct insertion into the ATC computer for correlation with radar data and subsequently to update both tabular and dynamic ATC displays, or for direct display on a cathode-ray scope, in which case a direct visual comparison can be made between airborne navigation and radar positioning.

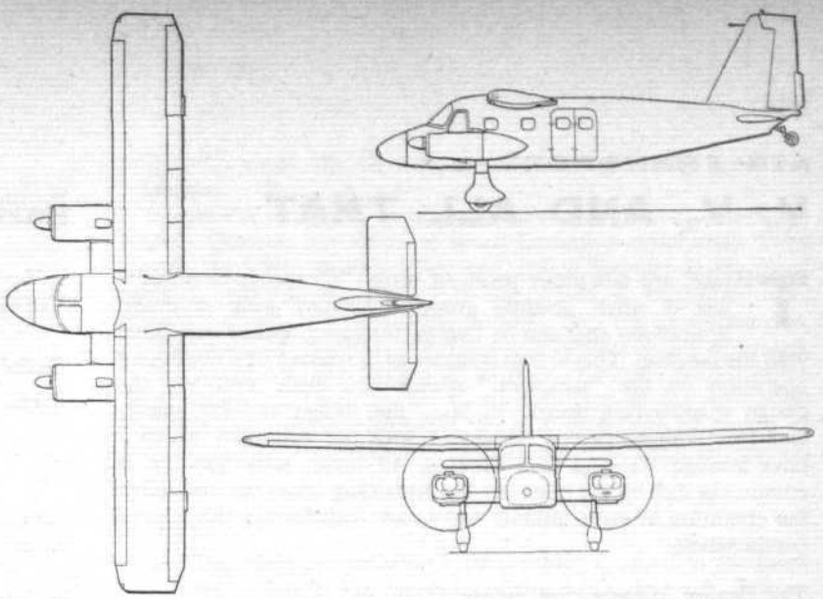
The second use, as a communications medium, is designed to relieve VHF R/T channels and to give the pilot a visual reminder for height clearances and so forth. If the controller wishes to clear an aircraft to a particular height he would press buttons on his console to select the aircraft call-sign and to pass the command. The information would then appear on a flight-deck display and a red light would flicker to attract the pilot's attention. When the pilot pressed the red light it would go to a steady red and the information which was displayed would be transmitted back to the ground to be checked by ATC. If it was correct ATC would acknowledge the signal and the red light on the flight deck would go out, indicating that the clearance was actionable. This safeguard of allowing the controller to know what is being displayed on the flight deck, rather than confirming the actual signal received, is obviously necessary in this semi-automatic communication method.

The range of data link is similar to that of VHF—120 miles at 10,000ft. Obviously the communications function has to be limited to the type of message which is better sent visually than aurally, but if the system was adopted it would do much to balance the ATC/pilot-workload problem—saving both controller and pilot much valuable time which is otherwise spent listening out and repeating back numerous clearances.

This was well illustrated when I flew back to Heathrow from Frankfurt in a BEA Comet. The two pilots "up front"—the third pilot monitors the systems panel—did little else but tune beacons, get clearances and amended clearances, check the weather and call up control authorities for the whole of the hour-long flight. Anything which can leave the pilot free to fly the aircraft and have an uncluttered overall picture of his navigation, clearance and weather problems would be heartily welcomed on the flight deck. The combination of Decca Navigation and data link would appear to be capable of going some way towards achieving this.

A combined radar and computer-analysis mobile laboratory, to be used by BLEU of Bedford for the study of aircraft-approach patterns, was recently handed over by Mr R. E. Ford, of Elliott-Automation Radar Systems, to Mr Slade-Southam of the MoA





Dornier's New Feederliner

AT the Paris Show Dornier released fuller details of its new commercial light twin, based on the well-proven Do28 layout. This latest contender for the worldwide feederliner market is called the Do28D Skyservant, and appears in the rapidly developing class of specialized aircraft catering for third-level commercial operations. Other notable contenders are the Britten-Norman BN-2, the DHC Twin Otter and the Short Turbo-Skyvan. In size, the Skyservant falls between the BN-2 and the Twin Otter.

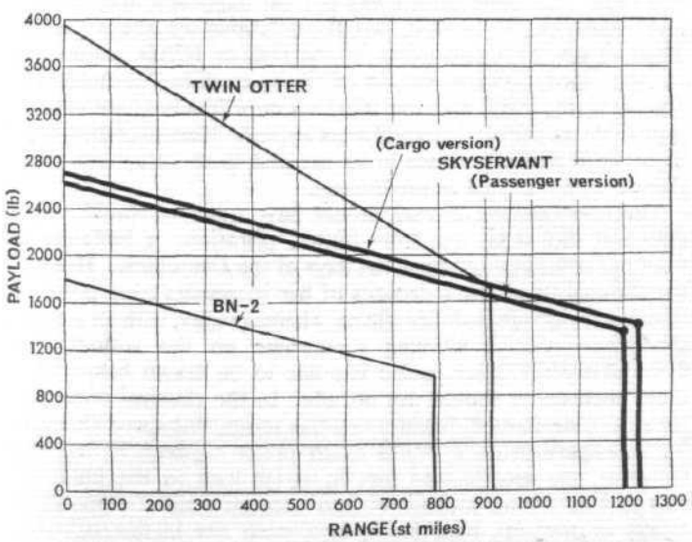
Two supercharged 380 h.p. IGSO-540 Lycomings are at present specified for the Skyservant, though Dornier already predicts that a future version will have turbine power. Ample cabin volume (and big double doors) are a feature of the Skyservant, and it should be a long time before the availability of more power outstrips aircraft capacity. A wide range of interior configurations is offered and in the all-passenger role up to 15 people can be carried with an operating crew of one pilot only.

STOL performance is almost mandatory for third-level operations and the Skyservant will be outstanding on that score. Under standard day sea-level conditions and zero wind, at full gross weight (7,700lb), the take-off distance to 50ft is estimated as 830ft (ground roll 500ft). At 6,400lb (mid-weight approximately) the landing from 50ft is accomplished in 770ft (ground roll 470ft).

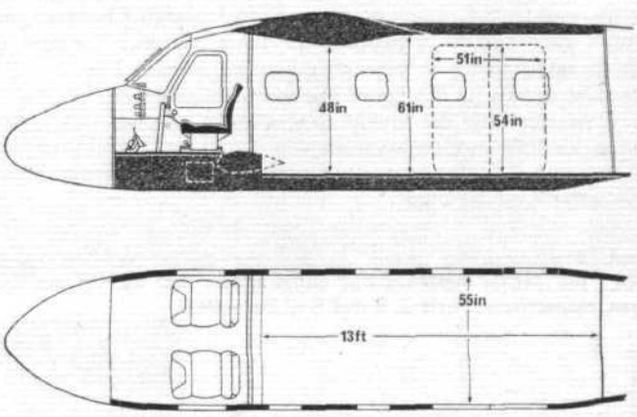
The Skyservant is designed for single-pilot operation, though dual controls and panel layout can be provided if required. A prototype is being built and should fly early next year, and the type should be in full production by the end of next year. Selling price has not yet been fixed but is expected to be around $150,000 (£53,500) basic.

LEADING DATA

Powerplants: Two Lycoming IGSO-540 of 380 h.p. each.
Dimensions: Span, 49.2ft; length, 37.5ft; height, 11.9ft; wing area, 302 sq ft.
Performance: ISA sea level take-off to 50ft, 830ft; landing from 50ft, 770ft; two-engine ISA s.l. climb, 1,280ft/min; single-engine rate of climb, 250ft/min; cruising speeds, at 7,050lb and 10,000ft, 198 m.p.h. (100 per cent power), 183 m.p.h. (75 per cent), 158 m.p.h. (50 per cent); service ceiling, 25,000ft; single-engine ceiling, 10,600ft.
Weights: Gross, 7,700lb; landing, 7,700lb; empty, 4,570lb.



The payload/range curves for the cargo and passenger versions of the Skyservant compared with those of the DHC Twin Otter and BN-2. The main cabin has a volume of approximately 290 cu ft



SPECIALIST ADVICE FOR OPERATORS

A NEW service of specialist information and analysis is being offered to airlines, aircraft manufacturers and other transport organizations. The founder of the organization, Transport Analysis Services, is Mr C. Hamshaw-Thomas, who feels that many smaller companies find it to be beyond their means to maintain the research and advisory staff needed for effective decisions.

The service is not confined to air transport, but is also offered in fields where air transport methods are being increasingly applied. TAS (Bryn Derwen, Gardener's Hill Road, Boundstone, Farnham) is prepared to study alternative methods of transport, to do market research for proposed and current vehicles, and to assist with the preparation and presentation of licensing applications.

Mr Hamshaw Thomas, who is a Cambridge M.A. in mechanical science, joined Vickers Armstrongs (Aircraft) in 1952 as an aerodynamicist, and has since held development and technical sales positions with that company and the British Aircraft Corporation. He has obtained considerable experience in a wide range of subjects, from aircraft performance estimation to the application of computer methods to route studies, and has travelled widely in the course of his technical sales work.

AIR TRANSPORT...

V_1 V_2 AND ALL THAT

Part II of C.C.J's "V" Classifications

THERE are not many more of these "V" speeds to cover—just a small residual group connected with structural limitations and one or two performance speeds associated with the landing. This article is rather in the nature of a tidying-up operation on the "structural" speeds and deals with V_A, the design manœuvring speed, $V_{FC}M_{FC}$, the design stability speed, and two limiting speeds associated with the autopilot, which I have labelled V_{AUTmax} and V_{AUTmin}. Of these, only the first is commonly met by the pilot but the remaining three can also affect the operation of some aircraft and so are included for the sake of completeness.

The Design Manœuvring Speed

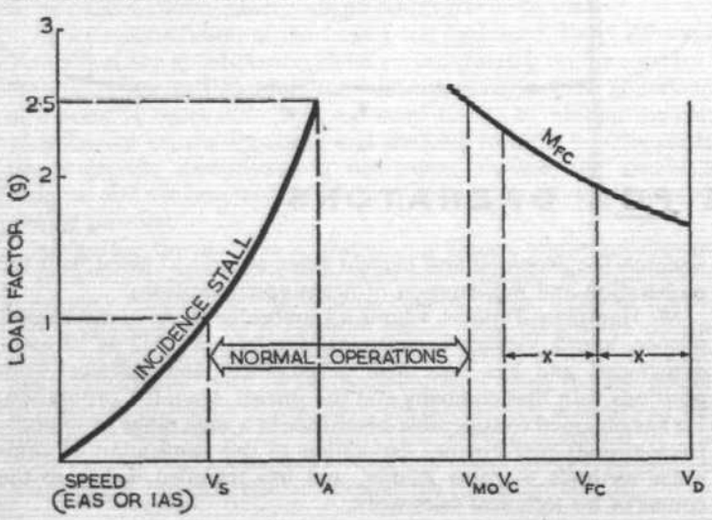
There has been some kind of maximum manœuvring speed since aircraft were first designed—as distinct from being lashed up with wood, wire and glue. However, it tended to be a long way above the performance capabilities of the aircraft and it was rarely that the pilot had to consider it in day-to-day operations. In fact, as late as World War II quite severe manœuvres were imposed on large aircraft, as in evasive action, and in this the pilot did not pay much attention to anything in the nature of a maximum speed. Nevertheless, the designer paid attention to it and now that we have engines capable of taking the airframe near to its limits and powered controls capable of imposing loads much higher than the manual load, both designer and pilot are obliged to pay much more attention to V_A. The safety margin is, however, still substantial and in practice the figure usually comes out only a little below V_C, which would be quite a speed at which to have the controls at the stops.

As V_A is a speed which is used both by the designer and the pilot, it carries with it an operational as well as a design connotation. For true consistency, therefore, I suppose that one should talk about the "design manœuvring speed" (EAS) and the "operational manœuvring speed" (IAS); however, as the speed values are really the same, this seems rather academic and I propose therefore to keep to the single, traditional, designation—namely, the design manœuvring speed, V_A.

The designation V_A lines up the speed editorially with V_B, V_C and V_D. However, two important distinctions should be borne in mind. Firstly—as will be seen from a comparison of the above figure with those accompanying Parts 8, 9 and 10 of the series—V_A is based on a different set of design criteria and these are not related to the gust. Secondly, it does not carry with it any specific speed margins as, for example, the regulatory margin* between the V_{MO}/V_C group and V_D. Instead, for large transport aircraft, it carries its safety factor in terms of g-loading, namely 2.5g.

The case shown in the figure is somewhat simplified in that it really illustrates only the low-altitude manœuvre case. At higher altitudes the difference between incidence stall and buffet becomes important and it is the practice to replace the incidence stall line by the buffet boundary line.

The design manœuvring speed V_A and the design stability speed V_{FC}/M_{FC}. See text for incidence-stall buffet effects. For V_S, V_C and V_D, V_{MO} see, respectively, Parts 2, 8 and 9 of the series



V_A is, incidentally, the only one of the *design* airspeed group, V_A, V_B, V_C and V_D, which the pilot is expected to know.

Definition

18. **The Design Manœuvring Speed** (V_A) is the maximum speed (EAS or IAS) at which the aircraft is designed to withstand the load imposed by the full travel of the flying controls. It is determined by the intersection of the incidence stall line or the buffet boundary line, whichever is critical, with the design load factor; this factor must not be less than 2.5g.
FAR 4b 210(b) (2); 211 (a)
BCAR D3-2 1.3.1
ICAO Annex 8 5.2

The Design Stability Speed

This speed is a fairly new member of the design group. It derives mainly from military experience and at the moment is referred to specifically only in FARs, where it rejoices in the name of "maximum speed for stability characteristics." This is a bit of a mouthful for operational use and, in settling for the shorter name of the "design stability speed," I have taken the liberty at the same time of departing somewhat from the FAR concept of a *maximum* speed, since it is a maximum only from the point of view of being the highest speed at which the design criteria for stability have to be met. From the operational point of view, it is more in the nature of a minimum—i.e., the *lowest* speed at which the pilot would expect control abnormalities.

As we get closer to a Mach 1 operation or beyond, handling characteristics may tend to dominate those of performance or structure in the determination of design limits. This criterion, therefore, though perhaps not generally applicable today, seems likely to afford a useful base for future work. Indeed, as we get into wing shapes where the stall becomes more difficult to use as the basic criterion, I can visualize handling characteristics becoming the critical factor† and V_{FC}/V_{MC} then developing into V_{FC}/M_{FCmax} while the low-speed handling line shown as CUT in the diagram accompanying Parts 9 and 10 of this series becomes V_{FC}/M_{FCmin}. However, that development has not yet happened and so here I have simply put down what the US regulations say about V_{FC}/M_{FC}. There is no exact equivalent in the UK or ICAO requirements though, since the whole subject of "flying qualities" is under active review by the ARB and the ICAO Airworthiness Committee,‡ it is possible that equivalents will soon appear. Meantime there seems to be little civil experience in its use and these comments should therefore be regarded as provisional.

The idea that an aircraft should have inherent stability in all axes and should be free from flutter, vibration, or buffeting has been taken for granted since the days of the Demoiselle. However, the Demoiselle and five decades of her successors were not much bothered by compressibility effects, whereas today, with an incipient shock-wave always nibbling somewhere on the aircraft when flying above 0.7 Mach, some line has to be drawn below which these phenomena should not intrude. In the classical concept so far governing Parts 8, 9 and 10 of this series, this speed should be V_D and, personally, I would much prefer to keep it that way. However, the specification for V_D is (at least in the USA) not regarded as taking sufficiently into account such compressibility effects as pitch-up, tuck-under, or a steep rise in the stick force required for a given manœuvre. In modern aircraft it appears to have been felt impracticable entirely to design out such tendencies right up to V_D and it has been argued that, since V_D is an emergency condition, some degree of heaving on the stick, etc, can be tolerated at the far end of the envelope. On the other hand, any form of difficult handling characteristics should definitely not show up at V_{MO} or V_C, which are speeds met in normal operation. Hence a compromise position, halfway between V_D and V_C, has been chosen to mark the regulatory limit of "conventional" flying qualities.

** See Definitions 13 and 14, "Flight," February, 11, 1965, page 217.*
† See RAE Tech note 2983, August 1964, by W. E. Gray, in relation to the handling characteristics of the slender wing.
‡ The item figures on the agenda for the next meeting of the Committee, tentatively scheduled for the second quarter of 1966.

Definition

19. **The Design Stability Speed** (V_{FC}/M_{FC}) is an indicated airspeed or Mach number, whichever is appropriate to the altitude, so selected that, in all operating conditions below that speed, the aircraft displays normal characteristics in respect of static stability, the damping of oscillatory motions, response to pitch, roll, or yaw inputs and is free from compressibility effects. V_{FC}/M_{FC} must not be lower than the midpoint between V_{MO}/M_{MO} and V_D.

FAR 4b 132(e); 155(a) & (b); 156; 156(a)(b) and 158.

The Autopilot Limit Speeds

Some autopilot/aircraft combinations are, in the high-speed regime, capable of giving rise to excessive structural loading if severe gusts are met or if a runaway condition develops in the autopilot; on the other hand, some combinations may result in hazardous loading, stalling, or stability conditions if the autopilot is used right at the bottom end of the low-speed regime. This is obviously a serious consideration on final approach but is also an important factor on take-off, climb, or at high altitude—indeed, in any regime where the speed margin from the stall is small. However, the defences in each regime need not necessarily be the same: for example, below a certain minimum terrain clearance (e.g., 400ft on the approach) it is considered, in the UK certification philosophy, that there must be no more than 2 seconds between the start of malfunction and the start of recovery; in other regimes and where only an easily identifiable and recoverable nose-up or nose-down is likely to occur, the allowance is 3 seconds; in other cases it is 5 seconds.

In general, with the great development put into automatic-landing systems, any form of speed limitation other than those already described in this series and falling broadly in the band marked "normal operations" in the figure is becoming rare; however, where such limitations do exist, they are important and, for completeness therefore, the following definitions are proposed.

The speeds are not named in BCARs or FARs but probably these designations will suffice. I am not fond of the mnemonic V_{AUT} but the natural alternative, V_{AP}, is ruled out by reason of possible confusion with the approach speeds—for which see Part 12.

Definitions

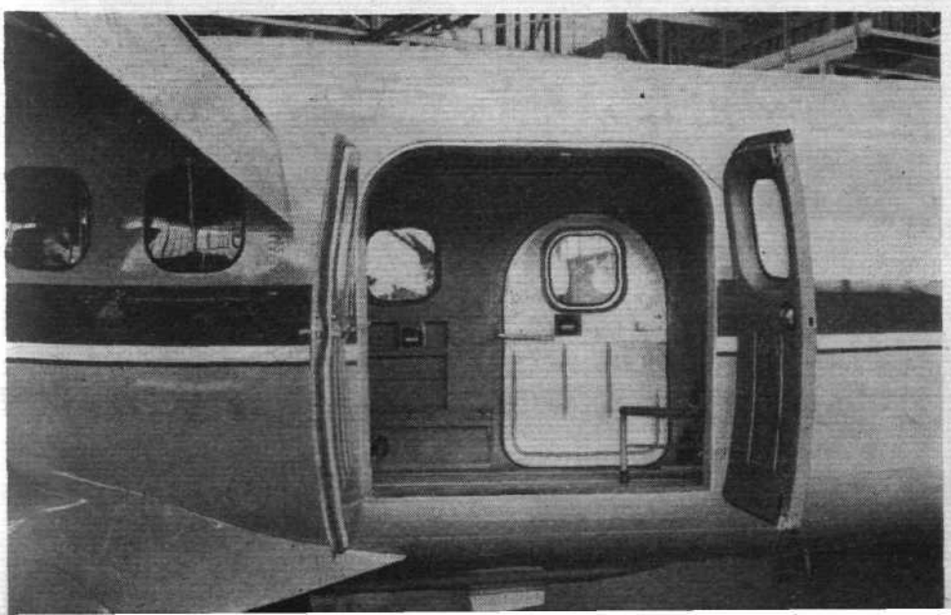
20.1 **The Minimum Autopilot Limit Speed**§ (V_{AUTmin}) is the speed below which the autopilot should not be used. It is so selected that, taking into account the possibilities of cut-out, runaway, or feed-back failure, the resultant upset should not require undue force or alertness on the part of the pilot in order to avert stall, severe buffet, or control problems.

20.2 **The Maximum Autopilot Limit Speed** (V_{AUTmax}) is the speed above which the autopilot should not be used. It must not be greater than V_{MO}/M_{MO} and is so selected that, in the event of a nose-down runaway, the aircraft's speed remains a safe margin below V_D.

BCAR D 6-4.

§ *To be placarded.*

Right, the port Pratt & Whitney PT6A-20 turbine of the DHC Twin Otter with its top cowling removed and its lower cowling hinged down. The Twin Otter has two crew doors and two cabin-entry doors—one, on the port side, a double door, which is shown open in the picture below. It measures 46in by 45in



INDUSTRY International

Products

Company News

Great Britain

E-A Lands Viggen Contract Elliott-Automation's Airborne Display Division, which claims to be the world's only company in full-scale production with advanced head-up display equipment, has been awarded the contract to supply a head-up system for the Saab Viggen multi-purpose strike/interceptor aircraft.

The equipment is to be supplied to Svenska Radioacktiebolaget and is expected to meet Royal Swedish Air Force requirements well into the 1970s.

E-A head-up displays have already been installed in eleven types of aircraft and one system is at present being evaluated at Bretigny by a Franco/German team in a Noratlas transport. An announcement of Elliott's break-in to the US market with this equipment is expected imminently.

Graviner Firewire for Concorde Fire protection equipment had been developed for the Concorde SST by Graviner (Colnbrook) Ltd. It is based on the company's most recent Firewire triple FD system and makes use of the latest extinguishant, BCF, which gives full fire protection without hazardous toxicity.

To meet the in-flight conditions characteristic of supersonic aircraft, the Concorde fire protection system has been specially engineered to have a variable detection datum which provides optimum protection in both the subsonic and supersonic regimes. The SST equipment design requirements, calling for an operating ambient airframe temperature range of −70°C to +150°C, have been fully met.

STC's "Pocket the Savings" Plan As an incentive to cut costs and improve products a "pocket the savings" plan is being put into action by Standard Telephones and Cables Ltd of London with its suppliers. Under the plan, believed to be the first of its kind devised by any company in the UK, suppliers can keep the savings they make in the first six months of adopting a new or improved design of an old product. STC will help its suppliers improve their own products by giving them advice on design changes, cost and performance.

The whole plan is based upon value analysis, the technique concerned with the cost of doing a particular job.

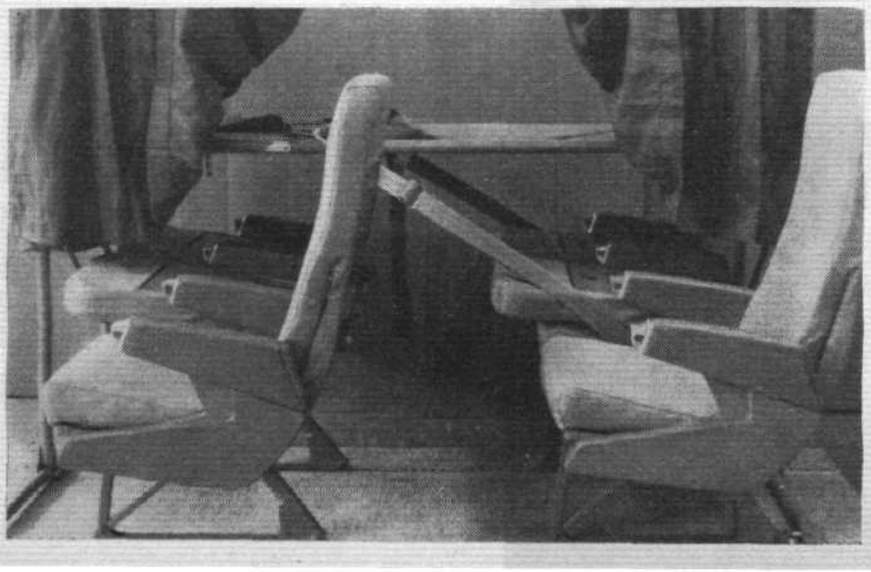
Explaining the plan, Mr R. N. Barton, STC's production director, said: "We recently found that by using a different form of moulding for a plastic component we could save £10,000 a year. Under the pocket-the-savings plan a supplier would thus have earned himself a bonus of £5,000."

Whitehall TV The largest closed-circuit TV system in Europe has been installed in the Ministry of Defence building in Whitehall. The network has been designed to use 32 camera channels feeding 70 different locations, with up to 100 screens. All these are remotely controlled from one main control room in the MoD building.

The network was designed and installed to Ministry requirements by Peto Scott Electrical Instruments, of Weybridge, using "Hi Q" cameras and studio monitors. Both mobile and static cameras are used in the system, which has been designed to speed up and clarify the transmission of information within the Ministry.

The system, in operation since the beginning of March and still not at full capacity, has already attracted the attention of other Ministries, and of officials from SHAPE headquarters in Paris, who are studying the system with a view to adapting it for their own HQ.

An invalid-passenger stretcher for use in Boeing 707, 720 and 727 and Douglas DC-8 aircraft has been produced by Aerotec Industries of Bantam, Conn. It fits against the cabin wall over two seats with the outer backs folded forward, but leaving inboard positions free for passengers. It can be installed quickly without tools and weighs, including mattress and cover, 47lb. It fits into a 9in × 12in × 77in container, which telescopes to 48in when not in use.



USA

Inflate, but no Deflate The Research and Advanced Development Division of Avco Corp, Wilmington, Mass, has developed a new process for creating expandable structures which retain their shape even after total loss of the inflating pressure. Applications include space structures, solar collectors, aerials and portable lightweight shelters.

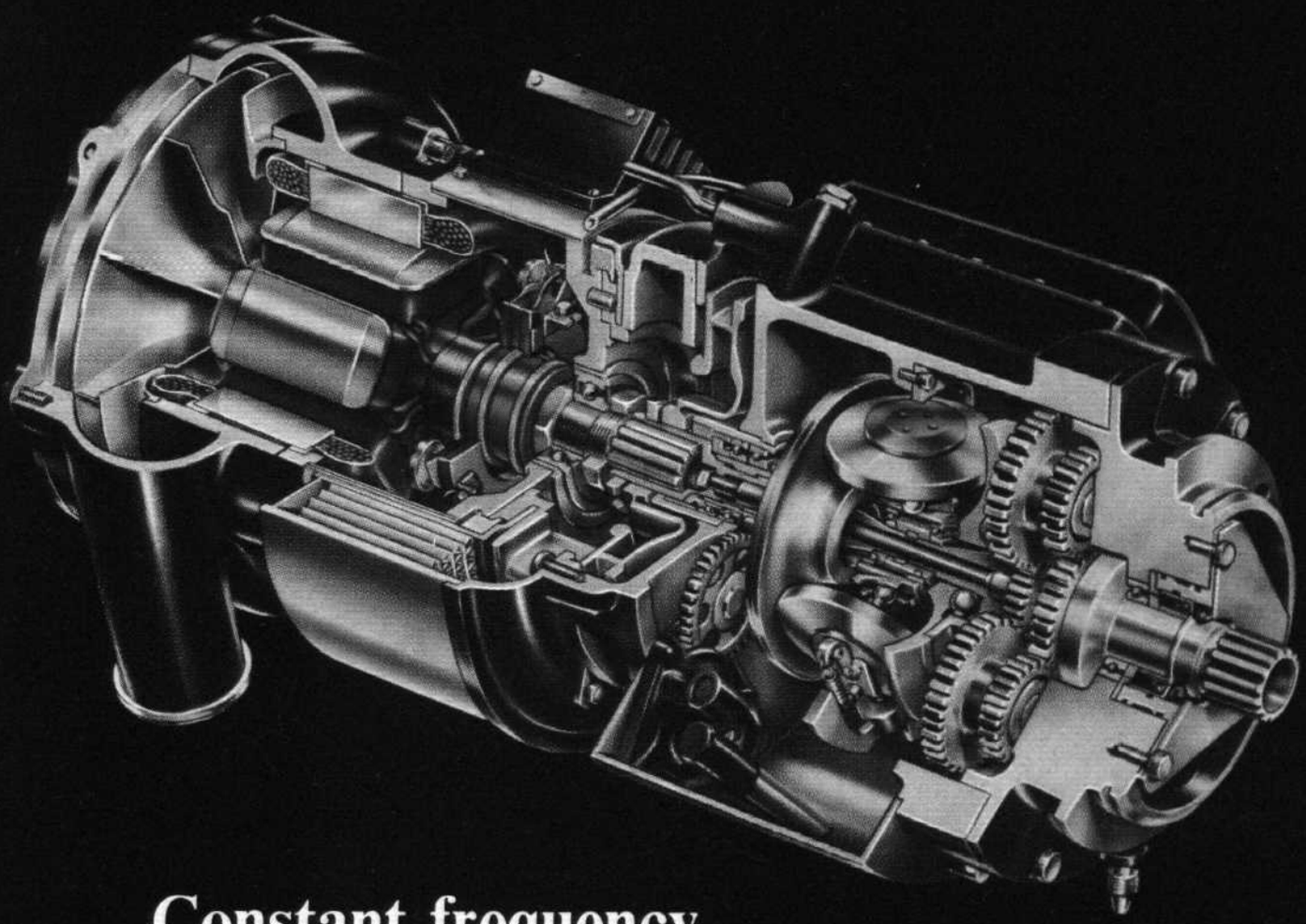
The new process uses aluminum foil as the basic construction material to create column members, three-dimensional trusses and toroidal shapes. The shapes are fabricated by seam bonding two identical flat patterns of aluminum foil, then inflating this bonded assembly to a wall stress slightly above the allowable yield of the foil.

The resulting structure is in a state of permanent set. Even if it is punctured and loses all its inflating pressure it will, states Avco, retain its original shape. The process is claimed to develop the highest stiffness-to-weight ratio of any known structural material.

For specialized applications requiring additional strength Avco has developed a cartridge which fills the depressurized internal volume of the expanded structure with a lightweight urethane foam.

France

200,000 Missiles In two weeks recently Nord Aviation passed two major milestones in guided-weapon manufacture, receiving orders which brought sales of the Entac anti-tank missile and of the SS-11 general purpose battlefield control weapon to 100,000 each. The Entac order, for 1,500 examples, made this type the first command guided missile anywhere to be ordered in such quantity. Seventy per cent of Entac sales have been overseas, while the SS-11 is standard equipment in 17 countries. Production of the latter weapon, at Nord's Bourges plant, fluctuates between 1,200 and 2,000 a month. The 100,000th round (the prototype was made in 1955) will be delivered in the third quarter of 1966.



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Air-Cushion Vehicles

DESIGN · COMPONENTS · APPLICATIONS

in this issue

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WHILE BRITAIN SLEEPS...

THE BRITISH NATIONAL PRESS is often criticized for being destructive, or at least unhelpful, in its attitude to British aviation and other technologically advanced industries—though it is often the least accomplished performers in their respective fields which make the most bitter criticisms. Last week, as we recount overleaf, it showed perhaps an excess of enthusiasm—in dispatching from Paris excited stories concerning the imminence of cross-Channel ACV services with mass-travel machines, of production before orders of the Westland SR.N4, of orders from British Rail, of American customers and so on. If they were only half correct, the stories certainly added up to a major boost for the ACV.

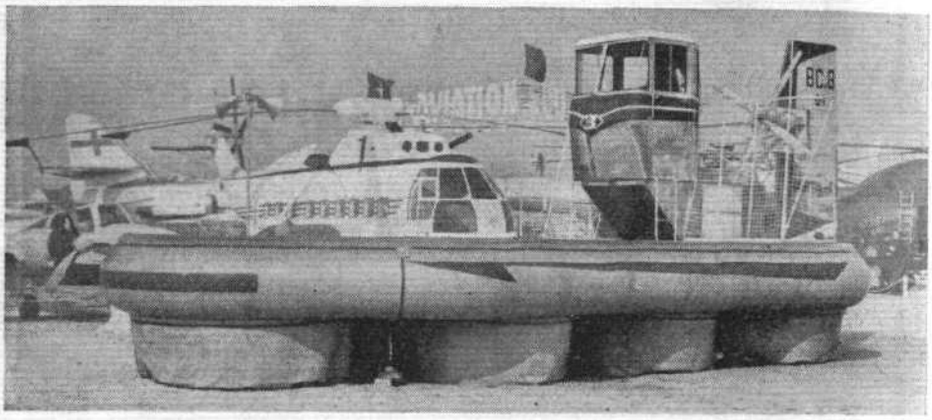
But what disheartened us as we delved to the bottom of these reports was not finding that they were hyperbole engendered by the competitive nature of Press coverage at a major event like the Paris Salon, and that in reality the existing position had not changed. The saddening, sobering thing was the apparent waspishness, the irritation, with which the boosting was denied in several quarters; the alacrity with which cold water was poured upon the half-news which had been spread.

And so we learned that British Rail is wending its laborious way, afraid, in this era when it is supposed to be alive to new commercial opportunities, to undertake commercial risks, groping for the Government's aiding hand—not intending (we have this from the new chairman of the British Railway's Board) of entering the hovercraft operating business on its own account but only as an agent of the Government. Truly, the aggressive commercialism which Dr Beeching was supposed to have engendered has not long survived his departure. Has it died within the month? Even as a potential agent of the Government, the railways seem to be enjoying one long sleep, for it was admitted by a BR spokesman that the background work, the market research, had not yet been done. And even that was for a service some would have said was scarcely necessary for the SR.N4—a proving season over the very short Solent route instead of in the more realistic, and more vital, environment of the cross-Channel routes.

The truth is that, as far as ACVs are concerned, British Rail is still the lethargic monolith that it ever was. While it dozes and dithers—in soporific counterpoint with its Ministerial friends—the French are preparing an experimental model of the 250 m.p.h. Bertin Aérotrain, with the enthusiastic support of the Société Nationale des Chemins de Fer. Meanwhile, Swedish shipping interests, with commendable commercial acumen, are quietly planning to raid the Channel (and slice into British Rail's sea traffic) with viable mixed-traffic ACV services before this decade is out. In doing so—and they seem likely to succeed—they will make British Rail, and the rest of Britain's transport industry, look more like the tortoise than the hare.

"Air-Cushion Vehicles" photographs

To the Rescue *Revealed at the Paris Air Show this month was the latest Bertin craft, the BC.8, which follows its forerunners in using the distinctive Bertin "petticoats." Designed as an airfield crash tender, the BC.8 is the subject of an accompanying news item*



INTERNATIONAL NEWS

BAC's Jumping Jeep

The British Aircraft Corporation's Preston Division has completed a feasibility study on a revolutionary Army scout car, designated the P.35, which would incorporate the ability to leap hedges, ditches and enemy obstructions. The project began some years ago on a company basis; the feasibility study enjoyed official support and a contract for a detailed design study is now anticipated.

Though possibly a forerunner of that long-time military dream, the "flying tank," the P.35 as at present conceived falls more into the light recce car category, being a four-wheeled vehicle, and is known to those who have worked on the study as the "jumping jeep." This name seems to indicate that its lifting ability is a short-term attribute for clearing obstacles and derived probably from a gas generator rather than a long-term sustentation derived from conventional ACV fans. When not jumping, the P.35 will proceed like any normal four-wheeled vehicle.

BAC (Preston) denied newspaper reports last week that a contract had been placed for two prototypes and declined to make any further comment on the project.

The Big SR.N4 Non-story

Large-scale cross-Channel services by Westland SR.N4s seemed only a matter of time away on June 14, to readers of several British national papers that day. Stories sent from the Paris Air Show told of Westland having decided to spend £5m on three SR.N4s, one each for British Rail and Swedish Lloyd and the third for another customer—"probably American." Westland chairman Sir Eric Mensforth was said to have approved plans to go ahead "and Westland are so confident of success that a third will be built ready for the next customer." Westland shares rose 1s 0d on the strength of these reports.

Westland spokesmen immediately denied that any statement had been made in Paris. A statement approved by sales director Mr Hugh Gordon said that negotiations with Swedish Lloyd were "well advanced" in regard to both the SR.N4 and the SR.N6 (which the shipping line has said it will use for cross-Channel services next year). British Rail had for sometime shown interest in an ACV for cross-Solent operations but to date no decision had been made to purchase an SR.N4.

Another Westland spokesman, in Paris, said that the newspaper stories were "a load of guff" and that no decision had been made to begin production in advance of orders. He confirmed that the Swedish Lloyd negotiations were well advanced but said that no negotiations "of any significance" had been held with British Rail for many months.

British Rail's connection with hovercraft had been mentioned the previous day by Mr David McKenna, general manager of the South Region, during the inauguration of BR's latest conventional cross-Channel car ferry. Mr McKenna was reported as saying: "We have no plans to go into the hovercraft business by ourselves. We are, however, quite prepared to act as agents for the Government if they so think." In the present state of hovercraft development, he continued, it would be wrong for a nationalized undertaking required to pay its way to take a large risk of this kind [a doctrine which does not augur very well for future railway developments, some may feel—Ed].

Questioned about the £1.75m investment in the latest BR ship, in the light of the possible Channel tunnel, Mr McKenna is reported to have said: "Commercial risks must be taken, but they must be sensible risks and not wild."

In its coverage of the new ship's inauguration, *The Times* said that the British Railways Board was prepared to put an N4 into service over the Solent, provided the Government would guarantee the difference in operating costs—some £100,000—between the N4 and a conventional ferry on the Portsmouth-IoW route. The board, said *The Times*, had proposed that the Government should buy the craft and charter it to the railways on appropriate terms. The proposal, the report continued, was receiving the urgent attention of the

Ministries of Transport and Technology.

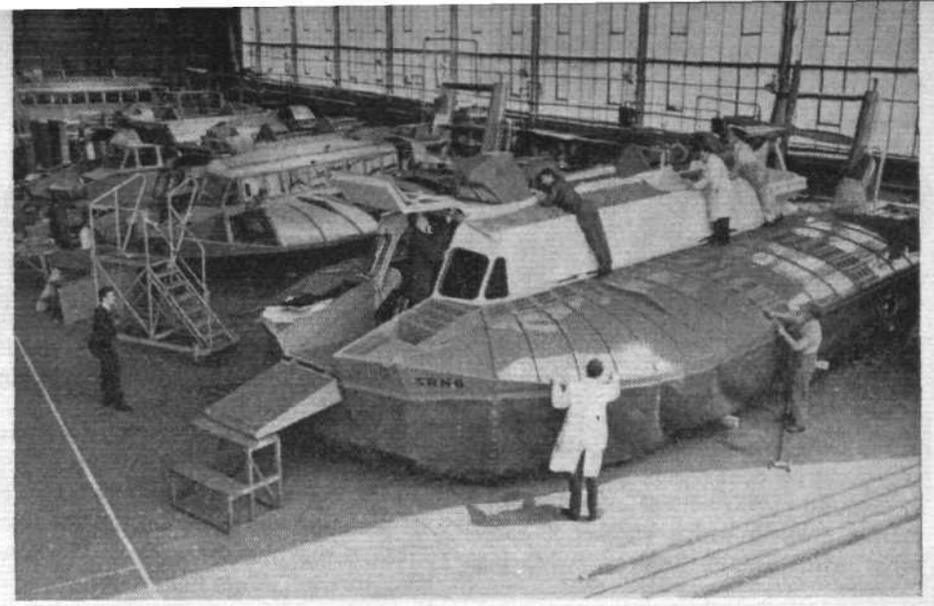
But at the Ministry of Transport a spokesman said that no formal proposals had been made to the Government by the British Railways Board, though the matter was under discussion. He referred enquiries to the Ministry of Technology and British Rail.

The Ministry of Technology said that they, too, had enquired of the Ministry of Transport that day, and had nothing to add, except that the NRDC had some responsibility on its behalf. The Ministry of Technology referred enquirers back to the Ministry of Transport. Meanwhile, the NRDC kept mum but, then, it was moving house that day.

At British Rail headquarters, yet another spokesman admitted BR interest but said that nothing was decided. His version was that Westland would own the craft and BR would merely operate it, if the idea went further, and the first one or two seasons would be spent on the Solent, before cross-Channel services were run. There was as yet no question of asking for a Government subsidy, as the economics of a Solent operation were not yet known. "There would have to be lots of market research; lots of background work would have to be done on this." One inferred that none had yet been done.

Only three facts are really clear after this exercise, which leave the *status quo* unaltered and make nonsense of last week's bigger headlines. Swedish Lloyd is negotiating for an N4—this was known. British Rail has shown some interest in ACVs (though this does not seem to have Mr McKenna's very keen support)—this was known.

The only new fact revealed is that any proposal that Britain should be the first to operate a viable mixed-traffic ACV over what was, until recently, the island kingdom's own defensive moat, is likely to be smothered under the weight of the bureaucratic bucks being passed. But some people will argue that this is not a new fact, either.



Customer Acceptance *Demonstrating cogently the commercial welcome which has been extended to the 38-passenger Westland SR.N6 in the few weeks since it was announced is this recent picture of the Cowes production line, which shows that the stretched craft has already supplanted the smaller SR.N5, at least in the main assembly jig and three adjacent downstream positions*

Bertin's Crash Tender

Société Bertin revealed its latest ACV, the BC-8 Terraplane, at the Paris Salon de l'Aéronautique at Le Bourget this month. Based upon the well proven and distinctive Bertin *jupes*, or petticoats, the BC-8 is designed specifically for the needs of aircraft crash rescue services, particularly at those airports situated adjacent to marshy areas or other difficult terrain.

The BC-8, as our pictures show, has a small "wheelhouse" and a flat deck on which crash crews and their equipment, or crash survivors, can be rushed to and from the scene. It would also be useful, Bertin claims, as an airport personnel and equipment runabout or for transporting passengers between aeroplanes and passenger buildings.

Lift power is derived from the efflux of an 880lb-thrust Marboré turbojet which entrains additional air in being ducted through special Bertin *trompes* to the seven individual *jupes*. An Artouste turboshaft engine drives two propellers through external gearboxes. Length is 33ft, width 16½ft and height 14ft. Empty weight is given as 5,180lb and maximum loaded weight 10,360lb. Bertin claims maximum speeds of 54kt over surfaced runways, 27kt over "bad terrain" and 43kt over water.

R-R Marketing Marine Gas Turbines

Bristol Siddeley's monopoly, among British engine manufacturers, in marine gas turbines is to be broken by Rolls-Royce. This is one implication of the recent news that Grumman has

Two rides for the Prince *Air-cushion-borne twice in recent weeks, both times in British craft, was Prince Bernhard of the Netherlands (left), who joined Princess Margaret in sampling a Westland SR.N5 during last month's "British Week" in Amsterdam. Subsequently, Prince Bernhard used the Union Dynamics UD.2 Dynacraft Netherlands demonstrator as a tender for the royal yacht during a regatta and was accompanied by Hr Jan Dutilh, UD's Netherlands distributor (in the fancy hat)*

INTERNATIONAL NEWS . . .

selected the R-R Tyne as the power plant for its Dolphin-class commercial hydrofoil craft to be built in Germany by Blohm und Voss.

The Tyne, developed to give over 5,500 s.h.p. in aircraft uses, will have a conservative continuous power rating of around 3,000—3,500 s.h.p. in the marine role, in which bracket it competes with Bristol Siddeley's Marine Proteus.

Rolls-Royce has not previously ventured into the marine field with gas turbines except for some experimental work years ago, but in recent years it has explored uses other than aircraft for its gas turbines and has sold many examples of the industrialized Avon. Other industrialized Rolls-Royce aero engines, including a version of the Dart, are projected.

If Rolls-Royce is similarly to exploit the marine potential of its engines, it will considerably widen the choice of powerplants open to ACV designers who have, hitherto, been tied solely to the BS range if using British gas turbines.

Possibilities widen, too, for designers planning to use internal combustion engines with last month's news that Rolls-Royce has taken a licence from NSU Motorenwerke and Wankel to explore the possibilities of using the Wankel rotary piston engine, in both diesel and multi-fuel versions, for use in combat vehicles. The licence specifically excludes R-R use of the Wankel patents in motor car or commercial vehicle applications but it is possible that military ACVs might well come under the designation "combat vehicles."

The Wankel engine offers compactness and greater efficiency than conventional reciprocating engines, and is already showing very promising power-to-bulk and power-to-weight ratios, which makes its use in ACVs a technically exciting prospect.

Good for MoD

In our report in last month's *Air-Cushion Vehicles* of the demonstration of a Westland SR.N5 for senior SEATO representatives at the Isle of Grain we were less than fair to the Joint Warfare Staff of the Ministry of Defence in London in failing to mention that they were the overall planners, organizers and planners of the demonstration. We hasten to make amends now, for this is further confirmation of a point we have made several times in these pages—that it is the MoD and the military Services in Britain that are setting the pace, ahead of industry, in the acceptance of, and stimulation of interest in, ACVs.

Ijmuiden - Cowes Non-stop

The Westland SR.N5/005 made the longest-yet non-stop open-sea ACV journey, 280 n.m., on May 22, when it returned direct to Cowes from its "British Week" appearances in Amsterdam. Its outward journey, from the Isle of Grain, was reported on this page last month.

The return route was Ijmuiden - Calais - Dungeness - Beachy Head - Cowes. Average speed for the journey—made in 3 to 4ft seas and winds of up to 18kt—was 37kt. Crew members were Westland chief driver Peter Lamb and Mr T. Kennedy, chief service engineer (hovercraft).

CAB Go-ahead for the 'Frisco Operation

The US Civil Aeronautics Board granted its first authorization for scheduled commercial ACV operations on May 28, when it approved the services to be operated in San Franscisco Bay by San Francisco-Oakland Helicopter Airlines with two Westland SR.N5s leased from Bell Aerosystems.

The CAB authorization is for a 12-month period beginning on the day services start, or until December 31, 1966, whichever shall first occur.

Many hundreds of trips have been made across the Bay this month as SFOHA crews familiarized themselves with the craft and *Air-Cushion Vehicles* understands that public services are being inaugurated on July 1.

The operating base is Oakland International Airport, which will be linked by the N5s to San Francisco International Airport and the downtown San Francisco Heliport.

Clydeside Scheduled Services Postponed

Clyde Hover Ferries' first Westland SR.N6 was delivered to the company's Tarbert, Kintyre, base on Monday, June 14, from John Brown's Clydeside yard, and the second being be delivered next month. Both are being purchased on five-year lease-purchase contracts with Westland.

The company had hoped to inaugurate the world's first permanent passenger and freight ACV services last Friday, June 18, on which day a press demonstration was being held, but with crew training behind schedule the commencement of regular services has been postponed until early July. Meanwhile, the N6 is giving public demonstration trips from Largs at weekends, beginning last Saturday, while crew training continues during weekdays under Westland driver Bob Strath.

Nine of the ten Clydeside towns approached by the operators for landing permissions have accepted and provided landing places, though not without fears of noise being aired in various council chambers. The sole refusal came from Kilcreggan, which already faces the loss of regular steamer services because of lack of support. The refusal stems from an anxiety not to aggravate an already difficult position.

Initial services will be over the route Tarbert - Tighnabruaich - Rothesay - Weymss Bay - Dunoon - Gourock - Helensburgh, with shuttle services between some of these points. Fares will average about 1s 3d a mile and crews will comprise a driver and stewardess.

Solent Hydrofoil Opposition Withdraws

The intended hydrofoil competition for Hovertravel's proposed cross-Solent ACV ferry service is now most unlikely to appear—and will certainly not result during the 1965 summer season. Cosmic Shipping Ltd, which had planned to operate the 40-seat hydrofoil *Cyra* between Southampton and Cowes, has now postponed the service indefinitely.

The reason, as forecast in these pages in March, is that Cosmic has found established displacement ferry operators unwilling to afford them landing rights at established piers and pontoons. The company shifted its planned island terminal from Ryde to Cowes after British Rail had refused it the use of Ryde Pier but at Cowes it fared no better. There, the only possible landing place was the pontoon operated by the Isle of Wight Steamship Co (Red Funnel Steamers), which itself operates services to Southampton. Cosmic has been unable to obtain rights to use it—though the IoW Steamship Co denies that it was asked for them.

Thus has a considerable commercial advantage held by potential operators of amphibious ACVs over aspiring hydrofoil operators been highlighted by Cosmic's experience. Hydrofoils' dependence on shore installations—piers, quays and so on—places their operators firmly in the hands of existing ferry owners, who may not welcome the faster, novel competition and, therefore, spike their guns by denying them facilities. The alternative is heavy capital investment in their own fixed terminals. But ACV operators, who merely need to obtain foreshore rights, are able to treat with other parties—local authorities and landowners—whose interests, rather than being vested in existing transport links, may be better served by faster services. This has certainly proved to be the case with the first planned ACV-hydrofoil commercial contest in Britain and it may well be a pattern to be repeated in the future.

LOOK FORWARD

to Westland hovercraft travel

The 38-passenger Westland SR.N6—now in full production, and already ordered for commercial service in UK and Norway this summer—sets a new standard in overwater travel.

A 60-knot cruise speed, and complete independence of deep-water channels and tide state, give exceptionally short journey times. Even in rough water, the ride has all that extra smoothness so characteristic of travel 'on a cushion of air'.

Floating debris is no problem to the high-riding SR.N6. The craft's amphibious capability eliminates the need for piers or docks. Passengers embark and disembark at land terminals which need be little more than small, fenced areas of beach. This contributes greatly to extremely low turn-round times and attractive operating economics.

For open-sea routes such as the English Channel, Westland offers the 150-ton SR.N4 passenger/car ferry, with the same high standard of performance and comfort. Typical loads are 210 passengers and 30 cars, 500 seated passengers or up to 800 passengers on commuter routes.

sustained
HOVERCRAFT LEADERSHIP

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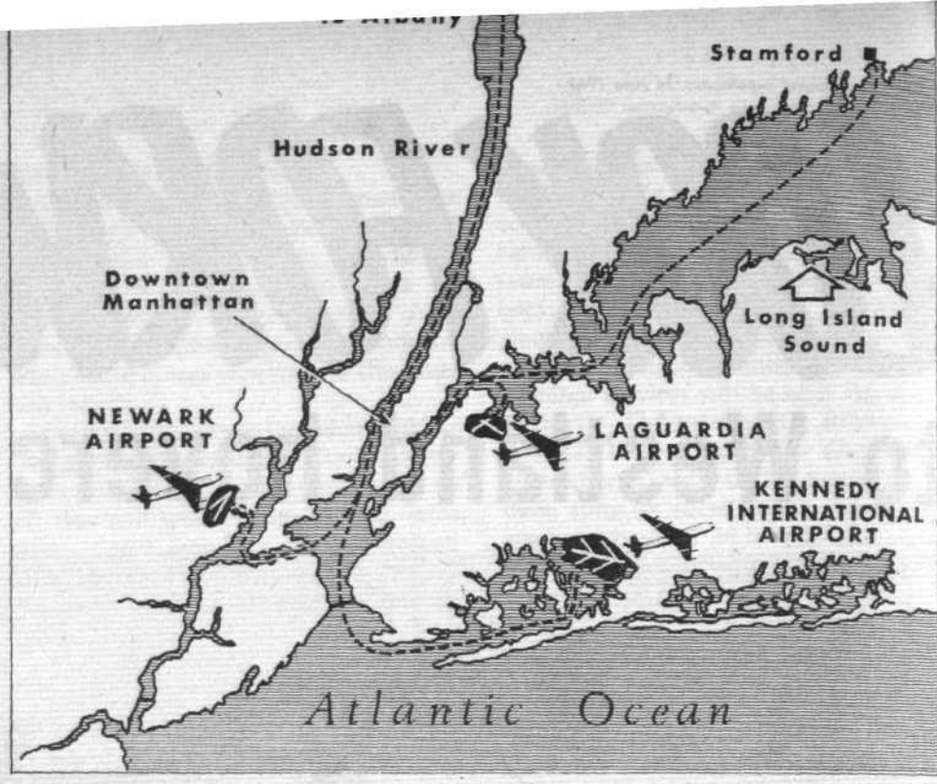
New York City and the ACV



Potential ACV routes, including the two discussed below, are shown on this map of the region around New York City

A major paper with the above title was read recently before the Metropolitan Section of the US Society of Automotive Engineers by J. B. Chaplin, assistant chief engineer in Bell Aerosystems' integrated systems engineering department, and W. J. Egginton, chief of ACV preliminary design with the same company. We reprint here the kernel of the paper, dealing with ACV services around New York.

IN the commercial field one of the most suitable applications of ACVs is that of mass transit in cities such as New York. In many cases there are large rivers or waterways close to the city with access to the centre of town. Many suburban housing areas are close to the water while major airports are often built on surrounding reclaimed land.

The vehicles considered are: (a) a 20-passenger annular-jet vehicle with 4ft flexible skirts (Westland SR.N5); (b) a 90-passenger plenum multi-cell vehicle with 3ft flexible skirts (a previously unannounced Bell Aerosystems project illustrated on page 63 in last month's issue); and a 600-passenger annular-jet vehicle with 7ft flexible skirts (Westland SR.N4).

The 20-passenger and the 600-passenger vehicles with flexible skirts have the maximum performance for ACVs of that particular size. The 90-passenger vehicle does not have the maximum performance possible for a vehicle of its size, but because of the simplicity of the plenum concept it is a relatively low-cost vehicle. The SR.N5 has demonstrated all the performance capability assumed; the 90- and 600-passenger vehicles are at the present time at advanced stages of design with detailed analysis and model test data to substantiate the performances assumed.

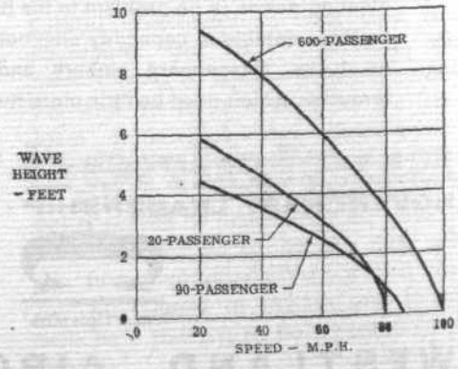
All three vehicles are powered by gas turbine engines, are constructed of aluminium and represent the present state-of-the-art. The performance of these vehicles as speed against wave height is shown in Figure 1. All the vehicles would be capable of ranges in excess of 150 miles with full payload. The prediction of this performance is based upon full-scale and towing-tank test data.

The East River, the Hudson River, Newark Bay, Upper Bay and Long Island Sound provide ideal natural hoverways for these craft. The Hudson River or Long Island Sound are excellent waterways for short-range applications such as the airport service, or longer-range mass transport. The 20- and 90-passenger craft would be confined to the rivers and bays in order to guarantee operation of 95 per cent of the time during the whole year. The 600-passenger vehicle could, in addition to these areas, operate in Long Island Sound or through the Verrazzano Narrows to Kennedy International Airport. The floating debris in the East and Hudson Rivers would be no problem to these craft. The passengers would sit in bus-like seats without seat belts since the maximum decelerations, even those due to a high-speed power failure, will not be sufficient to throw them out of the seats. While the craft will respond to waves the motion will not be unpleasant due to the softness of the air-cushion system. The lack of any wave or wake when at speed will allow the vehicles to maintain their cruise speed when close to shipping or shore installations.

It is important to note that all the ACVs will not be suitable to *all* the possible routes in the New York area. Acceptance of the vehicle's limitation is just as important as the exploitation of its capabilities. Some of the earlier prognosticators of the ACV's future have in their enthusiasm ignored this fact and presented the ACV as a wonder vehicle. Its development has not benefitted from such presentations.

The run from downtown Manhattan to Kennedy Airport, for example, is not a good application for the smaller vehicles. The journey by water is longer than overland and the sea conditions possible in the Lower Bay and along the Atlantic shore would be beyond their ability.

Figure 1: ACV overwave performance



BASIC DATA		
STAGE LENGTH		8 MILES
BLOCK TIME		10 MINUTES
TERMINAL TURN AROUND TIME		5 MINUTES
TIME FOR ROUND TRIP		30 MINUTES
VEHICLES USED		5
SCHEDULE		
NORMAL DAYS	340	
6 AM TO MIDNIGHT	20 MIN	FREQUENCY
MIDNIGHT TO 6 AM	60 MIN	FREQUENCY
PEAK TRAVEL DAYS	25	
6 AM TO MIDNIGHT	10 MIN	FREQUENCY
MIDNIGHT TO 6 AM	30 MIN	FREQUENCY
VEHICLE AVAILABILITY		
ROUTINE MAINTENANCE		50 DAYS
SCHEDULED SERVICE		200 DAYS
STANDBY		112 DAYS
UTILIZATION		1,520 HOURS

Figure 2: ACV service, Manhattan to La Guardia Airport

Two routes have been selected for our purpose as typical of those where the full ACV potential can be utilized. The 20- and 90-passenger craft have been considered on the downtown Manhattan - La Guardia Airport route as airline feeder services. The 600-passenger vehicle has been evaluated on the mass-transit route from Manhattan to Stamford, Conn.

The Downtown - La Guardia Route

A regular scheduled operation has been assumed, as shown in Figure 2. For both the 20- and the 90-passenger vehicles, five vehicles will be used and a 24hr service provided. During all the operations at least one vehicle will be available as a stand-by, only three vehicles being necessary for normal travel day operation and four for the peak travel days. Night operation has already been proved feasible with ACVs and high-power lights and radar will generally be standard future equipment. Normal daytime operation of the smaller craft will require only one crew member, a second member being necessary only for night or limited-visibility operation with radar. The annual utilization of 1,500hr per vehicle is within the capability of ACVs now in operation.

The variation of the one-way fare with utilization and first cost of the vehicle is shown in Figure 3 for the 20-passenger vehicle and in Figure 4 for the 90-passenger. This fare covers the direct operating costs, the indirect operating costs which are assumed to be 50 per cent of the direct, and a normal profit margin. In each case a point has been marked as representative of the present state-of-the-art.

It has been assumed for both vehicles that the traffic would allow a 50 per cent load factor. It is obvious that the selection of one craft in preference to the other would depend on traffic demands.

A simple 60-80ft-wide ramp with a slope of 1 in 10 would be required at La Guardia to give access from the river. Some form of hoverway would be required to enable the craft to unload at the terminal building. This hoverway would be separate from the normal taxiways but because of the low ground pressure of the vehicles it would not be expensive to construct or maintain.

At the downtown Manhattan terminal a large floating dock or barge would be used with a sloping end so that the ACV could drive up out of the water. A terminal building with ticket offices, waiting rooms, etc, would be required. A maintenance facility, ideally at the airport, would consist of one large hangar, the only major equipment necessary being a large crane or travel hoist to lift the vehicles for inspection of the skirts and for maintenance.

The fares indicated in Figures 3 and 4 are conservative; they could be achieved within the present state-of-the-art and the demonstrated operational capabilities of the vehicles. The first costs of $400,000 for the 20-passenger and $1m for the 90-passenger should be attainable with a limited production run when built in the USA. The influence of first cost and increased utilization is significant. Halving the first cost and ncreasing the utilization by 30 per cent would decrease the one-way fare for the 20-passenger vehicles from $2.86 to $1.85 and for the 90-passenger vehicle from $1.72 to $1.08. Although the 90-passenger vehicle appears to be the more competitive, the passenger-traffic flow variation and the required frequency of service must influence the final choice.

Figure 3: downtown Manhattan to La Guardia fare, eight-mile stage length, 20-passenger vehicle

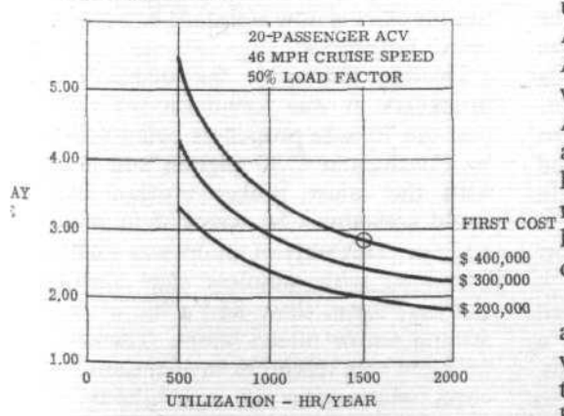
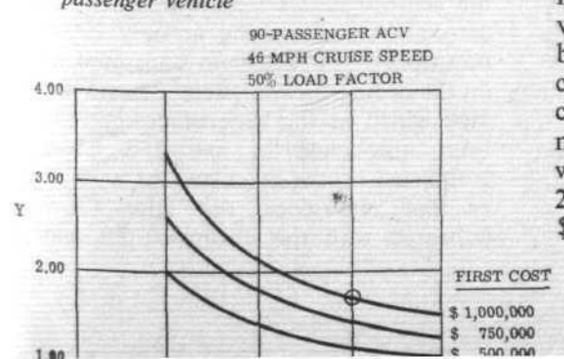


Figure 4 (below): Manhattan to La Guardia fare, eight-mile stage length, 90-passenger vehicle



The Downtown - Stamford Route

Although the airport route application is the more immediate, the longer route application for mass transport could in the long term be the most significant. For the megatropolis of the type forecast to develop from Boston to Baltimore or San Francisco to Los Angeles the waterways could be an important transport system.

As an example of this application, a 600-passenger vehicle operating on the downtown Manhattan - Stamford route has been considered. Analysis of sea-state data shows that the vehicle could operate and maintain the cruise speed of 67 m.p.h. for 97 per cent of the time anywhere in Long Island Sound. During the remaining 3 per cent of the time it would have to reduce speed but would still be able to operate. Since the route considered is over the south-western land-locked end of the Sound, it is reasonable to assume that an even higher operating capability than this would be possible. It is of interest to note that while the two smaller vehicles are not proposed for this application, the 90-passenger would be able to maintain its cruise speed of 46 m.p.h. for 83 per cent of the time and the 20-passenger for 87 per cent of the time. During rough weather, however, the passengers would not have as comfortable a ride in the smaller vehicles as they would in the 600-passenger vehicle.

The one-way fare variation with first cost and utilization is presented in Figure 5. Because of the increased stage length a higher utilization can be realized than for the La Guardia operation. A conservative fare value for the present state-of-the-art has again been indicated.

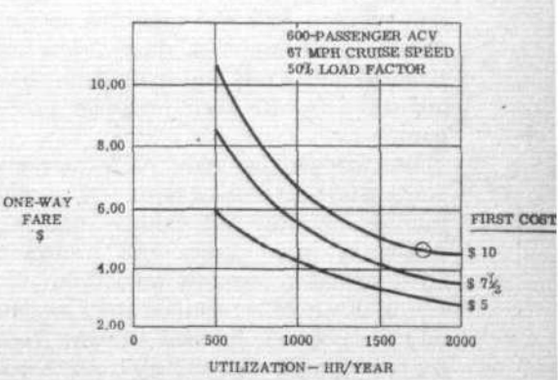


Figure 5: downtown Manhattan to Stamford fare, 30-mile stage length, 600-passenger vehicle

Britten-Norman's first hovercraft was the CC-1, seen here with a bigger-than-normal daylight clearance conferred upon it by an RAF Belvedere

THE SMALL HOVERCRAFT

By Christopher Bland*

FOR THE PURPOSES of this article "small hovercraft "is taken as meaning those of under 10,000lb gross weight, which are, after all, what we know most about at Britten-Norman.

In spite of many thousands of words having been written to the contrary, we are still absolutely convinced that the ultimate success of the small hovercraft lies in its amphibious capabilities. Admittedly there are economic advantages to air-lubricated hulls, sidewalls and so on, but these are much more pronounced commercially on larger craft, such as the Denny D-2 and upwards. Experience has already shown that sidewall craft are very prone to damage from debris in much the same way as is the hydrofoil in most coastal and inland waterways, with their littering of floating railway sleepers, tree trunks and general debris. It is argued that modern foils can take this sort of flotsam punishment in their stride but sidewall hovercraft and hydrofoils alike are still left with their propeller problems.

We foresee the main ACV markets being in fast-developing parts of the world such as Africa and South America, where in many cases the transport advance has completely missed out the laying down of a metalled road system or railways, and jumped straight from the camel, mule and donkey to the aeroplane. This leaves an enormous potential for setting up ACV transport networks in the many areas that are inaccessible by aeroplane, to say nothing of avoiding the costs of laying down landing strips and running aeroplanes. These countries provide many natural hover ways—large shallow rivers, which frequently dry up in the summer forming natural hovertracks. Other obvious applications are to be found on such rivers as the Nile, which suffers badly from choking by water hyacinth in the upper reaches, making navigation by conventional boat more or less impossible.

Turning from the warmer areas of the world, one must not forget such places as the northern territories of Canada where the transport problem is enormous and overcome to a large extent with power sleighs and ski-equipped aircraft. The small hovercraft could undoubtedly play an enormous part in providing cheap and efficient transport in arctic areas.

The military applications do not need harping upon but the hovercraft is a natural for beach landing vehicles. These can leave the mother ship much further out to sea than has previously been possible, make infinitely faster runs into the shore and, terrain permitted, penetrate well inland for disembarking their load.

Turning now to the design of the small hovercraft, we feel that after five years' experience with the CC-1, CC-2 and CC-4, three points are of paramount importance. The small hovercraft must not have aircraft-type propellers because they cannot be raised high enough from the ground to get away from the erosion problems and they create the most obvious physical dangers to passengers and bystanders; maximum use must be made of inflatable structures and the periphery of the craft must be of a soft nature; and lastly, standard automotive engines should be used purely for economy reasons. It is assumed that a flexible skirt is now standard equipment on all hovercraft.

Dealing first with the question of propellers, it was found on the CC-2 that the 7ft side propellers being driven by Continental C-90 engines and fitted with the latest rubber erosion strip could sometimes be wrecked in under an hour. This state of affairs was slightly improved with stainless steel sheaths but here again these had a life of only around ten or fifteen hours. The other problem was the erosion of the trailing edge, which after 25 or 30 hours of normal operation became razor thin and eventually eroded away. In contrast the centrifugal lift fans with their 40° aerofoil blades rotating at only 200ft/min tip speed showed no signs of wear on the ordinary commercial "Lassovic" tape which at the time of writing has been untouched in the 250 hours completed by the machine. As a result of this experience, the later CC-4 appeared with the integrated lift and

**The author is commercial director of Britten-Norman's Hovercraft Division*

propulsion system where the dynamic head from four vertically mounted fans was forced out of volutes at the rear in the form of a low-pressure jet. This system lived up to expectations and undoubtedly has a large potential in hovercraft of the future.

Flexibles do not need enlarging upon but the idea of inflating the craft when it is ready to operate is a thoroughly satisfactory one and also enables the flexibles—and here one must stress that they must not be supported in any way by solid structures—to be rolled up to prepare the craft for road transport or shipping, without the previous need for dismantling. There is a wide choice of materials for both flexible structures and flexible skirts and it seems on the small hovercraft that these should be kept as light as possible, so that the passenger ride over rougher terrain or choppy seas may be as comfortable as possible, due to the skirt taking all the height variations rather than causing the main structure to react.

The reason for our concentration on automotive petrol engines is purely commercial, as the turbine is obviously much more attractive from the power-to-weight point of view. But the price per horsepower of modern hovercraft-approved turbines is approximately £25 per horsepower compared with only £4 in the case of standard automotive engines. The supply of automotive engines is slightly limited, as advertised maximum power figures are usually totally different from the power figures which the manufacturers will guarantee for a continuous rating. This, we are pleased to say, has not been the case with the Rolls-Royce LV-8 used in the CC-2 and CC-4, which has maximum and continuous horsepowers that are identical at 240 b.h.p.!

The prototype CC-4, built for HDL, is now engaged in skirt development trials. The second prototype, now taking shape at Bembridge, incorporates substantial changes, though it retains the integrated lift and low-velocity jet propulsion system and the R-R LV-8 powerplant. Plans are being made for its production in quantity

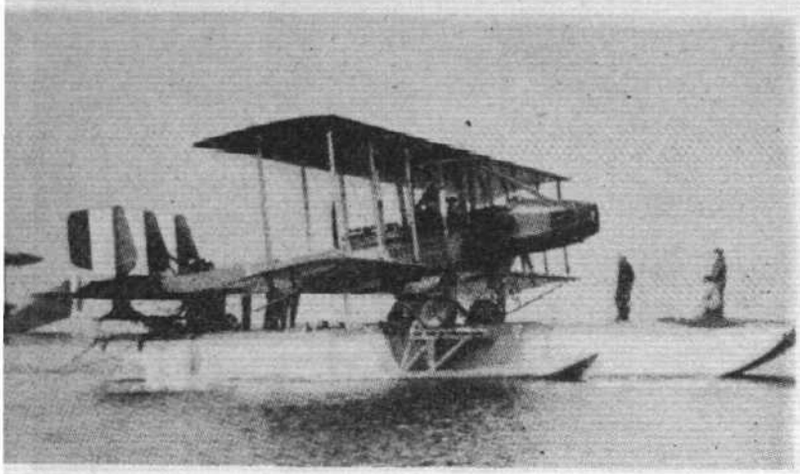
If the small hovercraft is going to be used universally, maintenance must be of a simple nature and not call for highly skilled technicians, who are both rare and expensive in the parts of the world where we feel the small ACV will fit in best. The same consideration is a further reason for using automotive components which are now generally becoming accepted even in the least developed parts of the world. The same applies to transmissions; it seems logical that these should be kept to basic automotive standards, with the possible addition of notched belts which have come into their own in recent years.

To summarise: it appears that the day of small hovercraft has not yet dawned but this should be apparent within the next twelve to eighteen months. We have, however, reached a stage, largely due to the success of larger machines, where one can undoubtedly say that this day is coming and it is now just a question of how long. What is required now is really concentrated homework on building hovercraft down to a sensible price (which involves getting away from aircraft techniques) and a concentrated test and development programme so that when small hovercraft first make their mark abroad, they will be capable, economical and, most important of all, reliable. History has shown that the first impressions with a new type of vehicle are of the greatest possible importance.

In the economic sense a gallant failure, the CC-2 nevertheless has contributed much valuable knowledge for the subsequent development of small hovercraft. Britten-Norman's own skirted machine is seen, left, undergoing comparative trials with the Fighting Vehicles Research and Development Establishment's unskirted version. It is hoped to publish more pictures and details of these trials in an early issue

An "Air-Cushion Vehicles" photograph

ACV Train and Carrier—Long Ago



The USN's Sea Sled of 1919, carrying a Caproni bomber

The Bértin Aérotrain and the Royal Navy's intended Hovership have both been preceded, in concept, by other projects over 100 years and nearly 50 years ago respectively, as these historical researches show

OF ALL THE PROJECTS in the scope of this journal, the air-cushion train and the aircraft carrier which itself rides on air come nearest to incredibility. Yet are they more incredible than these facts: that an air-riding train was schemed well over a century ago; that over fifty years have passed since one was built and tested; and that an ACV for the launching of giant bombers was being tested soon after World War One?

Around the middle of the last century a French engineer, M Girard, owned and managed the hydraulic engineering works of La Jonchère, and to this man came the notion of propelling a train by water jets. These would issue from nozzles standing along the centre of a railway track in such a way that they would exert their effect on the underside of the carriages and cause the train to move along the rails. About two years later, in 1854, it occurred to Girard to suppress the wheels entirely and to substitute bearing plates attached to the carriages and resting on rails of a specially designed section. Further—and this was the highest point of his vision—he proposed to reduce friction still further by maintaining the two surfaces some distance apart by means of compressed air.

The practical problems, of course, proved too much for him, but he nevertheless continued to develop his hydraulic scheme until in 1871 a Prussian bullet put an end to his dreams. Even so, his hydraulic railway came to pass; but that is another story.

It was a Frenchman, too—a M Bachelet—who made the headline "The Floating Railroad Train" in the *Scientific American*. I quote from the issue of March 30, 1912:—

"A number of years ago we described an electro-magnetic railroad in which the cars were raised by magnets that pulled up against the under-side of the rail, thereby relieving the car wheels of nearly all the load. Another even more novel scheme has just been patented. In this case use is made of Foucault or eddy currents to levitate the cars. Along the course of the road at frequent intervals electro-magnets are placed through which an alternating current is passed. The car is adapted to travel above the magnets and is arranged to energize only those magnets that are immediately adjacent to it. This is accomplished by providing brushes or shoes on the cars, which slide in channel rails at each side and above the car. The brushes also serve as guides to keep the car from sliding laterally out of the magnetic field. The car itself is formed of an iron cylinder mounted on an aluminium plate. When the magnets are energized, the alternating magnetic field induces eddy currents in the aluminium plate, which, owing to their repulsion, lift the car from the magnets. The car thus supported in space is then propelled by means of solenoids which are successively energized to attract the iron body of the car and de-energized at the moment that the iron body reaches the neutral position within them. The effect of this mode of propulsion would be to accelerate the car to an enormous velocity, as there would be no resistance to overcome except that of the air and the slight resistance of the sliding brushes. Of course, at high speeds the air resistance would be considerable, but this could be reduced by providing the car with conical ends and a smooth cylindrical body.

"While the project seems to be feasible one cannot help but feel that friction is bought off at an enormous cost, and when the actual power required for this purpose is estimated, the result is astonishing."

Astonishing, true, as the magazine proceeded to argue; but so, surely, is the fact that this occurred so long ago.

And the air-cushion carrier? This was a very real affair and was tried full-scale. It came about in this way.

In the early years of this century an American, Albert Hickman, developed what he called the Sea Sled, a type of craft having a concave bottom for much of its length with a view to "trapping air and forming an air cushion." The term was used in 1913, if not earlier, and to support my contention that this was truly a form of ACV I quote Mr John Teale, whose book *Fast Boats* observes of the Sea Sled:—

"The reason for the increased speed is a little obscure, though it is borne out in practice. However, what probably happens is that, in calm water, the inward bow-wave formations from the two bows converge into the inverted V and become trapped under the bottom together with the air forced in by the boat's progress. The transom is flat and fully submerged. All this provides a certain amount of lift. The boat will thus rise in the water and a fairly large portion rides in a mixture of air and water from the trapped bow waves. Though the wetted surface will be greater than in a conventional hard-chine boat, the wetting will be done by this mixture rather than purely by water, with a lowered frictional resistance effect. The faster the boat travels the greater the lift becomes, until at some point, presumably, the craft will rise completely out of the water and ride solely on the cushion of air. It would then be a hovercraft, rather than a boat!"

The Sea Sled achieved wide popularity, and was built in small numbers in Britain; but its internal capacity was limited by its physical form. As a fast deck-launcher, however, it had obvious attractions, and in 1919 a special craft of the type was adapted by the US Navy to carry a Caproni bomber—one of the largest in the world at the time. With four 450 h.p. engines the 50ft sled attained 50 m.p.h., which meant that the Caproni took to the air immediately it was released. The scheme was intended to get the bomber closer to its target and can truly be regarded as the precursor not only of Christopher Cockerell's own project for an air-cushion launching platform but of the ACV aircraft carrier contemplated by Westland.

I make no pretence that these were "Hovercraft" by the HDL definition; but at the same time I make no apology for placing them on record in this journal. I well remember the reception accorded J. M. Bruce's "historical" articles in *Flight* some years ago. Some of the most eminent pioneers of the British aircraft industry were astonished by what they said they had forgotten.

The truth is that they had never known.

H. F. K.

HOMEBUILT HOVERCRAFT

A PLAIN MAN'S GUIDE TO ACV DESIGN AND CONSTRUCTION—PART 6

By G. H. WILLIAMS, Dipl Tech (Eng) GIMechE, GradRAeS

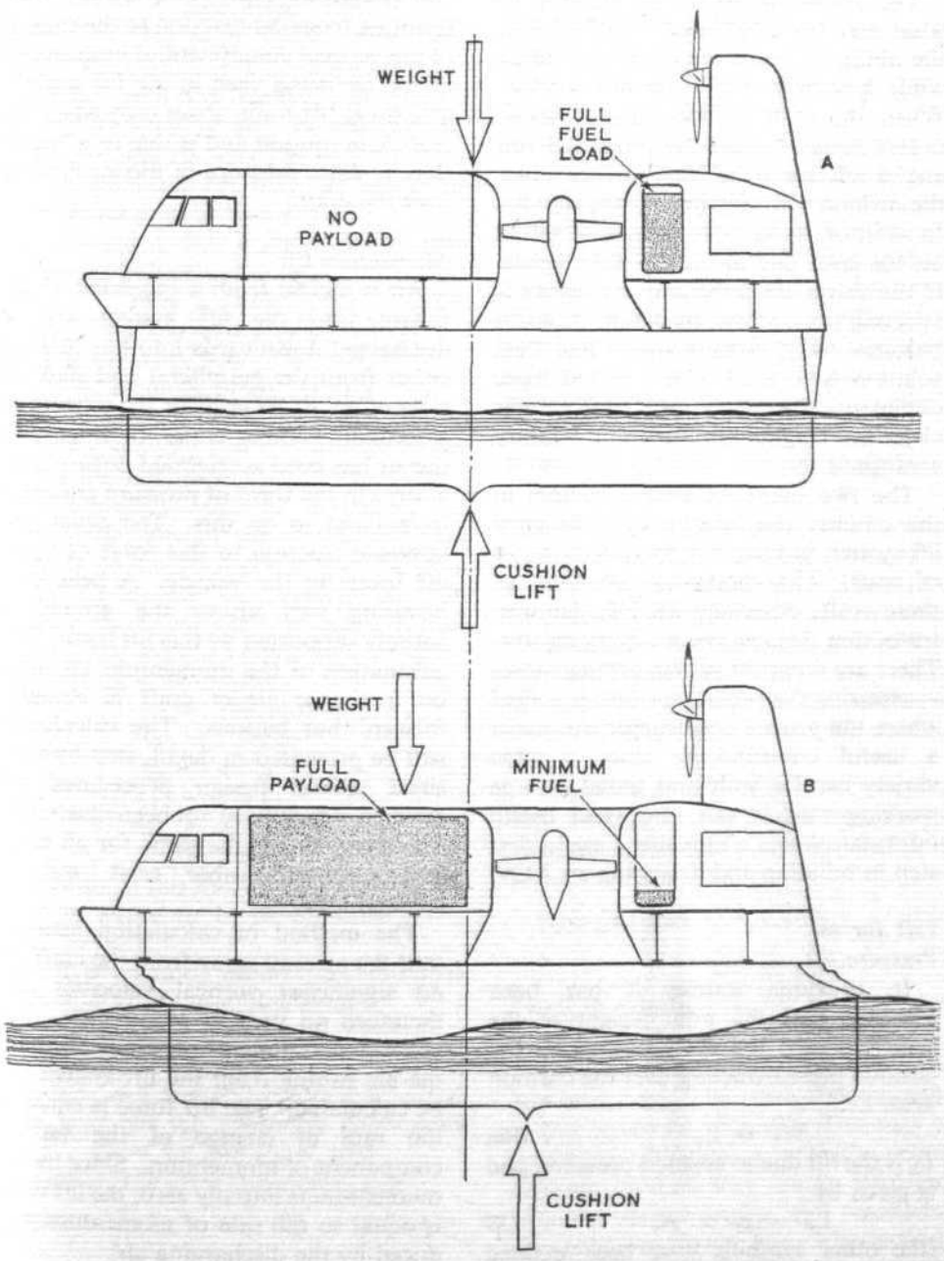
In this, the sixth article of the series, the author discusses lift system roll and pitch stability, considers the main secondary factors affecting the design of the lift system and some results of forward motion of the craft.

Previous articles have been mainly concerned with the lift system of ACVs under static conditions; in practical terms, to achieve the maximum hover gap over a smooth surface for a given craft shape and power-to-weight ratio.

Stability

Provided the lift system has the characteristics described in the last part, the craft will be "heave" stable. (*Heave* is vertical motion of the whole craft; *pitch* is vertical motion of the bow and stern, i.e., rotation around a transverse axis; *roll* is vertical motion of the sides, i.e., rotation around a longitudinal axis.) It has been mentioned before that problems may arise with the pitch-and-roll stability of the lift system. At the present time, unfortunately, there is insufficient information available to enable set design methods to be stated. The stability of ACVs, especially with long flexible members, is an aspect of design crucial to the future of the craft. This is more important than the detail construction of the flexible skirts or trunks. If these flexible members are poorly designed they will wear out quickly and probably have a high drag when passing over obstructions. These are undesirable features but their result is only reduced performance and increased operating costs. However, if the craft is not stable it is not safe and therefore is of no use.

Figure 24: an illustration of a possible combination of weight distribution and cushion shift giving a large nose-down pitching effect



The factors affecting pitch and roll stability are complex and interdependent. A few basic ideas will be considered. It was stated above that there is little difficulty in achieving heave stability. At rest, in the hovering condition, the lift of the cushion system balances the weight of the craft. If an extra weight is placed on the craft it starts to descend but the associated decrease in hover gap together with a correctly designed lift system automatically increases the cushion pressure to support the new load.

Therefore the lift system must be designed automatically to change the air pressures in the cushion in order to resist any disturbing forces or motions. This is achieved by using the design methods described in previous articles. Heave stability is obtained by ensuring there is a change of cushion pressure under the whole of the craft. To resist rolling and pitching the lift system must be able to produce different air pressures in different parts of the cushion. Within a single air cushion this is difficult, since the air can move easily and equalize the pressure. Therefore the single cushion must be modified in some way. It may be divided by some material device such as a flexible skirt; alternatively an air curtain may be used, or a combination of the two.

If a craft were to be supported on three or more separate air cushions, it would be pitch-and-roll stable by virtue of the heave stability of each cushion. This approach results in a very stable craft, but one having a complicated lift system and a high power-to-weight ratio.

In assessing the likely severity of

stability problems the following ratios are useful, h_v/l and h_v/b. Values of h_v/b less than 1/20 should not result in difficult stability problems. At h_v/b values around $\frac{1}{8}$, and h_v/l around $\frac{1}{10}$, adequate inherent stability becomes difficult to achieve. Future work and developments may improve the situation.

Clearly the greater the vehicle body clearance in relation to the length and beam the greater will be the chance of instability. Other important considerations are the manner in which any peripheral skirts deflect, and the range of trim changes resulting from variation of load distribution. This is shown diagrammatically in Figure 24. In addition to dividing the cushion, in order to produce pressure differences the air-supply system must be capable of delivering air at different pressures to different parts of the cushion. This causes complication since, for example, dividing the duct downstream of a single fan will not produce large pressure differentials. In addition, the air flow through the fan would be disturbed and cause a fall in performance. Frequently separate fans are required, and this is often the case with plenum-chamber craft. Craft using the peripheral air jet, however, can achieve useful pressure differentials with a single fan by reason of the characteristics of the jet.

The fan supplies pressurized air to a spacious duct from which the edge jets and stability slots are fed. The pressure is almost uniform in the supply duct, hence the total pressure in the jet, p_j, is almost constant around the craft. If the craft tilts the hover gap will change, so will the ratio h_g/t and the pressure coefficient P. This is shown in Figure 25. Therefore, on the down-going side, the jet can sustain a greater cushion pressure than the other side. The central stability jet sustains the pressure difference between the two sides. The thickness of the slot through which this jet issues is best determined by experiment. If the original design allows for stability slots equal to the thickness of the edge slots, they may, if required, be reduced in thickness by fixing strips inside them. Since it is required to make the craft stable in both pitch and roll, a single slot is rarely sufficient and some typical arrangements are shown in Figure 26. However they are arranged, the stability slots are a nuisance structurally. Plenum-chamber craft cannot achieve the same stability with a single fan.

At small ratios of h_v/b it *is*, however, possible to achieve a stable craft with a single fan—an obvious advantage, as multi-fan craft are more complicated and expensive.

Unfortunately values of h_v/l and h_v/b cannot be given at which more than one fan is necessary. Rigid sidewall craft usually obtain sufficient stability from the planing and buoyant forces on the sidewalls.

The above discussion has referred to what may be called static stability, i.e., the ability to resist asymmetric loading while hovering over a smooth surface. When the craft is operating at speed over a rough surface the pitch and roll angles relative to the local surface under the cushion will be changing very rapidly. In addition, sudden forces may be acting on the craft due to hitting wave crests. If the skirts are deflecting and spray is affecting the air flow, the whole problem becomes very complicated. The best solution is to start with a sound basic design and then experiment with greater clearance heights and different stability arrangements.

The two main ACV constructors in this country use substantially the same lift system in their VA and SR.N series of craft. The successful operation of these craft, especially SR.N5, demonstrates that this *one* system is practicable. There are other lift system arrangements —assessing their relative worth is a field where the private constructor can make a useful contribution, since a wide variety can be built and tested. Large working models can also yield useful information and a model is a useful first step in building and designing an ACV.

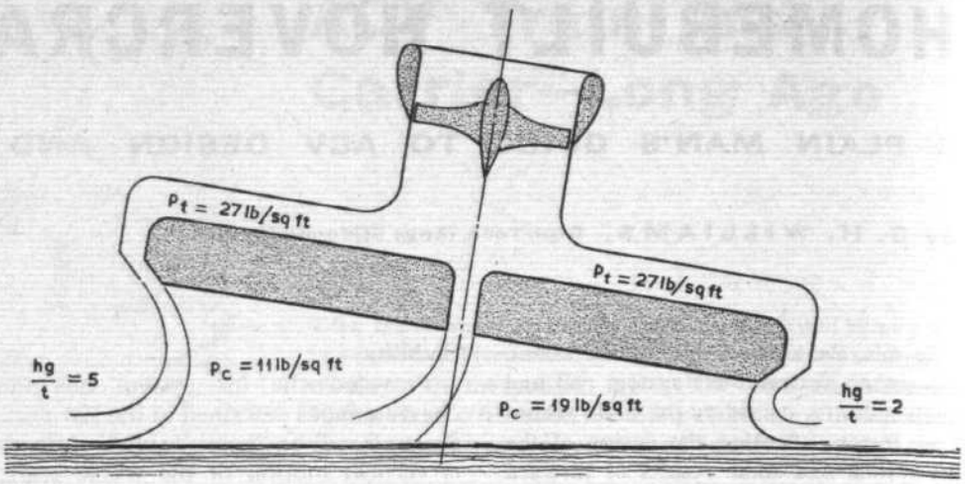


Figure 25: the lift system illustrated can produce differential pressures that resist tilting forces. The drawing is not to scale and the values shown are approximate

Lift forces

Pressure lift

In previous articles it has been assumed that the total weight of the craft equalled the lift provided by the cushion pressure acting over the cushion area, i.e.,

$$W_t = L_p \qquad \ldots 36a$$

L_p is the lift due to cushion pressure, and is given by:

$$L_p = p_c \times A_c \qquad \ldots 37$$

(the other symbols have been defined before). This assumption is close to the truth and is sufficiently accurate for most design purposes.

However, there are two other lift forces that arise from the air flow in and around the craft. One is a lift force resulting from the reaction to the change of the vertical component of momentum of the air being used in the lift system. The other lift force arises only when the craft is in motion and is due to a reduction in static pressure of the air flowing over the craft.

Momentum lift

Air is sucked from a quiescent atmosphere into the lift system and is discharged downwards into the cushion either from the peripheral and stability slots of an air-jet craft or the ducting of a plenum-chamber craft. In both cases the air has been accelerated downwards, a force in the form of pressure gradients is required to do this. The equal and opposite reaction to this force causes a lift force on the vehicle. A helicopter hovering well above the ground is entirely supported by this lift force. The calculation of the momentum lift force on a simple air-jet craft is straightforward but tedious. The calculation will be presented in detail, step-by-step, since several design procedures are covered, which have not been illustrated. The basic idea is the same for all craft, and plenum-chamber craft will be covered later.

The method of calculation assumes that the air well away from the craft has no significant vertical velocities and therefore no vertical momentum. The vertical component of momentum of the air issuing from the lift system can be calculated. The lift force is equal to the rate of change of the vertical component of momentum. Since the air momentum is initially zero, the lift force is equal to the rate of momentum produced by the discharging air.

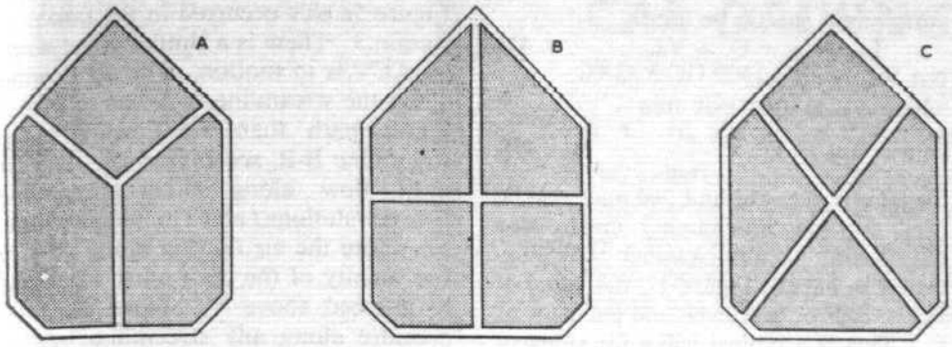


Figure 26: typical slot configurations

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Momentum = mass × velocity.
Force = rate of change of momentum (Newton's second law).
Force (lb) = mass flow per sec (slug/sec) × change of velocity (ft/sec) measured in the *same* direction as the force.

$$L_m = m \times \Delta V_v \quad \ldots 38a$$

Since the initial vertical component is assumed zero the vertical component of the jet velocity may be substituted. However, the stability jets contribute to the momentum lift and the complete expression may be written:

$$L_m = (m_j \times V_{jv}) + (m_c \times V_{cv}) \ldots 38b$$

It should be noted

$$m = \rho \times Q \quad \ldots 39$$

L_m is the momentum lift
m is the mass flow of air
ΔV is a change of air velocity
suffix j refers to the edge jet; suffix c to the stability slot and suffix v to the vertical component.

The method will be illustrated by considering the simple air jet craft first illustrated in Part 3 and Figure 13. For simplicity at that time, stability air was neglected. It will now be included, and C_x will be assumed equal to 1.25. The other data is as follows:

$A_c = 108$ sq ft
$W_t = 1{,}620$lb
$h_g = 4.0$in
$t_j = 1.0$ in
$a_e = a_c = 41.0$ft
$K_c = 0.6$

It is only in this example that the suffix j will be added to the jet thickness t, i.e., $h_g/t = h_g/t_j$

It will be assumed *initially* that equations **36a** and **37** are true, this gives:

$$p_c = \frac{W_t}{A_c} = \frac{1{,}620}{108} = 15\text{lb/sq ft}$$

At $h_g/t_j = 4$ and $C_x = 1.25$ a 45° jet at sea level has the following coefficients

$$P_x = 1.6 \text{ and } F_x = 10.0$$

equation **12a** gives the escape area

$$A_e = \frac{4}{12}\text{(ft)} \times 41.0\text{ (ft)} = \underline{13.7\text{ sq ft}}$$

using equation **10e** with F_x in place of F gives the total volume flow.

$$Q = F_x \times A_e \times \sqrt{p_c}$$
$$= 10.0 \times 13.7 \times \sqrt{15.0}$$
$$= \underline{530\text{ cu ft/sec.}}$$

using equation **11b** with P_x in place of P gives the total pressure in the jet.

$$p_j = P_x \times p_c$$
$$= 1.60 \times 15.0$$
$$= \underline{24\text{lb/sq ft}}$$

equation **7** gives the duct loss

$$p_l = K_c \times p_c$$
$$= 0.6 \times 15.0$$
$$= \underline{9.0\text{lb/sq ft}}$$

The calculations could be continued as before to find the fan area, f.s.h.p., and other quantities. However, it is the momentum lift that is of interest. It will be arbitrarily assumed that one-third of the duct loss occurs in the final bend. Therefore the total pressure in the main supply duct shown in Figure 27a will be:

$$24.0 + \tfrac{1}{3}(9.0) = 27.0\text{lb/sq ft}$$

Since this duct is relatively large the velocities will be low and the dynamic pressure is ignored, hence in the duct:

$$p_s = p_t = \underline{27.0\text{lb/sq ft}}$$

The result of assuming $C_x = 1.25$ is to fix the volume flow through the stability slots at 25 per cent of the volume flow through the edge slots. Therefore, if the total volume flow is 530 cu ft/sec, then four-fifths, or 424 cu ft/sec, flows through the edge slots, and one-fifth or 106 cu ft/sec, passes through the stability slots.

The area of the edge slots may be calculated since their length, equal to the escape perimeter, and their width is known.

$$\text{Edge slot area} = 41.0\text{ (ft)} \times \frac{1}{12}\text{ (ft)}$$
$$= \underline{3.40\text{ sq ft}}$$

From an equation similar to **1b**

$$V_j = 424/3.40 = 125\text{ft/sec.}$$

This is the air velocity along the centre line of the jet. The vertical component of this velocity is required. This may be found by drawing a velocity vector diagram to scale (say 1in to 100ft/sec) with the correct angles, and measuring the result, see Figure 27b. Alternatively the result may be found by trigonometry:

$$V_{jv} = V_j \times \sin\theta \quad \ldots 40$$

in the case of $\theta = 45°$, $\sin\theta = 0.707$, hence:

$$V_{jv} = 0.707 \times 125$$
$$= \underline{88.0\text{ft/sec}}$$

From equation **39**

$$m_j = \rho \times Q_j$$
$$= 0.00238 \times 424$$
$$= \underline{1.01\text{ slug/sec}}$$

The last two answers will be used in equation **38b** after the corresponding values for the stability jets have been found.

The volume flow through the stability slots is known, but the velocity must be calculated. Equation **5** may be applied between stations 1 and 2, Figure 27a.

$$p_{s1} + \tfrac{1}{2}\rho V_1^2 = p_{s_2} + \tfrac{1}{2}\rho V_2^2$$

It has been assumed that V_1 is small and may be neglected, hence:

$$\tfrac{1}{2}\rho V_2^2 = p_{s1} - p_{s2}$$

$$V_2 = \sqrt{\frac{2}{\rho}(p_{s1} - p_{s2})}$$

Compare equations **3c** and **3d** **(N.B. correction, equation 3d should read $V = 29\sqrt{p_d}$)**

$$V_2 = 29\sqrt{(27 - 15)} = 100\text{ft/sec}$$

In practice, losses would reduce this velocity by about 10 per cent. The discharge is in fact vertical; therefore no components need be calculated.

$$V_c = V_{cv} = \underline{90\text{ft/sec}}$$

Incidentally the thickness of the slot may now be found. The area of the stability slot is given by:

$$\text{Area} = 106/90 = 1.18\text{ sq ft.}$$

Continuous slots arranged as in Figure 26b would have a total length of 24ft. Hence the width would be $\frac{1.18}{24}$ feet or 0.60in.

It was found that the volume flow through the stability slots was 106 cu ft/sec. Using equation **39**, m_c may be found.

$$m_c = 0.00238 \times 106 = \underline{0.25\text{ slugs/sec}}$$

All information required by equation **38b** has now been calculated,

$$L_m = (1.01 \times 88) + (0.25 \times 90)$$
$$= 89 + 23 = \underline{112\text{lb}}$$

This is the value of the momentum lift; it is about 7 per cent of the cushion lift. This is a typical value for this type of craft. It can be shown that momentum lift is directly proportional to the cushion pressure. For simplicity only the edge jets will be considered. The first part of equation **38b** will be combined with equations **39** and **40.**

$$L_m = \rho Q_j V_j \sin\theta$$

Now $V_j = Q_j/A_j$ therefore

$$L_m = \frac{\rho \sin\theta}{A_j} \times Q_j^2 \quad \ldots 41a$$

Remembering equation **10e**

$$Q_j = F A_e \sqrt{p_c}$$

this may be squared and substituted in equation **41a**

$$L_m = \left\{\frac{\rho \sin\theta (F A_e)^2}{A_j}\right\} \times p_c \quad \ldots \mathbf{41b}$$

The important point about the above equation is that for a given craft at a given height the complicated expression in the curly brackets is *constant*. Therefore equation **41b** may be rewritten as follows:

$$L_m = K_m \times p_c \quad \ldots \mathbf{41c}$$

$$\text{Or } K_m = \frac{L_m}{p_c} \quad \ldots \mathbf{41d}$$

Where K_m is the momentum lift constant. In the case just illustrated $L_m = 112$lb and $p_c = 15.0$lb/sq ft.
hence $K_m = 7.5$
It is now assumed $W_t = L_p + L_m \ldots \mathbf{36b}$
Equations **37** and **41c** may be substituted to give:

$$W_t = (A_c \times p_c) + (K_m \times p_c)$$

Rewriting $W_t = (A_c + K_m)\, p_c \quad \ldots \mathbf{36c}$

$$\text{Or } p_c = \frac{W_t}{(A_c + K_m)} \quad \ldots \mathbf{36d}$$

In this case

$$p_c = \frac{1620}{108 + 7.5} = 14.0\text{lb/sq ft}$$

If required the main performance calculation is now repeated using the new value of p_c.

The method of calculating L_m for plenum-chamber craft is simpler than the above. The important quantity is **the air velocity at the exit from the ducting**, V_{de}. Plenum chamber ducting usually discharges vertically into the cushion, if it does not, the vertical component should be used.

$$L_m = \rho \times Q \times V_{de} \quad \ldots \mathbf{41e}$$

but $V_{de} = Q/A_{de}$
where A_{de} is duct exit area

$$\text{hence } L_m = Q^2 \times \frac{\rho}{A_{de}} \quad \ldots \mathbf{41f}.$$

Equations **41c**, **41d** and **36d** may also be used for plenum-chamber craft. For the sidewall plenum-chamber craft illustrated in Part 3, Figure 12, the value of L_m is 20lb or just over one per cent of L_p. This is a typical value for sidewall plenum-chamber craft.

This discussion of momentum lift has been included for completeness and because it has also illustrated calculations concerned with stability slots. However the value of L_m as a percentage of W_t is sufficiently small to be ignored in preliminary calculations.

Aerodynamic body lift

This lift is produced when the craft is moving through the air. Air speeds will be measured relative to the craft, i.e., as the air flow would appear to an observer on the moving craft. In Part 4 it was stated that it is normal to use the free-stream conditions. That is, air speeds and pressures measured in the flow undisturbed by the craft. These quantities are given the suffix o.

From Part 2 it will be recalled that if air is accelerated without any increase in total pressure, its static pressure must fall. For example, in the duct shown in Figure 5a this occurred in the throat at station 3. There is a similar effect when an ACV is in motion. The air flowing along the streamline A-A has to take a longer path than air flowing along streamline B-B, see Figure 28. The air must flow along either streamline between stations 1 and 2 in the same time. Therefore the air flowing along A-A in the vicinity of the craft must accelerate to a speed above V_o. Since the total pressure along any streamline is substantially constant and equal to the free-stream value, the static pressure in the vicinity of the craft will be below the free stream, or atmospheric, value. This reduction of static pressure results in a lift force on the craft. To distinguish this lift force from the cushion-pressure lift and momentum lift it will be called **aerodynamic body lift,** L_b. The value of this lift depends on the speed, size, and shape of the craft. To give a result of general use the lift will be expressed in terms of the main variables and a coefficient.

It is known that a force is the result of a pressure acting over an area. A convenient reference area for ACVs is the cushion area, A_c. The pressure may be related to the air speed by an equation similar to **3a**, but using free-stream values. A lift co-efficient, C_L, will take account of different body shapes.

$$L_b = C_L \times A_c \times \tfrac{1}{2}\rho V_o^2 \quad \ldots \mathbf{42}$$

The only unknown is the value of C_L. Manufacturers would use wind tunnel tests to determine the value. Typical values lie in the range: 0.10 for an unstreamlined craft to 0.35 for one with a smooth rounded upper surface.

The air flow around a moving ACV is very complicated. There are inter-effects between the air of the lift system and the air flowing round the craft. Not only is there a reduction of static pressure over the top of the craft, but around the sides as well. Therefore the pressure difference between the cushion and the surrounding air is greater than the equivalent static value. This will tend to decrease the expected lift by some unknown factor. However, it is useful to compute a typical value. Suppose the air jet craft used in the illustration of momentum lift was travelling at 45kt under standard sea-level conditions, and the value of C_L for this craft is 0.20.

$$L_b = 0.20 \times 108 \times \left\{\frac{76}{29}\right\}^2$$

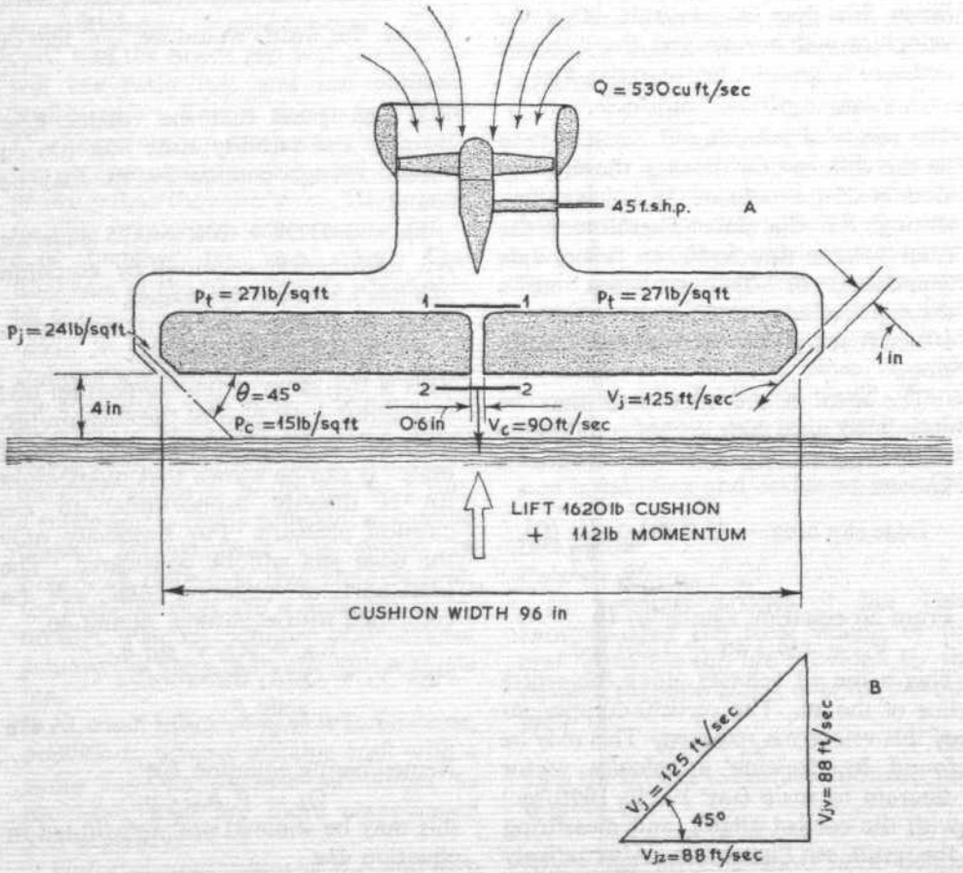
$$= 0.20 \times 108 \times 6.90$$

$$= 1.37 \times 108 = 148\text{lb}$$

It should be noted that in still air, a craft speed measured relative to the ground will have the same value as the free stream velocity. A speed of 45kt is equivalent to 76ft/sec.

The calculation shows the aerodynamic body lift is of the same order as the momentum lift and about nine per cent

Figure 27: "A" shows a transverse section through the air jet craft used as an example for calculating momentum lift. The drawing is not to scale. "B" shows the velocity vector triangle drawn to a scale of 1 inch to 100ft/sec



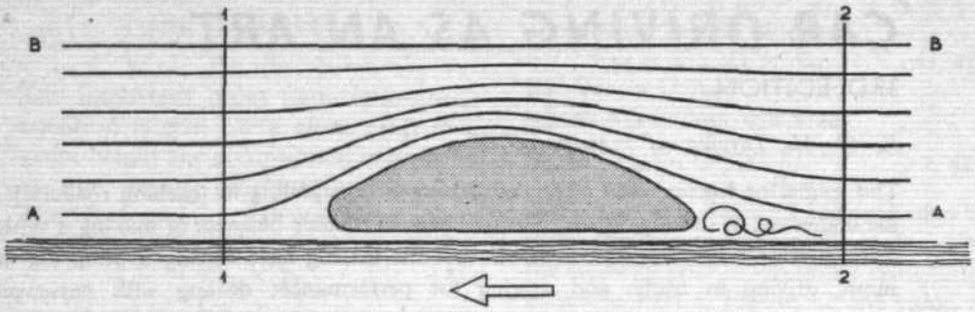


Figure 28: Diagram of streamlines past a vehicle moving over a solid surface

HOMEBUILT HOVERCRAFT . . .

of the cushion pressure lift. This is equivalent to a reduction of cushion pressure of 1.37lb/sq ft, see calculation above.

In addition to the above effects the increase of total pressure upstream of the fan is increasing with forward speed. This was discussed in Part 4. The result is to decrease the required pressure rise across the fan. Reference to Figure 20d will show that the volume flow will increase causing a corresponding increase in hover gap.

All these various effects of forward motion on the lift system occur concurrently although for convenience they have been discussed separately. With the exception of forward motion upsetting the flow in the intake ducting, all the effects of forward motion are beneficial. For private constructors, who do not have to meet a customer's rigid specification, a reasonable approach is to design the craft assuming the total craft weight equals the stationary cushion lift. Increase of lift, or hover gap, due to the various effects is then treated as a bonus. However, when the craft has been built and is being tested it is very useful to be able to calculate the various components of lift. This is especially true with fast craft having large hover gaps.

At speed the cushion pressure of these craft could decrease to 75 per cent of the value measured with the craft just hovering while stationary. If high speed craft, with large hover gaps in relation to their beam and length, are being designed it is useful to calculate the likely flow conditions at maximum performance. A check can then be made to determine if the fan is still operating efficiently.

In order to find the cushion pressure under operating conditions calculate L_b by using equation **42** and an estimated value for C_L. Using some arbitrary value of cushion pressure, e.g., the value given by equations **36a** and **37**, calculate the momentum lift. Using this data and equation **41d** the value of K_m can be found. The above data is used in the following equation to determine the cushion pressure.

$$p_c = \frac{W_t - L_b}{A_c + K_m} \qquad \ldots 36e$$

If there were no extra losses in the intake induced by forward motion, the free-stream dynamic pressure could be deducted from the pressure rise required from the fan. The duct loss calculated using equation 7 and assuming $K_c = 0.60$ is intended to account for the loss in the ducting when the craft is hovering at rest. In the absence of detailed wind-tunnel tests an arbitrary assumption has to be made. It is suggested that a pressure equal to half the free stream dynamic pressure is deducted from the required fan pressure rise. This, in effect, assumes half the dynamic pressure is lost in the intake.

High-speed Craft

In the above discussion the term high-speed craft was used without defining what is considered high speed. In order to define a measure of speed that has general application, the speed of the craft will be related to some feature of the craft. The air flow around a moving craft will affect the flow of the cushion air. The most important variable describing the air cushion is the cushion pressure. By using data and methods previously presented, the air flow velocities in the cushion system, e.g., V_j, can be related to the cushion pressure. The free-stream dynamic pressure is a direct measure of air speed relative to the craft. Therefore a speed coefficient K_v will be defined:

$$K_v = \frac{\frac{1}{2}\rho V_o^2}{p_c} \qquad \ldots 43$$

For values of K_v less than about 0.5 the cushion and the lift system will function in substantially the same manner as when the craft is at rest. A high speed craft would have a speed coefficient greater than 0.5. This value is consistent with the suggestion, in Part 4, that to avoid serious intake troubles V_o/V_d should not exceed 1.0. If K_c and K_f take their usual values for plenum-chamber craft of 0.6 and 1.5, then when $V_o/V_d = 1.0$ the speed co-efficient $K_v = 0.4$. For an ACV with $p_c = 10$lb/sq ft, $K_v = 0.5$ corresponds to a speed of just under 40kt at sea level. Above the speed at which $K_v = 0.5$ there is a progressive change in the air flow and an increasing proportion of the lift is provided by the aerodynamic body lift. The air under the bow of the craft is virtually brought to rest before it flows around the side. This causes an increase of pressure under the bow and around the front of the cushion, and this tends to lift the bow.

Aerodynamic body lift is usually concentrated near the front of the craft; this also tends to lift the bow. A slight bow-up trim often improves the ride at normal speeds. If it becomes too great, at very high speeds with K_v approaching 1.0, the craft can take off and perform a backward somersault. This is not unknown in hydroplane racing.

The next article will cover the various drag forces that resist forward motion of the craft. After this, the means of propulsion to overcome these drag forces will be considered.

LIST OF NEW SYMBOLS

	Quantity	Units
A_{de}	Exit duct area of a plenum-chamber craft	sq ft
C_L	Lift co-efficient	—
K_m	Momentum lift constant	sq ft
K_v	Speed co-efficient	—
L_b	Aerodynamic body lift	lb
L_m	Momentum lift	lb
L_p	Lift due to cushion pressure	lb
m	Rate of air mass flow	slug/sec
V_c	Air velocity along the centre line of the stability jet	ft/sec
V_j	Air velocity along the centre line of the edge jet	ft/sec
V_{de}	Velocity of air leaving the exit duct of a plenum-chamber craft	ft/sec
ΔV	Change of velocity	ft/sec

NEW SUFFICES

c	Stability jet or slot
j	Edge jet or slot
v	Vertical component or direction
z	Horizontal component or direction

NEXT MONTH'S ISSUE . . .

. . . will contain an article on the work of Hovercraft Development Ltd; a detailed "Air-Cushion Vehicles" cutaway drawing of HDL's HD.1 research machine; a major contribution on the development of flexible skirts; more historical researches, to show that ACV concepts have been bruited around for longer than commonly supposed; and other features.

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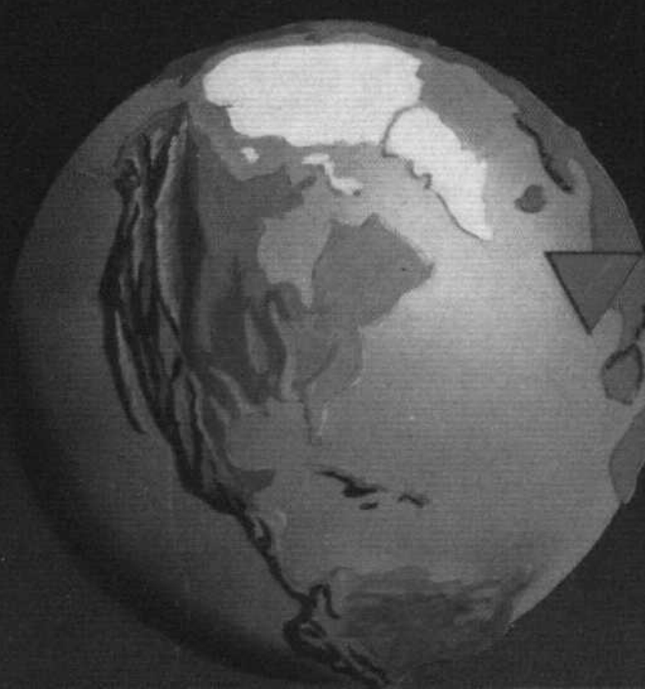

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BRITTEN-NORMAN BN-2 ISLANDER

Brilliant Private-venture Newcomer for Worldwide Feeder Routes

"FLIGHT" PHOTOGRAPHS AND DRAWINGS

TWO years ago Britten-Norman Ltd finally decided to do something about the acute worldwide demand for a commercially economical twin-engined transport aircraft of rock-bottom capital cost. Guided and encouraged by the experience and needs of B-N associate companies active in most continents (as outlined on page 1025), John Britten and Desmond Norman boldly formulated the brilliantly simple BN-2 specification. Their small team at Bembridge, Isle of Wight, began detail design in November 1963; work progressed steadily without time-wasting publicity, and the prototype flew on Sunday, June 12. *Flight* was there, and was able to publish the first photographs of the actual aircraft in last Thursday's (June 18) issue; and next day the BN-2 made its public debut at the Paris Show.

To convey an idea of size the ten-seat BN-2 may broadly be summarized as a Dragon Rapide replacement; but, in addition to complying with modern airworthiness requirements, the BN-2 promises even greater usefulness than the ubiquitous 30-year-old de Havilland type.

For 25 years aircraft manufacturers have been almost totally preoccupied with the quest for more speed, greater range and higher payloads, and the really small commercial aircraft has been sadly neglected in the process. Private and business aircraft too have been evolved with an eye to performance which has rendered them of limited appeal for commercial use.

Recently, however, more attention has been focused on the light feederliner market, but until now no manufacturer has really challenged the most important single aspect of the problem—initial cost. Significantly, both de Havilland Canada and Shorts have confessed that their £100,000-class 15-seat twin turboprop designs are the smallest economical transport they can build; the new 12-seat Dornier Skyservant is in the £50,000 class. The remarkable and so far unique BN-2 seats up to nine passengers and is expected to sell for a mere £17,750 in basic form.

A total of 15 BN-2s have already been earmarked for service with Britten-Norman associated operating companies. So far the project is entirely privately financed, and plans are in hand for a production rate of at least 30 aircraft a year. The programme is firm and will move ahead anyway, but Mr Desmond Norman said last week—in answer to questions at a press conference—that Government financial participation is being invited in order to ensure for the company an early foothold in the market. The Transport Aircraft Requirements Committee has been reviewing the project for several months and a recommendation to the MoA is expected shortly.

No visitor to the Bembridge factory can fail to be impressed by the good sense of the BN-2 specification or by the refreshingly practical, dynamic and well balanced nature of the team behind it. In these days it is a rare and exciting event that for a comparatively small investment a new British aircraft with a big worldwide sales potential can be launched. The good-looking BN-2 is at present without peer and it is to be hoped that the enterprising company at Bembridge will get all the support needed to press home the advantage.

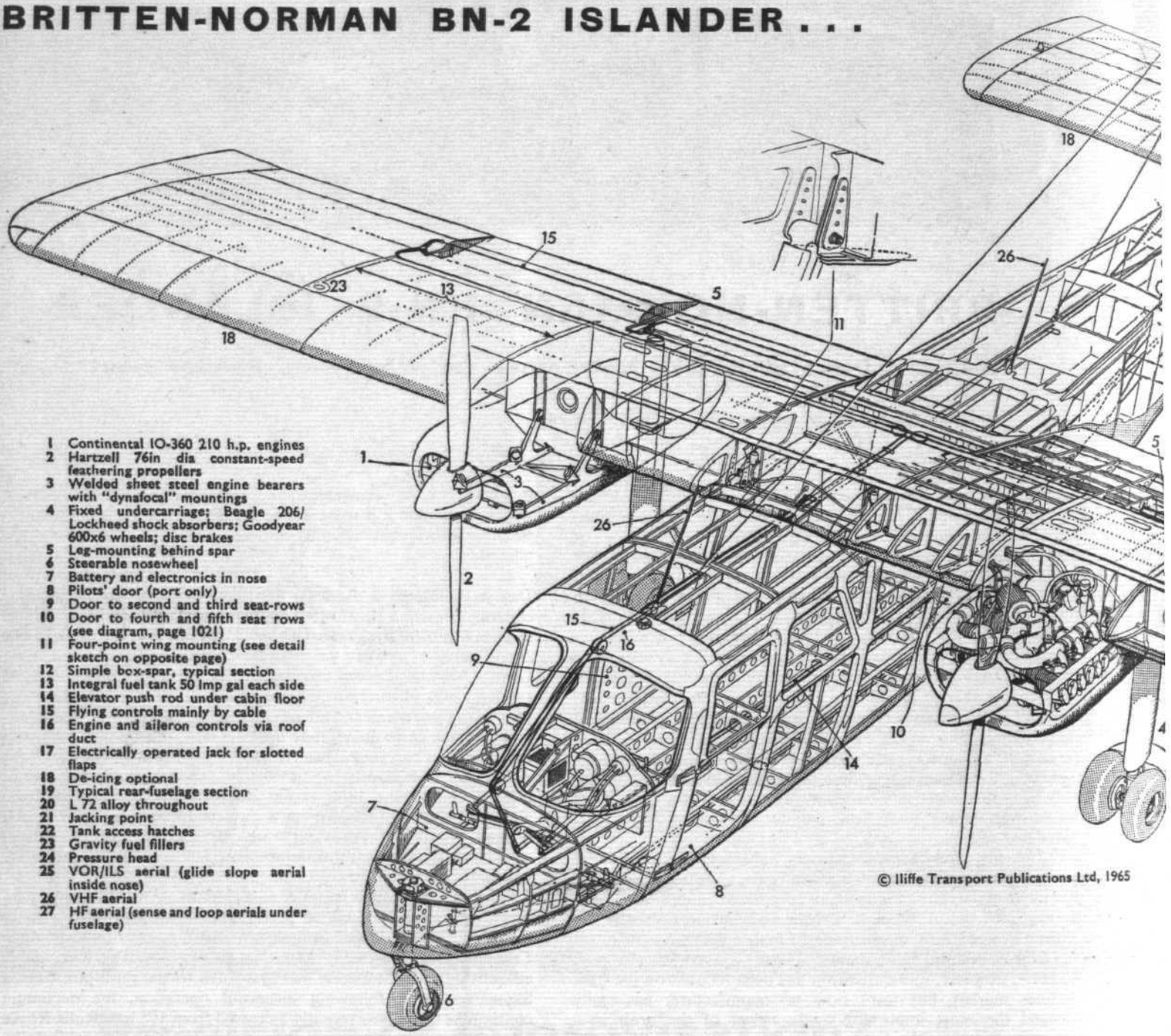
Design Philosophy At least 450 light twins of under nine-seat capacity (Anson, Beech 18 and Rapide class) are in scheduled service with world airlines. These operators also fly at least 300 single-engined aircraft of Beaver, Otter and Norseman type. Over 1,500 charter, air taxi and aerial work operators also use similar kinds of aircraft. There are thus nearly 2,000 operators, plus many government and military organizations who can use—and in many cases desperately need—a really cheap new twin with the accent on carrying capacity. Below the eight-seat Dove/Queen Air/Grand Commander price level of £60,000, choice of aircraft is very limited and little except small, highly powered business aircraft are offered. Based on a modest 10 per cent growth and normal equipment-retirement rate, Britten-Norman estimate a world *annual* demand for more than 500 aircraft of the BN-2 variety.

With the minimum capital cost requirement consistent with the biggest possible payload accommodation uppermost in mind the BN-2 was designed around two 210 h.p. continuously rated Continental IO-360 fuel-injection flat-six engines. This new, highly efficient lightweight engine was first fitted to the push-pull Cessna Skymaster; and, following successful operation, the maximum continuous rating was recently increased from 195 h.p. Rolls-Royce are, of course, handling the engine in Britain (it is also, incidentally, specified for the Beagle 242 four-seat twin and the new Victa Aircruiser). A decision has yet to be taken to build the IO-360 at Crewe, but it must be regarded as the next most likely choice.

By modern standards it may be considered that around 200 h.p. per engine is just about the minimum power for any kind of practical multi-seat twin-engined aircraft. The secret of the BN-2's not unsprightly estimated airfield and climb performance is a reversal of modern trends and a return to the moderate values of the Rapide era in such performance-setting parameters as power loading, wing loading, and span loading. The result is high lift at low speed without the help of costly and complicated devices. In spite of the big wing, climbing and cruising performance is not expected to be much inferior to that of similarly powered but less compromised aircraft. For instance, the BN-2 will comfortably out-perform the Rapide by virtue of the lower drag shape, smaller frontal area, and use of variable-pitch propellers, despite having lower power and wing loadings.

Minimum frontal area and fuselage cross-section are the other BN-2 key features in achieving the cost and performance targets. Overall width of the fuselage is only 47in and the maximum depth some 62in; nevertheless, internal width is enough for two people

BRITTEN-NORMAN BN-2 ISLANDER . . .



1 Continental IO-360 210 h.p. engines
2 Hartzell 76in dia constant-speed feathering propellers
3 Welded sheet steel engine bearers with "dynafocal" mountings
4 Fixed undercarriage: Beagle 206/ Lockheed shock absorbers; Goodyear 600x6 wheels; disc brakes
5 Leg-mounting behind spar
6 Steerable nosewheel
7 Battery and electronics in nose
8 Pilots' door (port only)
9 Door to second and third seat-rows
10 Door to fourth and fifth seat rows (see diagram, page 1021)
11 Four-point wing mounting (see detail sketch on opposite page)
12 Simple box-spar, typical section
13 Integral fuel tank 50 Imp gal each side
14 Elevator push rod under cabin floor
15 Flying controls mainly by cable
16 Engine and aileron controls via roof duct
17 Electrically operated jack for slotted flaps
18 De-icing optional
19 Typical rear-fuselage section
20 L 72 alloy throughout
21 Jacking point
22 Tank access hatches
23 Gravity fuel fillers
24 Pressure head
25 VOR/ILS aerial (glide slope aerial inside nose)
26 VHF aerial
27 HF aerial (sense and loop aerials under fuselage)

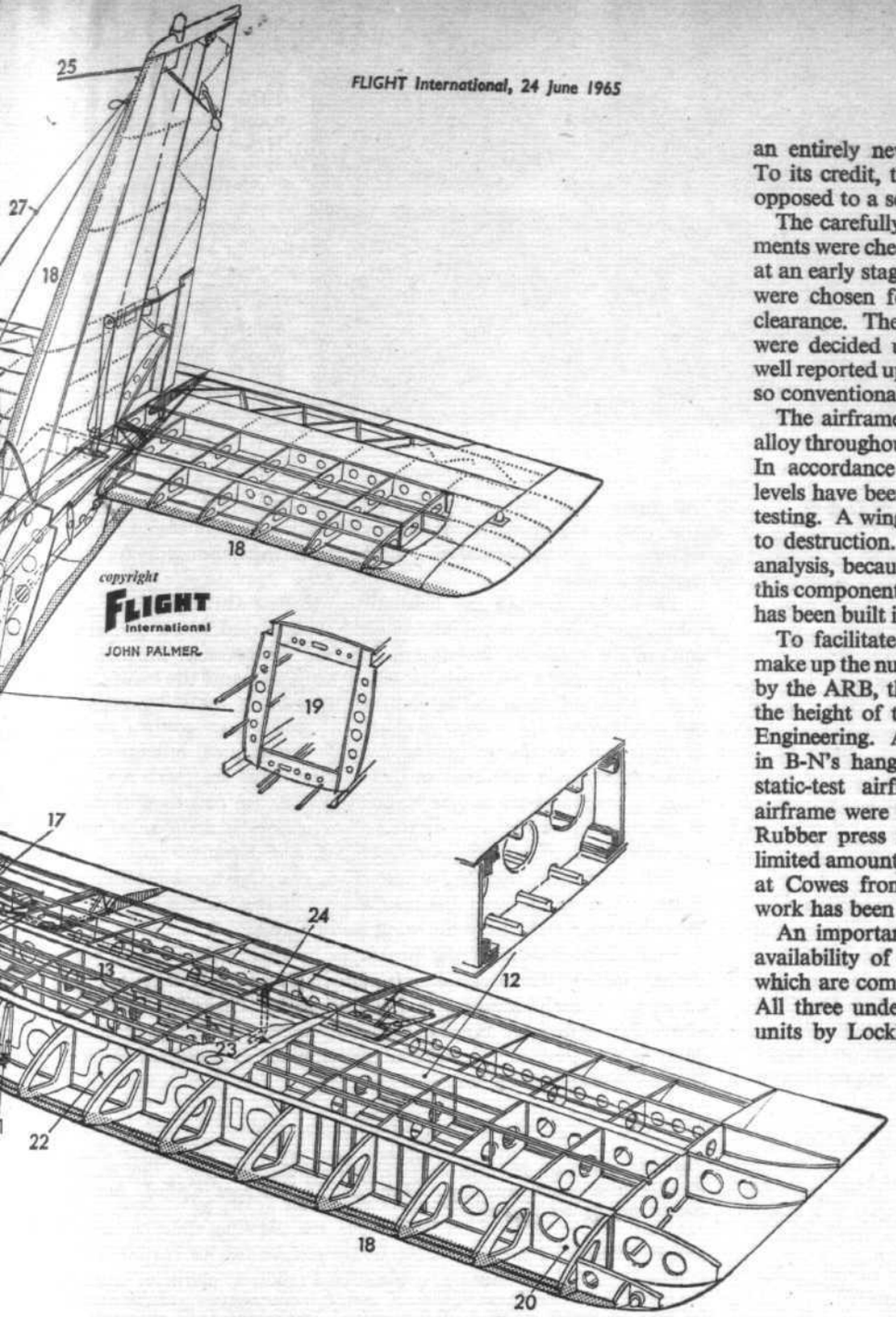
sitting side by side on a bench seat, and 55 US gal oil drums can be carried lengthways across the cabin. Britten-Norman philosophize—why pay handsomely for an unnecessary aisle? Three carefully sized and situated doors ensure absolute ease of access for anything, no matter how long or almost how wide, that the cabin itself could take. Optimum structural and cabin-access considerations dictated a cantilever high-wing arrangement.

Potential BN-2 commercial performance is well illustrated by comparison with the Piper Aztec C—one of the most popular aircraft of its type with commercial operators. Though the Aztec is more powerful (two 250 h.p. engines) it is similar in price to the BN-2; somewhat higher hourly operating costs might be expected because of the extra maintenance of the bigger engine and the retractable undercarriage, and the higher landing fees. BN-2 block times would be some 15 per cent longer but, on the all-important stage lengths of below 400 miles, the BN-2 would be able to carry progressively more than the five-passenger maximum of the Aztec, and so break-even with much lower revenue rates.

First versions of any new commercial aircraft are rarely outstandingly efficient; developed versions are invariably better. Even without a yardstick the BN-2 looks particularly good right from the start. Even so, the development possibilities are enormous. With IO-360 engines and operating at the initial permitted gross weight of 4,750lb the BN-2 will probably never be volume limited. In fact, even with a basic aircraft and dry tanks the gross weight is exceeded with ten average-weight adults aboard. Remarkably, such generous volumetric capacity does not seem to have been achieved with an empty-weight penalty.

Experience with the BN-2 airframe in static test and in service, together with increases in available engine power, will doubtless lead to higher permitted gross weights and useful loads. When the present surplus cabin volume is used up a small increase in fuselage width, for instance, would permit three-abreast bench seating for up to 14 passengers.

Design in Practice So much for philosophy; how have Britten-Norman translated ideas into practice? Simplicity has been the keynote throughout design; Mr John Britten, technical director, and his team realized from the start that the most effective design solutions were not always the most obvious. Big-aircraft practice has become altogether too automatic among British engineers, and it had to be consciously remembered that light aircraft represent



By combining well known aerodynamic and structural design principles with the latest engines and equipment developed for light aircraft, Britten-Norman have created a commercial aircraft of potentially outstanding utility. The light alloy structure is riveted together throughout and there is an absence of bonded metal joints and glass fibre components. The single-piece wing is attached to the fuselage at four points for transferring lift loads, and above and below for transmitting drag forces (below). The prototype is superbly built

an entirely new dimension and require first-principles thinking. To its credit, the BN-2 is very much a scaled-up light aircraft as opposed to a scaled-down airliner.

The carefully proportioned accommodation and access arrangements were checked for practicality by means of a wooden mock-up at an early stage of design. A high wing and tricycle undercarriage were chosen for easy loading, and for ample propeller ground clearance. The NASA 23012 wing section and single slotted flap were decided upon because their characteristics are particularly well reported upon; and the overall shape of the aircraft was deemed so conventional as not to require special wind tunnel investigation.

The airframe structure is also of conventional design. Of light alloy throughout, the semi-monococque structure is riveted together. In accordance with BCAR section K recommendations, stress levels have been kept low enough to eliminate the need for fatigue testing. A wing and a fuselage are, however, to be statically tested to destruction. The fuselage in particular required careful stress analysis, because of the extensive cut-outs. Static loading trials of this component are about to begin; meanwhile, some extra strength has been built into the first flying prototype.

To facilitate the flow of drawings to the workshops, and to make up the number of qualified engineers for design-team approval by the ARB, the small Bembridge team was supplemented during the height of the design effort by a few engineers from F. G. Miles Engineering. Assembly of the prototype was undertaken wholly in B-N's hangar at Bembridge Airport; and in addition to the static-test airframe assemblies, many components for a third airframe were finished by the time the prototype was rolled out. Rubber press forming of light-alloy sheet components, and the limited amount of heavy machining required, was done by Westland at Cowes from tools made at Bembridge; otherwise very little work has been subcontracted.

An important contribution to cost control has been the ready availability of the powerplants and associated accessories, all of which are common to the BN-2 and the Cessna Super Skymaster. All three undercarriage shock absorbers are Beagle 206 nose-leg units by Lockheed and the three identical tyres and wheels are

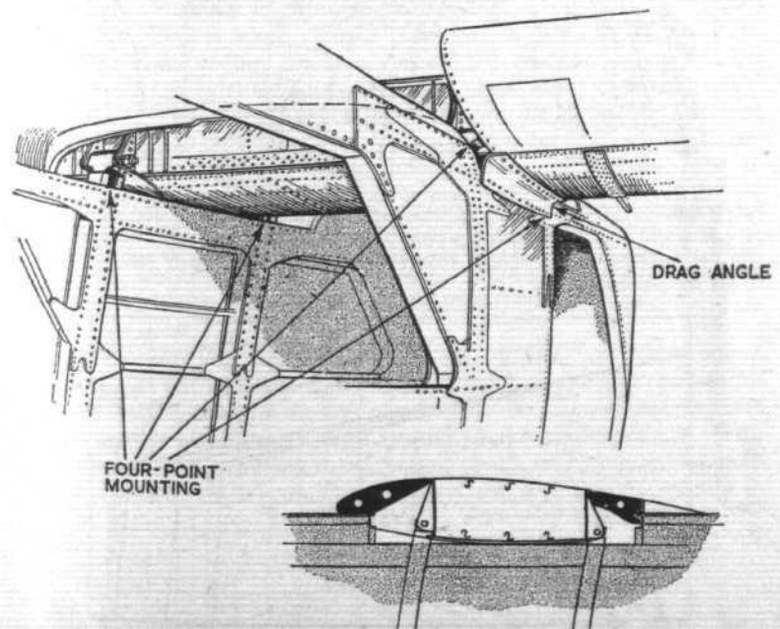
BRITTEN-NORMAN BN-2 ISLANDER

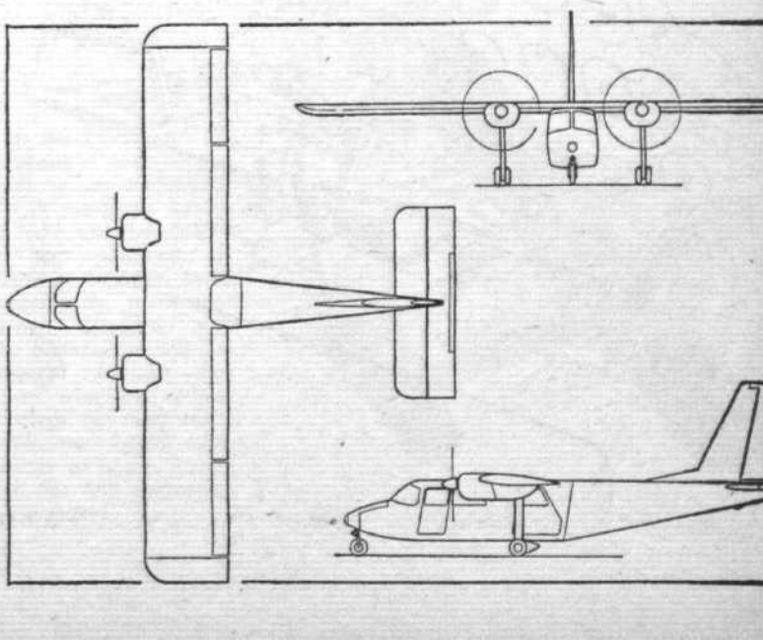
Powerplant Two Continental IO-360-Bs driving Hartzell 76in dia constant speed feathering propellers. Fuel capacity, 100 Imp gal.

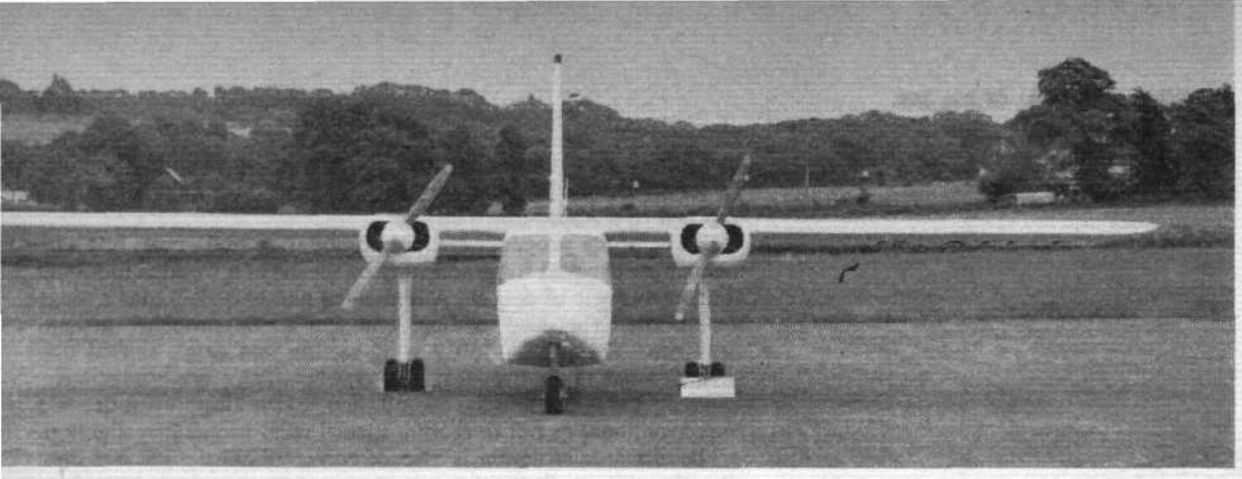
Dimensions Span, 45ft; length, 35.3ft; height (nosewheel depressed), 13.7ft; wing area, 298 sq ft.

Accommodation Front bench seat only standard; up to four additional bench seats optioned for maximum total of nine passengers. Interior and access arrangements, see page 1021.

Performance See graphs on page 1020.







The clean shape and minimum frontal area of the Islander compensate for the big wing and long cabin to achieve good cruising efficiency

BRITTEN-NORMAN BN-2 ISLANDER . . .

common to the BN-2 and the Piper Aztec. These low-cost, lightweight, proven items, together with compact electronic and other light-aircraft equipment, are important to BN-2 feasibility. Spares for practically every piece of BN-2 equipment should already be stocked around the world by agents for American light aircraft.

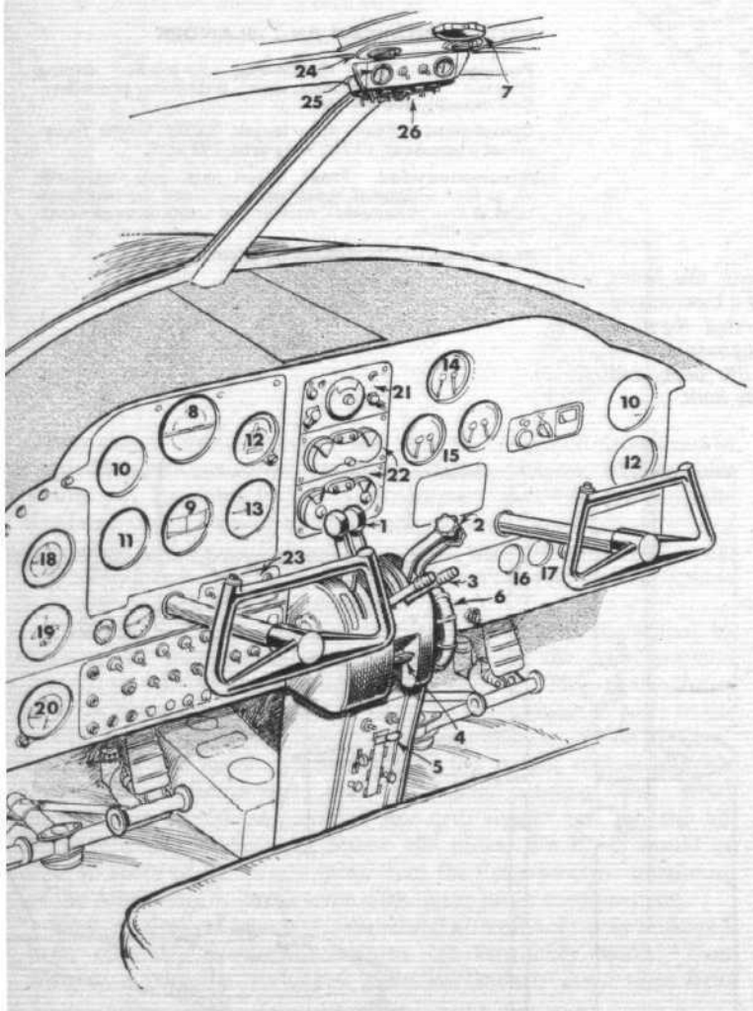
The possibility of licence production of the BN-2 in simply equipped workshops staffed by semi-skilled labour was considered right from the start of design. In fact, Britten-Norman are considering a number of proposals along these lines; plans vary from supplying just drawings and loft plates, through sets of tools and jigging to what the motor industry calls CKD (completely knocked down) kits. The company consider that such a policy will interest many less industrial nations and help to get the aircraft where it is wanted at an uninflated price.

The single-piece cantilever wing has a multi-bolt connection with the fuselage yet may readily be removed. Four main pins carry the lift loads, and drag and plan bracing is effected by multi-bolt flanges connecting the lower wing skin and the fuselage sides and by a stressed fairing which joins the centre-section top skin and the fuselage top panel. On the prototype and static test specimens the wing mainspar and rear spar are built up from U-section channel with nesting angle in the corners. Outboard of each engine part of the torsion box forms a single 50gal integral fuel tank (gravity filled only). The up-flared wing-tips developed by B-N are formed in sheet metal on the prototype, as are all fairings, though glass fibre may be used later.

All flying controls are manually operated through rods and cables from dual control wheels (only the second wheel and slide column are optional; the basic mechanism incorporates the pick-up for dual). From a yoke behind the instrument panel the cables and rods are routed under the cabin floor; the aileron cables then run in the slot shroud aft of the rear spar. Trimming of control forces in flight may be effected on the elevator (mechanical linkage to an adjustable geared tab) and on the rudder. The one-piece-per-side single slotted flaps are moved by an electric motor mounted inboard in the port flap shroud; positive interconnection is maintained, and not more than 3° of deflection discrepancy is expected.

Linkages for the throttle, propeller, mixture, and cowling shutter controls run up through the centre post of the windscreen, along the cabin roof and inside the wing leading edge.

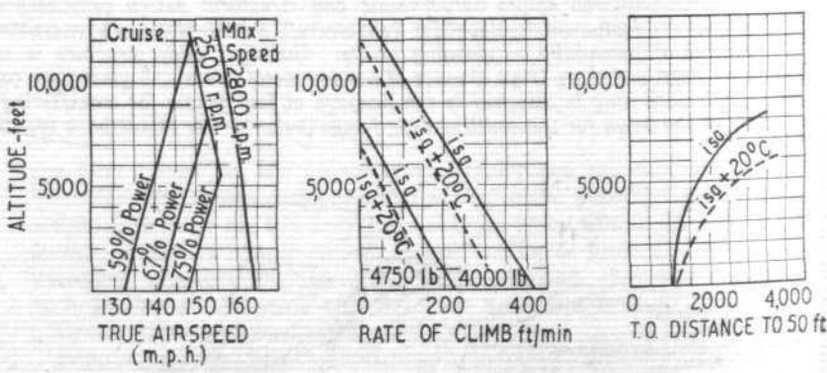
Flight-deck layout of the prototype is exceptionally neat and should satisfy the professional pilot without embarrassing the amateur. Clearly marked fuel selectors are centrally mounted above the windscreen, as are the switches for the battery, generators, ignition and starters. Instrument panel space is adequate for full IFR navigation equipment.



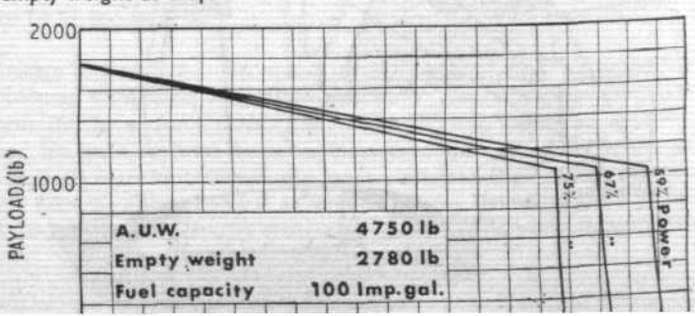
The Islander will be cleared for single-pilot operation; the second flying control wheel is optional. The pilots' bench seat is fixed, but the rudder pedals are adjustable

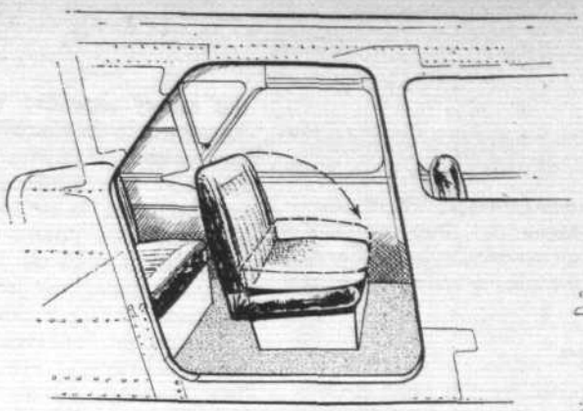
Layout of the BN-2 panel

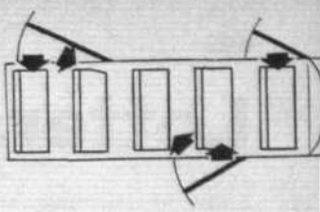
1, throttles; 2, mixture levers; 3, propeller pitch levers; 4, electrically operated flap switch; 5, parking brakes; 6, elevator trim; 7, rudder trim (in roof); 8, artificial horizon; 9, direction indicator; 10, airspeed; 11, vertical speed; 12, altimeter; 13, turn and bank; 14, twinned tachometers; 15, twinned manifold and fuel pressure gauges; 16, ammeter; 17, suction gauge; 18, ILS; 19, ADF; 20, VOR; 21, ADF controller; 22, VHF nav/com controllers; 23, audio mixer unit; 24, fuel tank selectors; 25, fuel pump gauges and switches; 26, ignition group



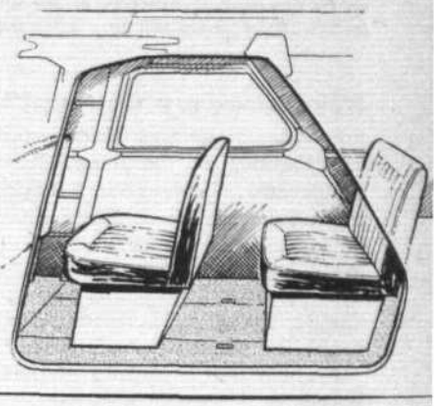
Performance: (above) estimated true air speed v altitude, single-engine rate of climb v altitude, gross weight take-off distance to 50ft; (below) still air payload-range without reserves and with a basically equipped empty weight aircraft

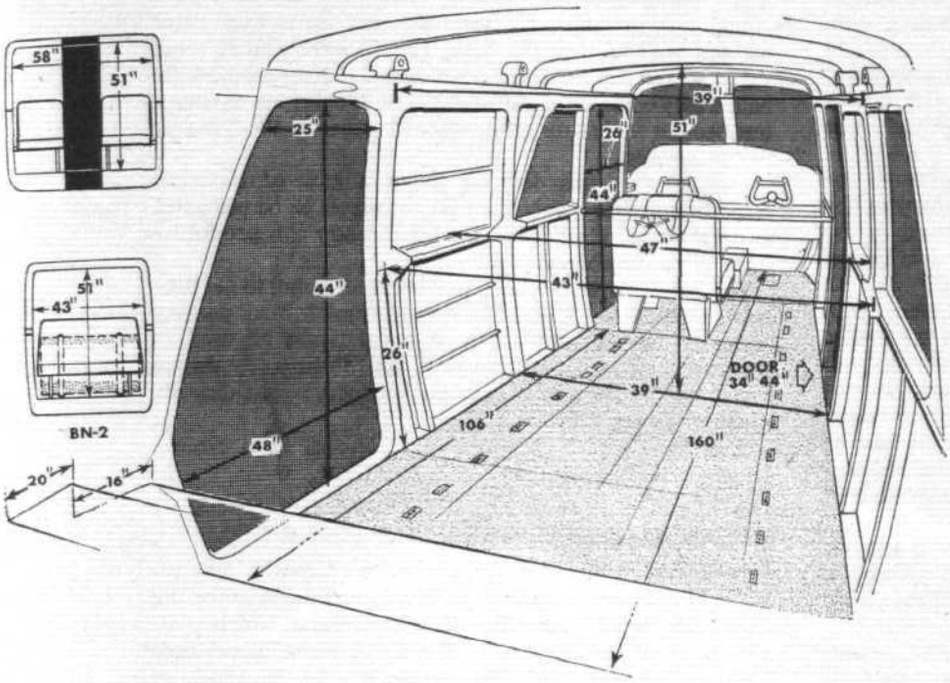






The bold decision to dispense with an aisle in the cabin has the advantage of reducing fuselage frontal area and structure weight while still leaving ample cabin width for passengers and quite big items of freight. Three carefully sited doors give direct access to all parts of the cabin. Slots in the floor permit various arrangements of the bench seats; two stretchers and attendants may be carried. The section below shows how fat the fuselage would have been with an aisle





Mr John Britten (left) and Mr Desmond Norman formulated the Islander specification

Each main undercarriage oleo-pneumatic shock absorber (interchangeable with the nose leg unit) has two 600 × 6 wheels, each with a disc brake unit and fully interchangeable with the nosewheel. The BN-2 should have no difficulty in staying on top of the average soft-surface airfield. Non-clogging wheel fairings are designed to reduce the aerodynamic drag of the fixed undercarriage; all-enveloping retractable clamshell fairings may be evaluated as a means of reducing drag further.

The prototype BN-2 is actually fitted with two of the earlier IO-360-A engines which are only flat-rated to 195 h.p. Production aircraft will have the 210 h.p. continuously rated -B version. These very efficient engines have established a good reputation for reliability since their introduction in the Cessna Skymaster two years ago. Approved time between overhauls is already 1,000hr.

Engine accessibility is excellent, and the two-piece metal cowlings may be quickly detached. The Hartzell constant-speed feathering propellers (and the spinners) are interchangeable with those on the Skymaster front engine. Woodward unfeathering pneumatic accumulators are fitted as standard.

The BN-2 is being offered, according to Britten-Norman, "the way operators like it—as a basic VFR aircraft." For £17,750 ex-works it is fitted with a limited panel of instruments, night lighting, and a single bench seat, but with the cabin fully trimmed and ready to take any choice from a wide range of interior arrangements. Alternative to the maximum ten-seat interior (five forward facing bench seats) are various spacious arrangements for private and executive use in addition to flying-doctor and freighter roles.

Apart from various com/nav radio installations, full blind flying instruments and dual control wheels, optional equipment includes every conceivable need from headrests to cargo tie-downs.

Developing and Marketing In the absence of Government financial participation BN-2 test flying will be aimed at airworthiness certification by the end of next year. Production delivery rate thereafter would build up to around 30 aircraft per annum. With more capital available development could, of course, move very much faster: a Group C transport C of A within 12 months is

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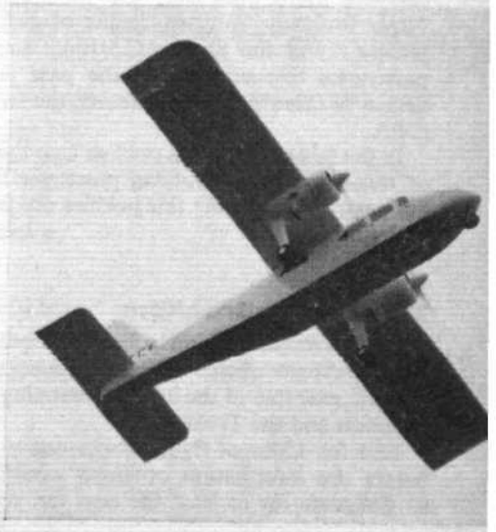


The BN-2 concept unashamedly owes something to the example of the de Havilland Rapide of 1934; but the Islander in fact promises, as might be expected, to be considerably more efficient. Compared with the biplane the similar-powered Islander has lower wing and power loadings, two more seats, 450lb more useful load, cruises 25 m.p.h. faster, and has ARB engine-out performance

Letters

Letters for these columns are welcomed, though "Flight International" does not necessarily endorse the views expressed. Name and address should be given, not necessarily for publication in full. Brief letters will have a better chance of early publication.

Revolutionary Concept?

SIR,—This letter has been inspired by the very erudite contributions to the recent Royal Aeronautical Society symposium on low-cost air transport. Some of the solutions suggested to the problem—outstanding among them, perhaps, the flying-wing concept—were revolutionary and intriguing and most attractive technically. One must agree with the underlying philosophy of the meeting, that (a) the cheaper flying is, the more people will fly; (b) the more people fly, the cheaper will it be to fly.

I would like to suggest as particularly apposite to the European Airbus an idea (equally as revolutionary as the flying wing) which can perhaps best be expressed in the modern idiom as a "systems philosophy." The two underlying assumptions will bear stating in full: (1) the air traveller, who is perhaps typified by the businessmen, has a navigational ability at least equal to that of the train traveller or car driver. (2) This ability is sufficient for him to navigate himself to a given point—for example, the entrance door of an aircraft—at a given time, provided that (a) the "given time" is published and posted on notice boards at least as legibly as at railway stations; and (b) that the "signposting" to the aircraft door is at least as good as the signposting of train departures at railway stations.

These are not, Heaven help us, high standards to set; but think of the benefits they bring: (1) "Reporting time" is now "door closing time," just as on a train. (2) The salaries of thousands of "shepherds" can be saved.

While the careers open to young ladies of graceful contour but limited intelligence may unhappily be reduced, the fares should certainly come down. And think how many more people might be tempted to fly if they could just arrive and "step aboard an aeroplane." Good heavens, air transport might even be said to have come of age.

Did I hear a whisper "Air shuttles to you"?

With your agreement, I would like to sign myself

Loughborough, Leics AIR TRAVELLER

Eggs in One Basket

SIR,—I feel I must register my unrest at the growing tendency to make civil transport aircraft of ever-increasing seating capacity. Tables regularly appearing in your magazine show that, although the safety record of world airlines is steadily improving, air transport is still not as safe as rail or marine transport. It is an acknowledged fact one is safer in a train than in one's own home. Surely only when air transport can reach this level of safety should we consider carrying more than say, 150 passengers in one aircraft. *Flight* for May 27 gives details of two such aircraft, the DC-8-61 and the Short SC.5/10A, carrying 200 and 284 passengers respectively. In the past you have published details of other projected aircraft, the stretched 707 and the C-5A.

In the tables which you publish I see that a high proportion of those accidents involving passenger fatalities involve *all* the passengers. Surely this justifies my point?

Bristol ANDREW R. G. DOW

The Plane-Breakers

SIR,—The recent decision to discontinue the flying programme of the three completed TSR.2s, on economic grounds, is yet another example of the lunatic reasoning of the Ministry of Aviation and the Treasury.

£3m for 150hr of flying works out at £20,000 per hour. Surely the information obtained would have been useful to designers for at least the next ten years—in which case the money expended would be a relatively inexpensive investment in the aircraft industry's future. As an interesting comparison, *Those Magnificent Men in their Flying Machines* also cost approximately £3m—for a mere three hours of entertainment. Is Mr Jenkins so little interested in the future of our aircraft industry that he refuses to sanction serious aeronautical research at £20,000 per hour while a film company apparently finds it profitable to invest £1m for each hour of film produced?

Not content with this, the Minister and his plane-breakers have also decided literally to scrap the three completed TSR.2s—again on economic grounds! I would suggest that this decision shows an almost criminal lack of imagination. Assuming that a TSR.2 contains 40 tons of salvagable aluminium, titanium and steel, and that the average value per ton is £500, then the three TSR.2s have a mere scrap value of £60,000. On the other hand, if they were mothballed they could be modified at a later date for use as engine test-beds as well as for other research—thus in effect paying for themselves.

Furthermore, this decision shows a lack of historical responsibility, for surely the TSR.2 deserves to be preserved as an example of what the aircraft industry can produce—when given the chance.

Are Mr Jenkins and his plane-breakers going to get their way and crush the TSR.2 like so much junk? If so, perhaps some of the resultant cubes of metal could be used to decorate the corridors of power in the Ministry of Aviation and in the Treasury to remind the occupants what they are capable of when they really try.

Exeter BERNARD CARR

Polish Airmen's Week, June 21-27

From Air Chief Marshal Sir Hugh Pughe Lloyde, GBE, KCB, MC, DFC

SIR,—May I appeal through your columns for help for the Polish Air Force Association Benevolent Fund, which exists for the same purpose as the Royal Air Force Benevolent Fund? This year is the 25th anniversary of the Battle of Britain, during which (and throughout the war) the Polish Air Force fought side by side with us and gained great fame and our admiration. They also fought in every Command in the Royal Air Force. When victory came, over 2,000 Polish airmen had lost their lives; and those who survived stayed here, for there was no place for them in Poland.

This Polish Air Force Association Benevolent Fund is a charity which deserves help, and I am sure your readers' opinion of the Poles is like mine when we were up against it and when every eighth pilot who fought in the Battle of Britain was a Pole. Although the Poles finished the war with us they were fighting long before we started.

Any donation sent to the address below will be most gratefully received and acknowledged by me.

14 Collingham Gardens, London SW5 HUGH LLOYD, *Chairman of Appeal*

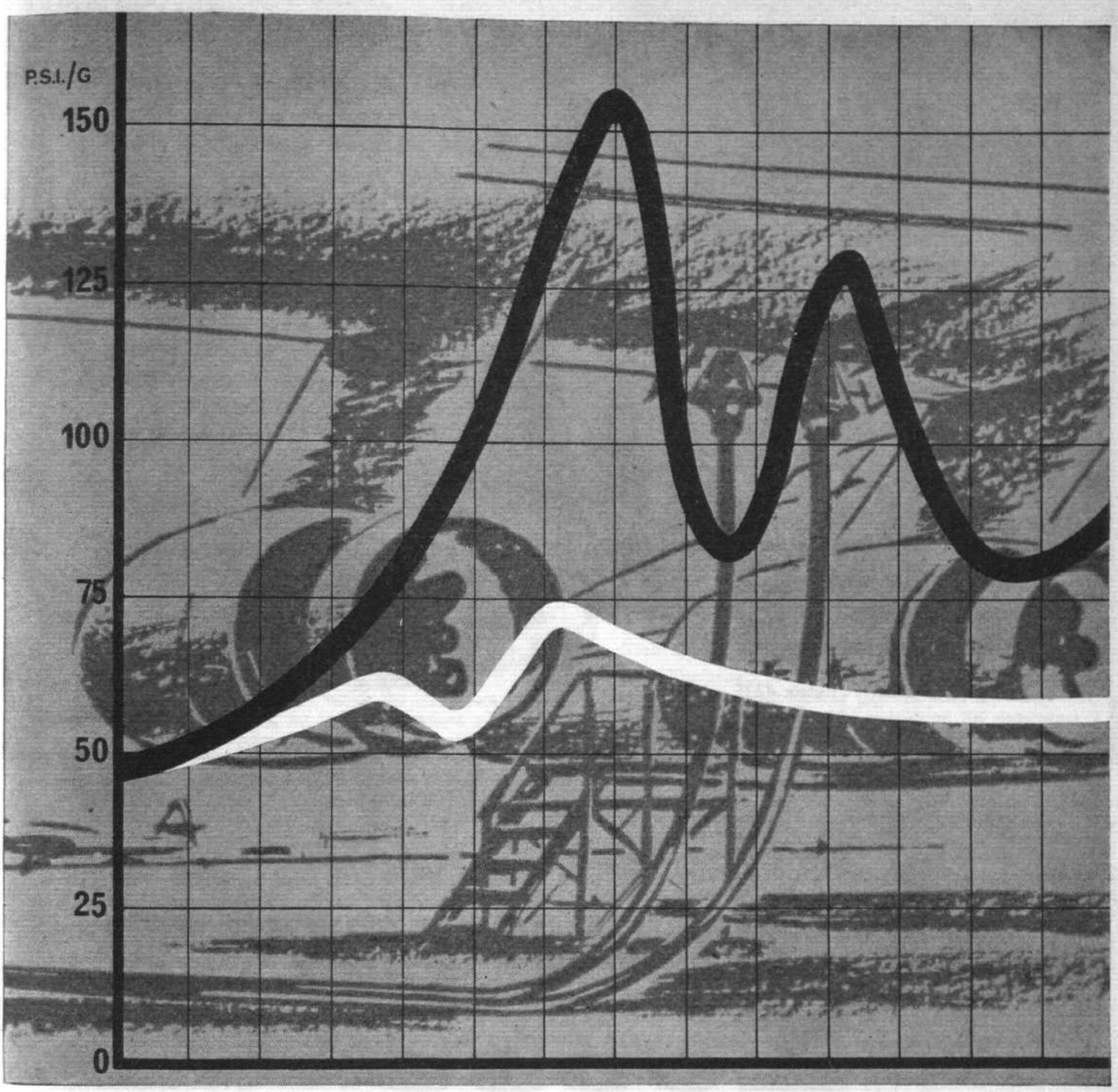
In Memory of Rhodes-Moorhouse, VC

From Gp Capt F. L. Newall, RAF (Retd)

SIR,—To commemorate the award of the first "air" Victoria Cross, which was awarded posthumously to Lt W. B. Rhodes-Moorhouse, in May 1915, a parade will be held at Beaminster, some six miles north of Bridport, Dorset, on Saturday, July 3.

This parade will precede the opening of a fête, in aid of the National Association of Mental Health, which will be opened by Mrs Rhodes-Moorhouse, widow of Lt Rhodes-Moorhouse, VC, at Parnham House, once the home of the Rhodes-Moorhouse family and about a mile from Beaminster.

The parade will form up at 1.40 p.m. and march off at 2 p.m. to the private burial ground in Parnham where Lt Rhodes-Moorhouse and his son, a flight lieutenant in the Royal Air Force, also killed on Active Service, are both buried. At the graveside a short ceremony of commemoration will be held, at which it is hoped that the Royal Air Force will fly past.



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- Eliminates high transient pressure on aircraft fuel systems.
- Gives faster response rate than any fuelling shut-off valve in service today.
- Simplifies ground fuelling equipment, with marked economies for oil companies.
- Overcomes risk of fatigue effects of high transient pressures on fuel systems.
- Improved serviceability.

This new controller replaces the standard 2½" aircraft fuelling unit and can be supplied with a one-hundred mesh filter and quick-release couplings. Write for details.

FR FUEL SYSTEMS EQUIPMENT

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LETTERS . . .

It is hoped that the original Victoria Cross will be exhibited in a room in Parnham; and the Imperial War Museum have promised to loan other relics of Rhodes-Moorhouse and the Royal Flying Corps. The organizing committee would much appreciate the loan of items of RFC interest, such as photographs, log-books, uniforms, pieces of aircraft or anything of interest from the Air War of 1914-1918 to put on exhibition for the day.

As a member of the organizing committee I would ask all ex-Servicemen's associations (in particular, the Royal Air Forces Association) to make every endeavour to send their Standards to this parade, with any of their members who would like to pay tribute to two brave men.

It is emphasized that this parade should not be undertaken by the elderly, but if any ex-RFC personnel wish to attend the graveside ceremony they should write to me beforehand so that arrangements may be made to transport them to the graves, which are situated on a hill in the grounds of Parnham House.

I would much appreciate it if offers of help, participations or any other enquiries be sent to me at the address below.

South Eggardon House, F. L. NEWALL
Askerswell, Dorchester

BOAC's Specialist Navigators

SIR,—Seeing Mr H. E. Smith's name on an account of the IATA Navigation Conference in your May 27 issue reminded me that BOAC have never rendered thanks to their specialist navigators, now almost an extinct breed; nor has the sad story ever been revealed to the Press, aviation or general, of the long fight which the navigators made for survival. Ted Smith, on the few occasions when we encountered him across the floor of the Industrial Court, was always anxious to claim the navigators as "my colleagues," so in all probability he is just the man to furnish us with a valedictory history of the specialist navigator in BOAC.

I shall not try with any personal recollections to anticipate this account, the eventual publication of which, long overdue, I await with interest. I would, however, like to draw attention to certain facts. These are: (1) that because the cost of employing pilot/navigators greatly exceeds that of employing specialists, BOAC (whatever may be the case in the electronic future) are at present paying more than they need to navigate their aircraft; and (2) BOAC successfully resisted all the efforts of navigators to have this aspect of operations fully and impartially investigated. (Our mind is made up; do not confuse us with facts.)

However profitable BOAC may be now, the owners and shareholders—which is to say, the British taxpayers—should never forget that the profits could be even larger if reason and justice had here prevailed.

As for thanks, the navigators served BOAC for periods ranging from sixteen-and-a-half to twenty-three years. I certainly received no official word of thanks from anyone when I left, nor has any one of my ex-colleagues to whom I have spoken since. Was I naive to expect some such small gesture, or is the truth that the bureaucrats in the Kremlin actually felt some sense of shame, even of guilt, about what has been done?

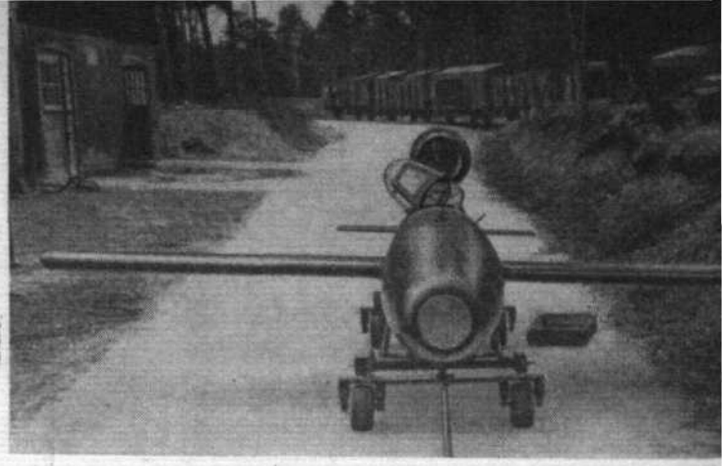
Farnborough, Hants W. G. HUNT,
Master Air Navigator

Piloted Bomb

SIR,—Thanks to Major T. J. O'Brien, RE, of the Horsham bomb-disposal unit, details and a photo of a rare Luftwaffe "aircraft" (held at the unit) have reached me for the booklet I am producing in aid of the Trueloves Home for seriously handicapped boys.

The R.E.4 was a modified version of the FZG 76, with similar dimensions, but carrying a human pilot in place of the automatic control of the missile.

A cockpit with canopy was constructed immediately in front of the propulsion unit and was fitted with conventional stick and pivoted crossbar flight controls; in addition there were flaps to the trailing edge of the wing, presumably for retarding the speed of the missile before the pilot baled out.



The piloted flying bomb referred to by Mr Leslie Hunt

A gyro compass was fitted in a shock-mounted bracket with a small 24V wet battery and three-phase inverter. This assembly was mounted on the deck between the pilot's knees, so that the compass was just below the instrument panel, which included an airspeed indicator and altimeter.

These bombs were intended specifically to be launched from aircraft, He111 or He177. The pilot was to fly his missile towards the target until he was relatively certain of accuracy, then lock the controls and attempt to bale out. Although the pilots were equipped with parachutes, it was anticipated that 99 per cent would not survive.

The R.E.4 was first flown by Frau Hanna Reitsch.

Leigh-on-Sea, Essex LESLIE HUNT

The C-5A Sails at Noon

SIR,—The project for a 700-passenger C-5A is truly magnificent, and brings the airliner into line with the ocean liner. As for the delay involved in embarking 700 passengers, I suggest that this need not take any longer than embarking a similar number on the *Queen Mary* or *Queen Elizabeth*. And think of the excitement of impending departure when the steward and stewardess (or would there be several of each?) sound their gongs and shout "All visitors ashore!"

I suggest that all airports handling C-5A departures should be equipped with facilities for fore-and-aft mooring lines. And couldn't the C-5A be fitted with one of those booming sirens which always sound so impressive, just before the gangways are lowered?

Truly, this could herald a new era for air travel!

Doncaster E. BACKWELL

IN BRIEF

Mr J. Hunt, secretary of Blackbushe Aviation Group, Blackbushe Airport, Camberley, Surrey, writes concerning the Proctor 1, G-AJLS, which AVM D. C. T. Bennett has presented to the group. The members intend to restore it with its original wartime markings, and would welcome information on (*a*) details of the paint scheme, serials, etc, and (*b*) where they could obtain suitable paint.

DIARY

June 24-26	Royal Netherlands Aero Club: Tour of Holland, Hilversum.
June 25	RAeS: Third Handley Page Memorial Lecture, "Aspect of Accessibility," by B. S. Shenstone, College of Aeronautics, Cranfield, 5.30 p.m.
June 26	RAFA: Air day, Exeter.
June 26	RAFA: Air display, Wolverhampton.
June 26	Royal Belgian Aero Club: Victor Boin Gliding Cup.
June 26-27	Vichy Aero Club: Sixth international air rally, Vichy.
June 27	Norfolk and Norwich Aero Club: Rally, Swanton Morley.
June 28-29	Perugia Aero Club: Air rally, Perugia, Italy.
June 29-July 4	Tour of Germany, Brunswick-Munich.
June 30	Kronfeld Club: "First Reflections on World Gliding Championships," by the British team: 74 Eccleston Square, London SW1, 8 p.m.
June 30-July 1	Royal Aero Club: Invitation rally, la Baule.
July 3	Naval air day, Yeovilton
July 3-4	Royal Aero Club: Invitation air rally, Deauville
July 3-5	Italian Aero Club: International tour of Sicily, Palermo.
July 3-12	Aeronautical Union of Yugoslavia: Adriatic parachuting cup, Portoroz.

SPORT AND BUSINESS

Bournair, the Hurn Airport Cessna dealers, recently supplied a Cessna Skywagon to the Organisation Internationale Contra le Criquet Magrateur African in Mali. Bournair fitted the aircraft with a 160gal Sorensen tank and also the Britten-Norman Micronair spray gear

Two members of a German parachute team, Schirring and Heim, collided over a Jutland airfield at 1,000ft and their rigging lines became entangled. The 'chutes partly deflated and began to fall faster. The men clung together, and Heim opened his emergency 'chute. Both landed unhurt

Enstrom F-28 Helicopter The three-seater Enstrom F-28 helicopter which was described on pages 784-785 of our May 20 issue has received its FAA Type C of A. It is now in production and the makers, the R. J. Enstrom Corporation, say they have orders for $872,000 worth although the sales campaign has not yet got under way. A particular feature of the aircraft is the offset flapping hinge rotor hub, which provides a powerful hub moment that gives a 6in c.g. range. Control response is said to be positive, with a good feel and practically no vibration feedback under any flight condition. The helicopter is being marketed as a trainer, TF-28, as an executive three-seater, EF-28, and as a stripped agricultural vehicle, the AGF-28.

Now For Plastic Floats The first promising new development for many years in waterborne aircraft design has been successfully demonstrated by Fleet Manufacturing of Fort Erie, Ontario. The company has built and tested foam-filled glass-fibre floats fitted to a Cessna 180.

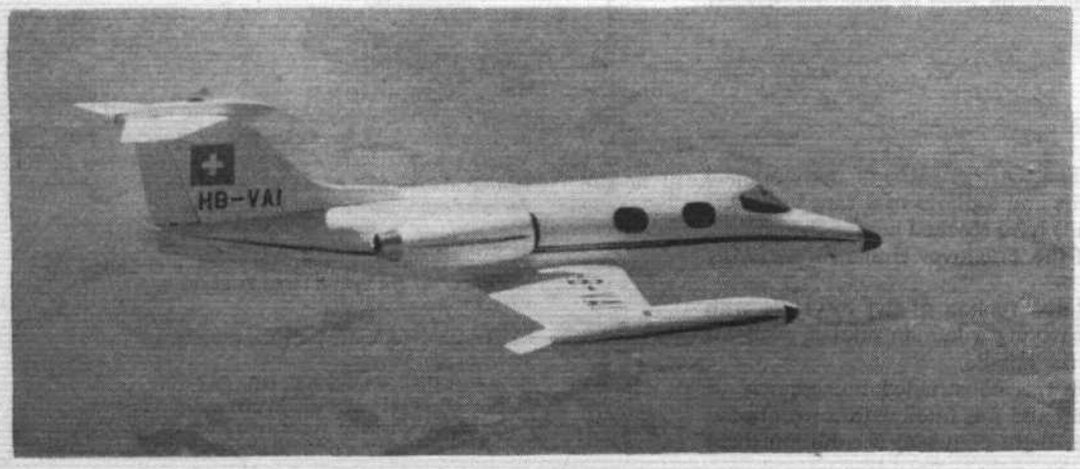
Each float is built around a full-length aluminium beam designed to take all the loads imposed on the float. The glass-fibre shell is moulded in several pieces and assembled with the aluminium beam positioned inside. Polyurethane foam plastic is then injected, after which the top of the float is sealed with a foam plastic block and capped with glass fibre.

Advantages claimed for this kind of float construction include improved performance, because of the smooth rivet-free finish; resilience to resist minor damage; and complete watertightness. Canadian Department of Transport approval of the basic design is expected shortly. The floats will then go into production, in several configurations and sizes, for use with various types of aircraft.

Cessna 411 Sales Thirteen of Cessna's new eight-seat 411s have been sold outside America—six of them to retail customers, the rest to distributors and dealers. Deliveries have been made to agents in Australia, Belgium, France, Mexico, Argentina, and Venezuela.

Cessna produced 422 civil aircraft during May. It was the third all-time record month for the company this year, delivery records were also set up in March and April. The May total was made up by 54 model 150s; 140 Model 172s; 18 Model 180s; 21 Super Skywagons; 12 Super Skylanes; 23 Centurions; 22 Super Skymasters; 21 Model 310s; one Skyknight; and 11 Model 411s. This output is equal to one aircraft every 23 minutes of the working day.

Scottish International Parachute Championships From Thursday, July 15, to Saturday, July 24, the annual Scottish Free-fall Parachute Championships (which this year will be an international event) will be held at RNAS *Condor*, Arbroath. The competition is being organized in conjunction with the station's 25th Anniversary Air Day. Additional information can be obtained from the Royal Aero Club, Artillery Mansions, 75 Victoria Street, London SW1.



Baron Thyssen of Switzerland is the second operator of a Lear Jet (HB-VAI) in Europe; Executive Aviation, the distributors for Europe and Africa, have the third aircraft, and a fourth is on order for the Swiss company Vodavia

The line-up at Shoreham before the start of the first heat of this year's National Air Races

"Flight" photographs

FIRST OF THE NATIONALS

AS briefly reported last week, the first qualifying round of the National Air Races organized by the Royal Aero Club was held at Shoreham on Saturday, June 12, for the John Morgan Challenge Trophy. (The second race is to be held at Middleton St George on August 7, and the 24 entrants with the highest number of points from the combined total of both races go forward to the Kings Cup at Coventry on August 24.) Two non-NAR races followed the main contest.

This year's Shoreham course differed from that of last year, but only by having the finishing line off Worthing pier instead of Brighton pier and thus shortening it by 13 miles to 87 miles. From Shoreham Airport and round a scatter point on Shoreham beach, the circuit went *via* Beachy Head lighthouse; the Martello tower on Langley point; a small pylon on the private landing strip at Deanland Farm, near Hailsham; Knepp Castle, an ancient monument five miles south of Horsham; the control tower at the disused Ford naval air station; the end of the jetty at Littlehampton; and finally along an eight-mile leg to the finishing line off Worthing pier.

Practice on the Friday afternoon was badly disorganized by that old South Coast bugbear, sea fog. It drifted in and in a matter of minutes blanketed the coast, the airfield and part of the course, with the result that aircraft already in the air were forced to land at airfields over a wide area from Blackbushe to Deanland Farm.

Early on the Saturday morning, to anyone not knowing of the chaos of the evening before, the race looked like being badly supported, with the possibility of no race at all. But as the morning wore on the aircraft returned and the pilots reported in and departed once again for another try at the course.

Sea-fog Threat

Briefing at 2 p.m. forecast cloud at 2,000ft, with sea fog drifting in at 6 p.m.—starting time for the third race—and thickening considerably from then on. With the news that the main race at least would escape with nothing more than the possibility of a shower here and there, the first competitor, Gordon Janney in a Turbulent, took off shortly after 3 p.m., followed at handicap intervals by the rest of the field of 35.

Fifty-six minutes later the first aircraft was sighted: it turned out to be the Jodel Ambassadeur of Beverley Snook, followed 35sec later by John Spiller in his Cessna 180, with Peter Masefield in his special Chipmunk beating Frank Gathercole's Mooney to third place by a cowling's length.

The first of the two non-NAR events—the Silver Tiger Moth Trophy race, sponsored by Mr Norman Jones and for Tiger Moths only—got under way in a steady drizzle with the eight competitors airborne in just over six-and-a-half minutes. Bob Winter in one of the Tiger Club's "ecclesiastical" Tigers, *The Archbishop* (G-ANZZ), crossed the finishing line 16sec ahead of Tim Lodge in G-AOAA, with Robin Voice (G-ANMZ) third.

The third and last race of the afternoon was strictly "ladies only" —believed to be the first of its kind, other than informal contests, ever held in this country. The organizers were the British section of the American 99s association, and the first prize was a challenge trophy presented by the Champion Sparking Plug Co. The sea fog forecast for 6 p.m. fortunately failed to materialize and the nine contestants duly took off in handicapped order. Sheila Scott in her Comanche 250 soon overhauled the majority of the slower aircraft and on the final leg passed the leading machine up to that time, the BWPA's Condor piloted by Christine Hughes of *Flight*, to win by 24sec; Diana Barnato Walker, in the Auster Alpine of the Girls Venture Corps Air Wing, was third.

Mr John Blake of the Royal Aero Club public-addressed the Shoreham spectators in his usual urbane and knowledgeable manner.

RESULTS IN BRIEF

John Morgan Challenge Trophy 1, B. Snook (Jodel 1050), 134.5 m.p.h.; 2, J. Spiller (Cessna 180), 165.5 m.p.h.; 3, P. Masefield (DH Bristol Chipmunk), 149 m.p.h.; 4, F. Gathercole (Mooney), 169 m.p.h.

Silver Tiger Moth Trophy 1, R. Winter (G-ANZZ), 120.5 m.p.h.; 2, T. Lodge (G-AOAA), 117 m.p.h.; 3, R. Voice (G-ANMZ), 113.5 m.p.h.; 4, M. Pruden (G-AMTO), 105 m.p.h.

British 99s Air Racing Challenge Trophy 1, Sheila Scott (Comanche 250), 181 m.p.h.; 2, Christine Hughes (Rollason Condor), 120 m.p.h.; 3, Diana Barnato-Walker (Auster Alpine), 120 m.p.h.; 4, Margo McKellar (Turbulent), 99 m.p.h.

Above, Beverley Snook, winner of the first round of the National Air Races; right, Bob Winter, winner of the Silver Tiger Moth Trophy; and, below, Sheila Scott receiving the British 99s Air Racing Challenge Trophy from Mr Richard Starling of the Champion Sparking Plug Co. In the background is Mr Simon Ames, clerk of the course

WORLD GLIDING CHAMPIONSHIPS 1965

FIFTEEN-METRE SAILPLANES WIN BOTH CLASSES

BY KENNETH OWEN

ILLUSTRATED WITH "FLIGHT" PHOTOGRAPHS

ONCE upon a time there was a myth. Fifteen-metre gliders, it was said, were somehow inferior to the best type of high-performance sailplane. No self-respecting 18-metre machine would be seen fraternizing with mere 15-metres, who were therefore relegated to a special category known as the standard class.

This myth has been broken for all time by Jan Wroblewski, a 24-year-old technical student from Poland. At the World Gliding Championships at South Cerney, Wroblewski flew a 15-metre Foka 4 into top place in the open class.

Poland entered four Foka 4s for the championships, two in each class. France did the same with the 15-metre Edelweiss. So effective was this combination of good 15-metre sailplanes and excellent pilots that the Fokas came first and fourth in the open class and third and fourth in the standard class; while the Edelweiss not only won the standard class (flown by François Henry) but was also placed seventh in that class and eighth and tenth in the open class.

The second week's flying began with a goal race to RAF Spitalgate, a distance of 162km, on **Monday, June 7.** Radiation fog soon burned off, and launching began just before noon. The wind was fluctuating at the launch point when Tony Deane-Drummond in the Olympia 465 began his take-off run; his glider was seen to swing off to the right and hit two runway markers. Deane-Drummond switched to Slingsby's demonstration Dart for a second launch, leaving the organizers to decide later whether this would be permitted to count as a scoring flight.

Most pilots crossed the start line early, having been warned of over-convection and spread of cloud in the afternoon. Another incident occurred soon after one o'clock, when an Edelweiss was seen banking in to land back at South Cerney with an abbreviated right wingtip.

It was Jean-Pierre Cartry's machine, and it had suffered a collision during thermalling with one of the Hungarian all-metal A-15s, at first believed to be Thuri's (No 33) but later confirmed as that of Petroczy (No 34). In 12min flat the right wing had been removed and replaced with one from the spare Edelweiss which had been flown by the OSTIV jury, and the aircraft was taking off for a second attempt—again "without prejudice" to the possibility of awarding points.

Not only was the visibility better today but conditions strengthened to enable almost everyone to complete the race. Spänig in the D-36 left everyone behind to arrive at Spitalgate in 1hr 47min—a speed of 90.4km/hr. Some 25km from the goal many pilots found and used a well-defined sea-breeze front, but the sink and headwind associated with the front caused Richard Schreder in the HP-12 and a few other pilots to land just short of Spitalgate.

Behind Spänig in the open class came the A-15s of Thuri and Chuvikov (the best performance yet by the Soviet pilot), followed by Kriznar (Meteor), Kuntz (SHK-1), Petroczy and Wroblewski. Williamson was 11th at 71.1km/hr.

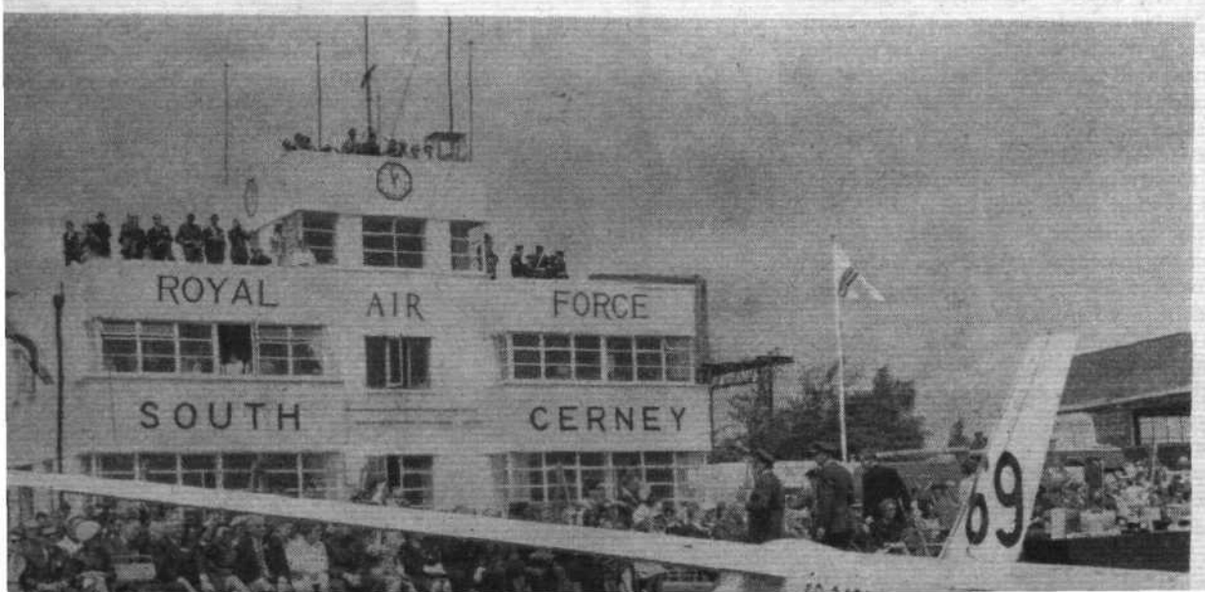
In the standard class Henry was fastest at 77.1km/hr, followed by Ritzi (Elfe), Wiitanen (Vasama), Kepka (Foka 4), Huth (Ka-6) and Popiel (Foka 4). After five contest days the leading pilots on overall points were:—

Open Class					
1	Wroblewski	Foka	Poland		4,295
2	Spänig	D-36	W. Germany		4,164
3	Kriznar	Meteor	Yugoslavia		4,098
4	Makula	Foka	Poland		4,032
5	Kuntz	SHK-1	W. Germany		3,994
6	Williamson	Olympia 419	Britain		3,793
Standard Class					
1	Henry	Edelweiss	France		4.125
2	Ritzi	Standard Elfe	Switzerland		3,951
3	Popiel	Foka	Poland		3,687
4	Burton	Dart 15	Britain		3,670
5	Kepka	Foka	Poland		3,627
6	Scott	Ka-6CR	USA		3,539

An overnight deluge continued into **Tuesday, June 8,** forcing the organizers to declare no task, the airfield to be closed, and Mr C. E. Wallington to use an umbrella instead of a pointer for his morning weather briefing. In a very difficult situation, the met-man affirmed, the only thing to do was to "wet and see."

After a heavy agenda of meetings the organizers announced their rulings on the previous day's two incidents. Normally the rules would not permit the substitution of a major component or complete aircraft, although this might be allowed if the damage was not the fault of the pilot or his crew. The mid-air collision was no fault of Cartry's, and so the wing substitution was allowed. Petroczy should have seen Cartry's Edelweiss, but his failure to do so was not "behaviour prejudicial to the safety of other competitors."

As for Deane-Drummond and the 465, the stewards sought the advice of the international jury (all team managers) because the pilot was "a member of the host nation." By a majority vote (with



One of the four Polish Foka 4 sailplanes shared the place of honour at the closing ceremony with the French Edelweiss flown by François Henry

Open-class (left) and standard-class winners at South Cerney: the Polish pilot Jan Wroblewski is flanked by Rolf Spänig and (nearest the camera) Rolf Kuntz, respectively second and third in the open class. On the standard class rostrum, François Henry has the runner-up Markus Ritzi of Switzerland on his right and the Polish pilot Franciszek Kepka on his left

Ann Welch and British team manager Gerry Burgess abstaining) it was decided that the pilot's "inability to avoid obstructions" was not his fault, and so his full marks were allowed for his flight in the substituted aircraft.

The daily *Championships Journal* reported the two incidents, and others, in a single sentence: "The Swedes discovered they had brought with them the Norwegian national anthem whereupon a Swede drove over a Norwegian wingtip and an Englishman flew into the runway markers followed by a Hungarian and a Frenchman colliding while a wheel was coming off a Canadian retrieve car and the Indians were having engine trouble."

The French team announced that they now had only one spare Edelweiss wing. This was a left wing, and so the team requested all pilots to be especially careful of all French *right* wings. This was, of course, a non-political statement.

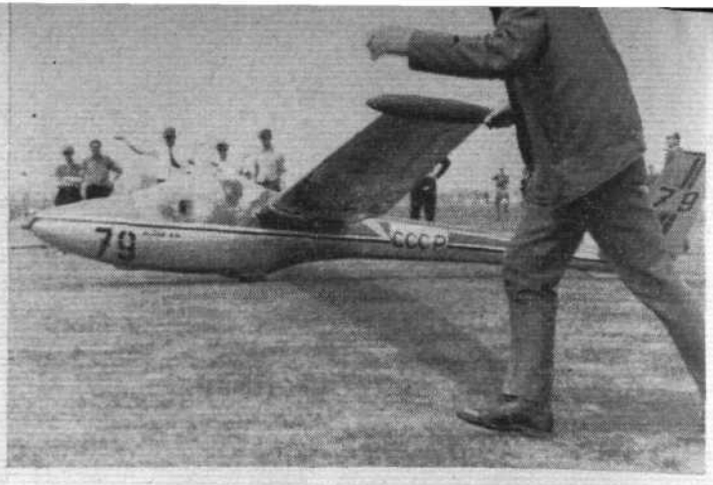
There was again no flying because of bad weather on **Wednesday, June 9.** On **Thursday, June 10** an ambitious task was set—a 288km triangular race with turning points at Lasham and Sherborne. Strato-cumulus remained over South Cerney, however, to make conditions much more difficult than forecast. The Tiros 9 satellite photographed cloud cover over the United Kingdom, confirming an isolated piece of cloud sitting directly over the championships.

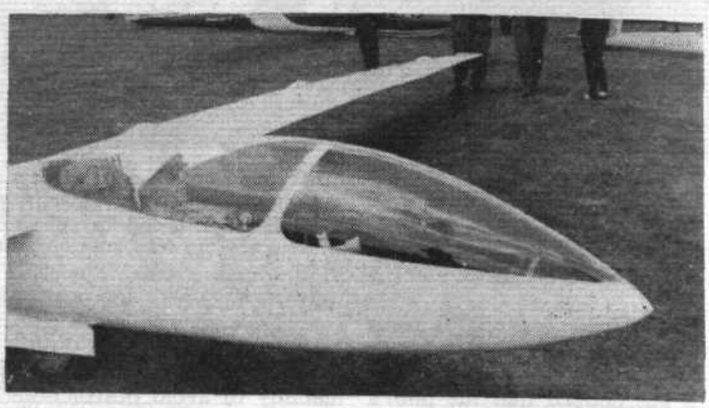
After the 40 open-class sailplanes had been launched in the record time of 15min, many were forced back for second attempts. The standard-class task was cancelled at 1.30 p.m.

Open-class pilots struggled along the course as best they could. It was a great day for the Irish, with Air Cdre N. W. Kearon managing to reach Old Sarum airfield in his Olympia 419. John Williamson's Olympia 419 was not far behind, and had it been a

Above, two of the more interesting sailplanes in the open class at South Cerney were the Yugoslav Meteor flown by Kriznar (top) and the SHK-1 flown by Kuntz. Championships officials (below, from the left) included meteorologist Peter Wickham, chief marshal Ken Fitzroy, championships director Ann Welch and Joe Croshaw, in charge of flying operations

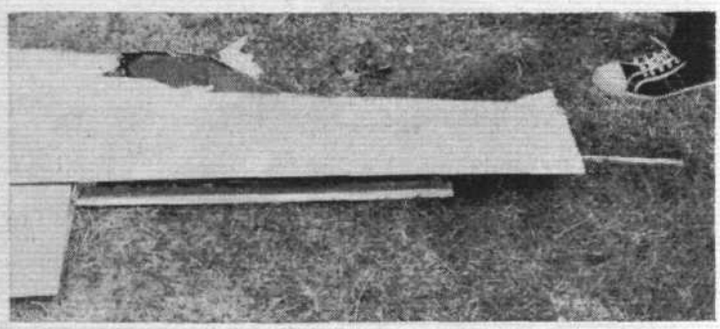
Finland's new Havukka Standard was flown by Juhani Horma and was named "Goldie"



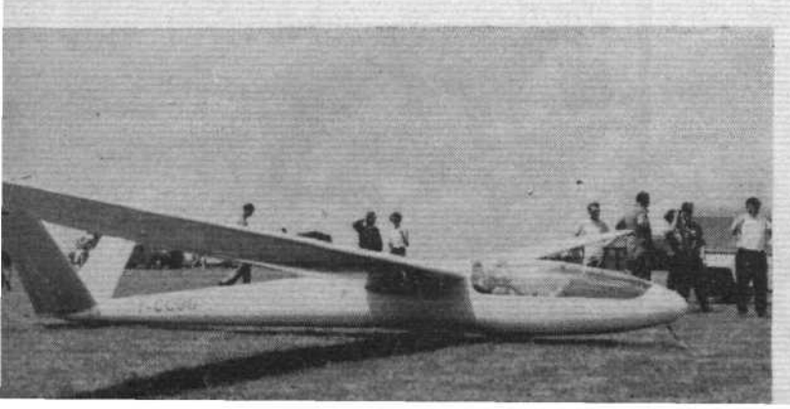


Oleg Suslov's Russian KAI-14 (top), seen on its first contest launch following its repair by the RAF. Above, the low-drag nose of Rolf Spänig's D-36; the front part of the canopy is fixed rigidly to the fuselage

WORLD GLIDING 1965 CHAMPIONSHIPS



Above, the abbreviated wingtip of Cartry's Edelweiss following a mid-air collision with the A-15 flown by Petroczy of Hungary on June 7. Below, Cartry checks the attachment of a replacement wing; 12min after landing he was ready to take off again (bottom picture)



contest day there was every possibility that the British pilot would have moved into the open-class lead. But the rules specified that eight pilots must fly a minimum qualifying distance: on this day only six pilots did.

Distance along a dog-legged line with turning points at Long Marston and Thame and then on towards (or through) Perranporth was set for **Friday, June 11**. Most competitors rounded the two turning points but came to earth on and around the Mendips as a warm front moved in slowly from the west. Nobody, it was clear, would reach anywhere near Perranporth.

Yet again Spänig's sleek D-36 took him quickly ahead of the others. He was forced to land as early as 4.20 p.m. after a 275.5km flight to South Chezdoy, near Bridgwater. Other pilots reached the Bridgwater area between 5.30 and 6 p.m., one of the last to land being Williamson at 6.25. Close behind Spänig were Kuntz, Wroblewski, Williamson, Kearon and Makula. In the standard class Kepka made 268.5km, landing near Bridgwater at 5.40 p.m. and followed by Wödl, Mestan, Schreder, van Bree and Persson. Two American sailplanes—Andrew Smith's Sisu and Wally Scott's Ka-6CR—suffered tail damage on landing.

On overall points totals the leading two in each class remained unchanged—Wroblewski and Spänig (open) and Henry and Ritzi (standard). Kuntz and Kriznar exchanged third and fifth open-class positions either side of Makula, with Williamson and Goodhart staying in sixth and seventh place. Kepka and Popiel moved ahead of Burton in the standard class, with Scott holding on to sixth place.

No contest flying was possible because of bad weather on **Saturday, June 12** and so the six-day totals stood as the final championships results. Wroblewski, first time in a world championship and first time out of Poland, was open-class champion in the Foka 4. Henry, 28-year-old French Air Force test pilot, was standard-class champion in the Edelweiss.

As always, consistency in the daily placings (see table) had paid off. The most spectacular flights had been those of the D-36, yet Wroblewski's lower-performance sailplane had remained ahead of the efficient Darmstadt machine. The result was a tribute to the thoroughness of the Polish training and the skill of the Polish pilots, who were surprised by the strength of the soaring conditions in Britain.

Certainly the D-36 was the most interesting machine at South Cerney. Balsa-reinforced glass-fibre sandwich construction is used, and Spänig worked on a gliding angle of 1 in 40 in his calculations. The aircraft was designed to achieve the maximum possible cross-country speed in weak lift, and wing flaps are used (moving from

DAILY LEADERS

OPEN CLASS

Day 1	Day 2
1 Spänig	1 Kuntz
2 **Wroblewski**	2 Makula
3 Kriznar	3 **Wroblewski**
4 Makula	4 Hossinger
5 Johnson	5 Johnson
6 Williamson	6 Chuvikov
7 Cartry, Kuntz, Yeates	7 Spänig
10 Hossinger	8 Cartry
	9 Petroczy
	10 Stouffs

Day 3	Day 4
1 **Wroblewski**	1 Kriznar
2 Makula	2 Goodhart
3 Smith	3 Webb
4 Goodhart	4 Svoboda
5 Spänig	5 Jackson
6 Williamson	6 Kuntz
7 Kriznar	7 Vergani
8 Vergani	8 Makula, **Wroblewski**
9 Petroczy	10 Williamson
10 Thuri	

Day 5	Day 6
1 Spänig	1 Spänig
2 Thuri	2 Kuntz
3 Chuvikov	3 **Wroblewski**
4 Kriznar	4 Williamson
5 Kuntz	5 Kearon
6 Petroczy	6 Makula
7 **Wroblewski**	7 Hossinger, Penaud
8 Johnson	9 Cartry
9 Makula	10 Svoboda
10 Svoboda	

STANDARD CLASS

Day 1	Day 2
1 Deane-Drummond, Kepka	1 Ritzi
3 Schreder	2 Lindner
4 Scott	3 Schreder
5 **Henry**	4 **Henry**
6 Pronzati	5 Popiel
7 Cameron	6 Wiitanen
8 Lacheny	7 Kepka
9 Horma	8 Burton
10 Ritzi	9 Fritz
	10 Deane-Drummond

Day 3	Day 4
1 **Henry**	1 Scott
2 Popiel	2 Burton
3 Lindner	3 **Henry**
4 Huth	4 Kepka
5 Ritzi	5 Ritzi
6 Persson	6 Horma
7 Lacheny	7 Rodling
8 Sejstrup	8 Huth
9 Fritz	9 Reparon
10 Rodling	10 Deane-Drummond

Day 5	Day 6
1 **Henry**	1 Kepka
2 Ritzi	2 Wödl
3 Wiitanen	3 Mestan, Schreder
4 Kepka	5 Van Bree, Persson
5 Huth	7 Johannessen
6 Popiel	8 Popiel
7 Fritz	9 Lacheny
8 Scott	10 Sejstrup
9 Lacheny	
10 Lindner	

10° up to 10° down) to keep the attitude of the fuselage and wing constant, and so minimize drag, whatever the speed.

Aspect ratio is 24, span is 17.8 metres and wing thickness/chord is 13 per cent. To reduce fuselage drag the forward section of the blown Plexiglass canopy is rigidly fixed to the nose. The T-tail, also, was chosen in order to reduce drag (the tailplane appears incredibly small). The flexible wings droop noticeably when the sailplane is on the ground and adopt a marked dihedral in the air.

Another sailplane which surprised us at South Cerney's was the Jugoslav Meteor—not by its design, a familiar ten-year-old, but by its repeatedly good performance at the hands of Ciril Kriznar. Ritzi in the standard-class Elfe was another consistent pilot.

Much nonsense has been talked in the past about the performance of relatively "hot ships" in British conditions. The South Cerney results will give much food for re-appraisal.

Against formidable competition the British sailplanes did well. The Darts had a good free-distance day, and George Burton in particular flew excellently to make fifth standard-class place in his first world championship. Dart prospects are good following the award of the 1965 OSTIV Trophy.

On the ground the organization of the championships was the best ever, thanks to the effective combination of the BGA and the RAF. The result was enthusiasm plus efficiency, and it worked.

At the closing ceremony on **Sunday, June 13,** Mr Philip Wills, BGA chairman, said:—

"As far as we are concerned the British gliding movement will never be the same again. Unexpectedly we seem to have sparked off more public interest both here and abroad than we had ever imagined and the consequences will be indeed far-reaching. We have shown, I think, that we are not a cold-hearted island race living most of the time in a thick fog—we are a warm-hearted island race living most of the time in a thick fog.

"We have shown that you can get exciting and worthwhile flying in a sailplane in weather which, under ordinary circumstances, would cause most of us to go indoors, light the fire, and take out a good book to read."

In a witty speech, Mr Mauricio Obregon, president of the Fédération Aéronautique Internationale, defined championships comradeship as "You cut off my wing, I'll cut off yours." Prizes were presented by Hilda, Lady Brabazon of Tara.

At the final banquet the speakers included the president of the Gliding Commission of the FAI, Mr "Pirat" Gehriger. The competitors presented a painting of a Skylark 4 to the Station Commander, Gp Capt Peter Ottewill; championships director Mrs Ann Welch thanked all her helpers; gifts were exchanged and the party dissolved into a fusillade of bursting balloons.

Although the weather could have been better, it had been a wonderful championship. Now Gp Capt Ottewill could bring his officer cadets back from Shawbury and No 1 Initial Training School could get back to normal—perhaps. From Warsaw to Woking cars would be bearing South Cerney's "SC" windscreen stickers for quite a while. Their drivers were privileged to be at the 1965 World Gliding Championships. Ask them what it was like.

1965 WORLD GLIDING CHAMPIONSHIPS RESULTS

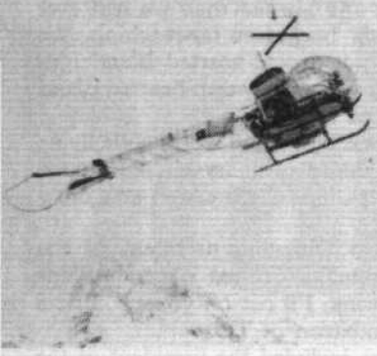
STANDARD CLASS

					Points
1	F. Henry	Edelweiss	France		4,945
2	M. Ritzi	Standard Elfe	Switzerland		4,798
3	F. Kepka	Foka 4	Poland		4,627
4	J. Popiel	Foka 4	Poland		4,578
5	G. Burton	Dart 15	Britain		4,517
6	W. Scott	Ka-6CR	USA		4,375
7	J. Lacheny	Edelweiss	France		4,263
8	R. Lindner	Phoebus	W. Germany		4,249
9	A. J. Deane-Drummond	Olympia 465	Britain		4,179
10	E. van Bree	Ka-6CR	Netherlands		4,144
11	J. Fritz	Standard Austria SH	Austria		4,130
12	H. Wödl	Ka-6CR	Austria		4,092
13	M. Wiitanen	Vasama Standard	Finland		3,975
14	H. Huth	Ka-6	W. Germany		3,921
15	R. Schreder	HP-12	USA		3,913
16	L. Brigliadori	Uribel C	Italy		3,902
17	P. A. Persson	Pik 16C Vasama	Sweden		3,830
18	N. Sejstrup	Ka-6CR	Denmark		3,800
19	U. Bloch	Ka-10	Switzerland		3,788
20	S. Rodling	Pik 16C Vasama	Sweden		3,770
21	D. Reparon	Ka-6CR	Netherlands		3,761
22	R. Mestan	Standard M-25	Czechoslovakia		3,445
23	A. Pronzati	M-100S	Italy		3,281
24	J. Horma	Havukka Standard	Finland		3,218
25	M. Baeke	Ka-6CR	Belgium		3,189
26	R. Clifford	Ka-6CR	South Africa		3,133
27	R. Picchio	Ka-6	Argentina		3,075
28	R. Johannessen	Pik 16C Vasama	Norway		2,987
29	M. Jinks	ES-60 Boomerang	Australia		2,912
30	M. Cartigny	Foka 3	Belgium		2,875
31	R. Handley	Ka-6	New Zealand		2,488
32	I. Braes	Ka-6CR	Denmark		2,475
33	V. Marecek	Standard M-25	Czechoslovakia		2,467
34	K. Korpar	Libis 18	Yugoslavia		2,396
35	T. Evans	Ka-6	Ireland		2,346
36	T. Filippusson	Pik 16C Vasama	Iceland		2,233
37	V. Stepanovic	Delfin	Yugoslavia		2,224
38	H. Höimyr	Ka-6CR	Norway		1,988
39	V. Gupta	Ka-6	India		1,904
40	P. S. Mortensen	Olympia 463	Canada		1,800
41	A. Cameron	Olympia 465	New Zealand		1,788
42	R. Rowe	ES-60 Boomerang	Australia		1,528
43	L. Magnusson	Ka-6CR	Iceland		1,475
44	O. Suslov	KAI-14	USSR		725
45	I. Jarushevichus	KAI-14	USSR		229

OPEN CLASS

					Points
1	J. Wroblewski	Foka 4	Poland		5,269
2	R. Spänig	D-36	W. Germany		5,164
3	R. Kuntz	SHK-1	W. Germany		4,990
4	E. Makula	Foka 4	Poland		4,971
5	C. Kriznar	Meteor	Yugoslavia		4,937
6	J. Williamson	Olympia 419	Britain		4,756
7	N. Goodhart	Dart 17	Britain		4,617
8	J-P. Cartry	Edelweiss	France		4,496
9	C. Yeates	Skylark 4	Canada		4,321
10	J. Penaud	Edelweiss	France		4,257
11	H. Stouffs	Ka-6CR	Belgium		4,177
12	R. Hossinger	Standard Austria	Argentina		4,124
13	K. Thuri	A-15	Hungary		4,109
14	N. W. Kearon	Olympia 419	Ireland		4,084
15	M. Svoboda	L-21 Spartak	Czechoslovakia		4,081
16	W. Vergani	Skylark 4	Italy		4,079
17	G. Petroczy	A-15	Hungary		4,056
18	R. Johnson	Skylark 4	USA		4,052
19	A. Smith	Sisu 1A	USA		3,903
20	H. Nietlispach	Skylark 4	Switzerland		3,629
21	R. Frene	Standard Austria	Argentina		3,416
22	V. Chuvikov	A-15	USSR		3,390
23	D. Reid	Skylark 4	Australia		3,338
24	M. Jackson	Olympia 419	South Africa		3,267
25	D. Arber	Skylark 4	Israel		2,855
26	S. H. Georgeson	Skylark 4	New Zealand		2,833
27	G. J. Ordelman	Sagitta 1	Netherlands		2,816
28	D. Webb	Dart 17	Canada		2,582
29	F. Ulbing	Ka-6CR	Austria		2,549
30	E. Nielsen	Pik 16C Vasama	Denmark		2,524
31	D. F. Westenra	Skylark 3G	New Zealand		2,468
32	M. Veretennikov	A-15	USSR		2,464
33	J. Harrold	Skylark 4	Rhodesia		2,184
34	B. Dommisse	BJ-2	South Africa		2,139
35	I. Silesmo	Ka-6CR	Sweden		2,138
36	R. Smith	Skylark 3F	Rhodesia		2,125
37	H. Jensen	Hütter Libelle	Denmark		2,050
38	J. Blackwell	Standard Austria	Australia		1,900
39	M. Slazenger	Olympia 419	Ireland		1,703
40	F. Lamera	M-100S	Italy		1,604
41	S. Hämäläinen	Skylark 4	Finland		314

Now fully operational with the RCAF's four SAR squadrons are its Vertol CH-113 helicopters (named "Labrador" in the SAR role, and "Voyageur" in their Canadian Army version). A Labrador from RCAF Comox, BC, recently performed the highest-ever such salvage mission in Canada when it air-lifted a civil Bell 47 helicopter from the 13,500ft Mt Kennedy, in the Yukon, near the summit of which the 47 had landed with engine trouble. The Labrador, with a six-man flight/para-rescue team and captained by Flt Lt Dan Campbell, flew the 47, less its rotor, 140 miles to Whitehorse



RAF Honours

PRINCIPAL HONOURS conferred upon members of the RAF in the Birthday Honours List were the GCB for Air Chief Marshal Sir William MacDonald, Air Secretary at the MoD; the KCB for Air Marshal T. O. Prickett, AOC-in-C, NEAF; and the KBE for Air Marshal C. Broughton, UK Permanent Military Deputy at CENTO, and Air Marshal P. D. Holder, AOC-in-C, Coastal Command.

Military Order for PD.808

THE ITALIAN AIR FORCE has confirmed its expected order for 25 Piaggio PD.808 light twin-jet transports, in addition of its financial sponsorship of the two prototypes. Series production is to begin immediately and the Aeronautica Militare will use the type for light transport and liaison duties, training and radar calibration.

PAF Detours

SINCE THE INDIAN GOVERNMENT prohibited Pakistan military flights over Indian territory, linking West and East Pakistan, as a result of the Rann of Kutch conflict, the regular PAF C-130B Hercules schedules have been routing through Ceylon.

GW Cruiser with Nine Helicopters

THE KEEL was laid on June 10 of the first of two guided missile cruisers for the Italian Navy, the *Vittorio Veneto*. The cruisers will each carry no fewer than nine Agusta-Bell 204B ASW helicopters, one twin-Terrier ship-to-air missile launcher and two 4.1in rocket launchers.

DEFENCE

AIRCENT's Weapons Meet

TOMORROW the awards for this year's AIRCENT Tactical Weapons Meet are to be presented at Chaumont AFB in France, and on Saturday the captains and the teams depart. Will the top award, the Broadhurst Trophy, go to Second Allied Tactical Air Force for the first time, or will 4 ATAF carry it off for the fourth year in succession?

It looks very much like 4 ATAF again this year (writes a correspondent who was in Chaumont for the opening days of the two-week competition). First, they have a 100 per cent record of victories to maintain. Secondly, they have better equipment: F-105s, CF-104s, F-104Gs and F-100s against 2 ATAF's F-104Gs, Canberras and F-84Fs. Thirdly, there is the national determination of the USAF and RCAF to prove their F-105s and CF-104s respectively, against all opposition, as the best possible types for their tactical role.

Strictly speaking, any ideas of national prowess have been purged out of this international competition by the rules; but it is well known that rules may be bent, even among the best of allies.

What the AIRCENT Commander looks for from this competition is a reading as to the operational efficiency of his ground-attack squadrons. As one senior officer put it at Chaumont: "What really matters is not who wins but why the losers didn't do better." Competitors have to fly a low-level cross-country of anything from 300 to 600 miles (F-84s do the shortest distance, Canberras the longest), pass over an *en route* target on time, then attack their actual target—on the Suippes Range, when the Meet is located at Chaumont—on time. There are four methods of attack according to aircraft type—strafing, skip bombing, rocketry or simulated nuclear weapon delivery—but there is one common criterion for success: accurate, on-time delivery of weapons.

Allowances are made in the scoring procedure for different types of nuclear delivery (Canberras do a LABS manœuvre, F-105 Thunderchiefs use the "lay down" technique) and there was one major change in the rules this year: the number of participating aircrew was doubled, a new set of competitors starting from scratch last Monday. This should have favoured 2 ATAF, because it meant that 4 ATAF would not automatically increase its initial lead. But, for reasons already adduced, it looks as though 4 ATAF will be receiving the Broadhurst Trophy again tomorrow, thus gaining redress for 2 ATAF's superiority in reconnaissance, proved recently in "Royal Flush."

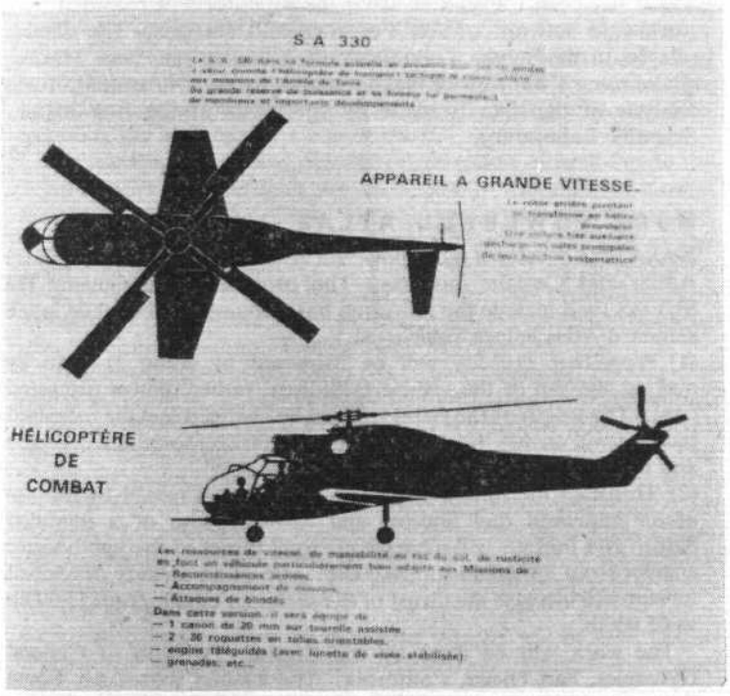
RCAF F-5 Announcement Due

EXPECTED IMMINENTLY is the Canadian Government announcement that Northrop F-5s—numbering about 140, reliable Ottawa sources report—will be ordered for the RCAF. The decision, it is understood, has been made for weeks but has been held up by a recently concluded seven-week strike at the Canadair plant, where the aircraft will be built.

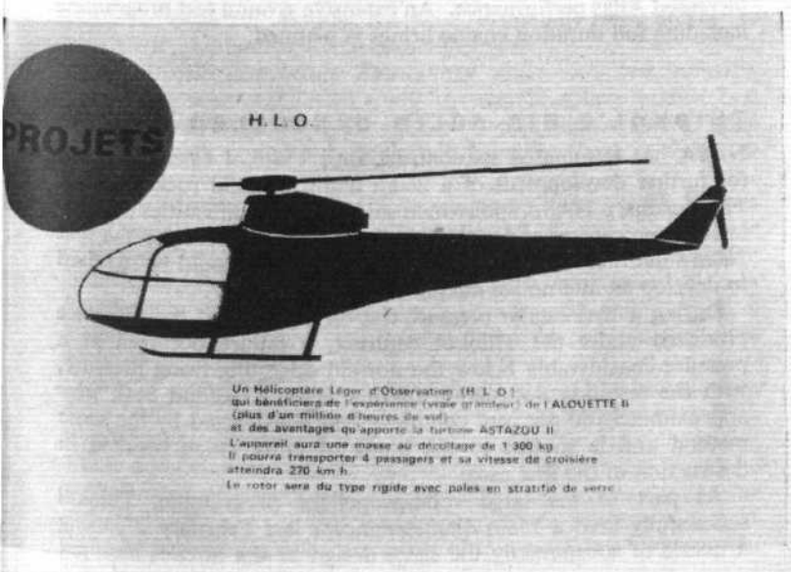
The new CAS of the RAAF, Air Marshal A. M. Murdoch (right), has taken over from Air Marshal Sir Valston Hancock. Air Marshal Murdoch was formerly AOC-in-C, Operational Command, Penrith. Air Marshal Hancock has retired after 36 years' service. During his farewell tour of the RAAF he escaped unscathed from a Canberra crash near RAAF Butterworth

Overload take-offs, or use of small airfields, are achieved by the Dassault Mirage IV with 12 inclined JATO units. The second Armée de l'Air Mirage IV squadron is now forming; the 24th production aircraft of (62 ordered) was at Le Bourget

FROM THE PARIS COLLECTIONS

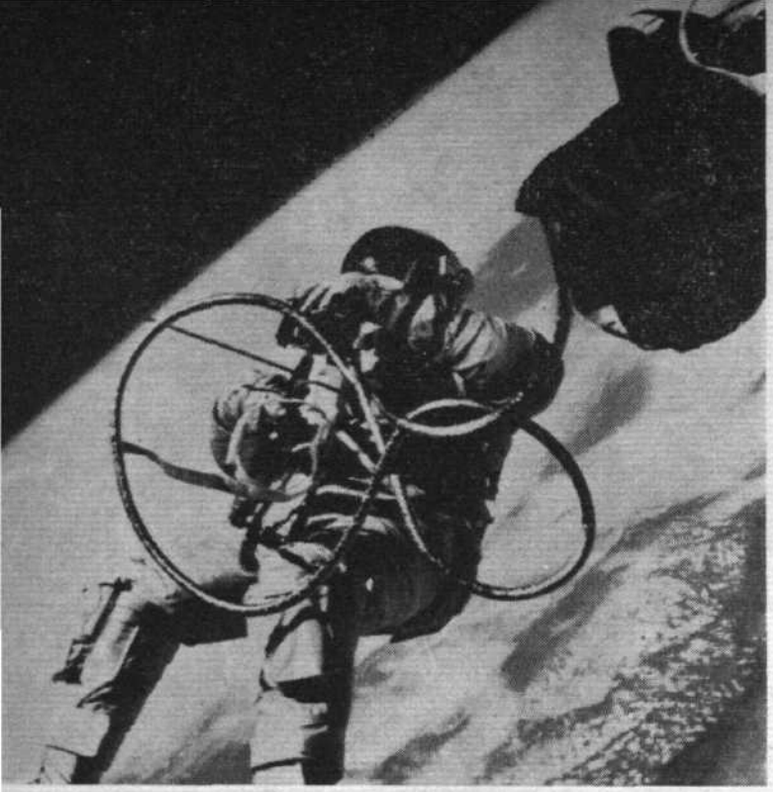


Sud has a project for an AAFSS version of the SA.330 tactical helicopter, which will have a cut-down fuselage with nose-mounted 20mm gun, a small wing and a swivelling tail rotor for cruise thrust. Below, the same company is entering the LOH market with a prototype next year of this Alouette 2-based, Astazou 2-powered light helicopter. It will have the Bölkow rigid rotor with plastic blades, which is already being flight tested



Nord's R.20 battlefield surveillance drone, with an hour's endurance at Mach 0.85, is transported and launched from a three-ton lorry. Cameras or TV are in the nose, and the wings fold for transport

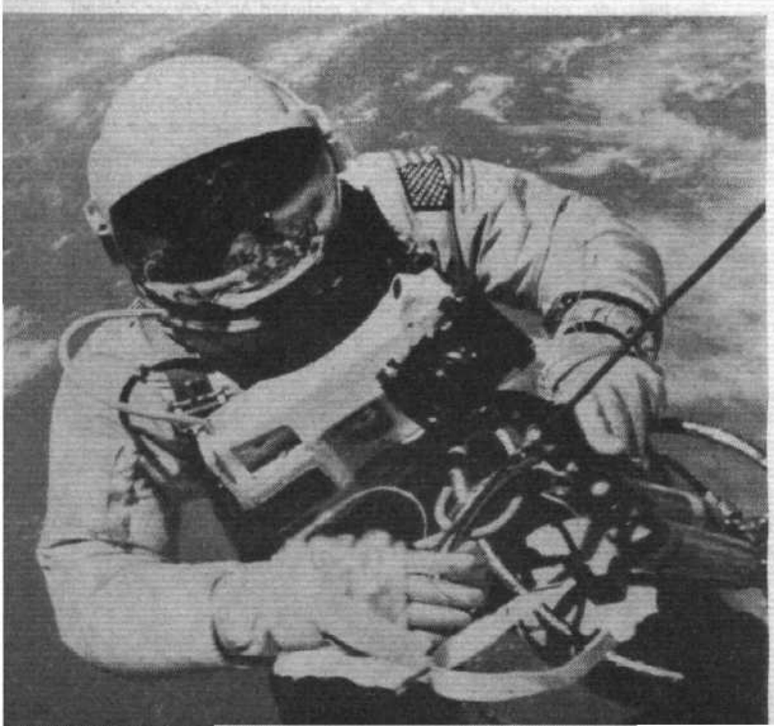
The new Nord infra-red aiming turret for four SS.11 missiles is mechanically controlled and can be mounted on lorry or coastal emplacement. Below, the cabin of the Hughes OH-6A, winner of the LOH competition, holds four people, but can squeeze in seven



During his 21min period outside the Gemini spacecraft on the third orbit of his June 3-7 flight, Maj Edward White was secured to the craft by a 25ft umbilical line and a 23ft tether line, wrapped together with gold tape to form one cord

Spaceflight

An emergency oxygen supply was carried by Maj White in his chest-pack during his Gemini 4 space flight. He and the command pilot, Maj James McDivitt, performed scientific and engineering experiments during their 62 orbits



PROGRESS WITH VELA

Two Vela satellites, used by the United States to detect high-altitude nuclear explosions that might not be detected directly from the ground, have been in operation since October 1963, and two more have been in orbit since July 17, 1964. The satellites contributed in part to early US assessment of China's recent nuclear test.

The Vela programme, which has been highly classified, was established soon after the Nuclear Test Ban Treaty came into effect in 1963. The satellites are launched in pairs. Each satellite weighs about 500lb and is studded with a score of X-ray, gamma ray and neutron detectors. Each pair of satellites is in orbit on opposite sides of the Earth at a distance of about 60,000 miles.

The US Air Force, which is responsible to the Advanced Research Projects Agency of the Department of Defense for the nuclear-explosions-in-space detection programme, eventually plans to have ten Vela satellites in orbit at one time. The 12 external X-ray detectors, six internal gamma detectors and one internal neutron detector used in the present Velas were developed by the Atomic Energy Commission, and they can distinguish nuclear explosions from cosmic showers, solar plasma and natural background radiation. Detectors are estimated to be sensitive enough to detect nuclear explosions even more distant from Earth than Mars and Venus.

Data from the four satellites totals over 12 thousand million bits, which has been transmitted from the satellites and recorded by a worldwide network of Air Force ground stations. The data is relayed to the Sandia Laboratory in Albuquerque, New Mexico, where some 1,400 reels of magnetic tape are used to store it. Final analysis of the data is made by specialists at the Los Alamos Scientific Laboratory.

MORE POWERFUL ATLAS

NASA is to develop a more powerful Atlas space booster for future Agena and Centaur missions. The programme, designated the SLV-3X, will include the following basic changes to be made in the standard Atlas launch vehicle (SLV-3):—

(1) Propellant capacity will be increased by some 21,000lb by making the top of the vehicle cylindrical rather than a truncated cone. The length of the Atlas will not be changed but the increased tankage will enable the Atlas to carry 15,000lb more liquid oxygen and nearly 7,000lb more RP-1 kerosene fuel.

(2) Thrust of the three Atlas engines will be increased by the use of an improved fuel injector and turbine. Use of a modified Saturn H-1 injector will increase the total thrust of the two booster engines from 330,000lb to 350,000lb. Use of an already developed turbine will increase the thrust of the sustainer engine from 57,000lb to 65,000lb.

The work will be done by the Convair Division of General Dynamics, San Diego, California. The United States Air Force Space Systems Division is the procurement agency acting as NASA's agent as in previous NASA procurements of Atlases. NASA's Office of Space Science and Applications has assigned Atlas-Agena and Atlas-Centaur project responsibility to the Lewis Research Center, Cleveland.

The modifications will use proven components to gain the increased Atlas performance. An extensive ground test programme including full duration engine firings is planned.

THIOKOL'S BIG SOLID CANCELLED

NASA has terminated its contract with Thiokol Chemical Corp for further development of a 260in diameter solid rocket motor. The reasons, a NASA spokesman said, were the difficulties encountered in processing and welding special steel required for the first 260in solid fuel rocket case, and the time which would be required to develop an alternative method.

During a hydrostatic pressure test on April 11 of the first case produced under the Thiokol contract, a failure occurred at a pressure considerably below the normal operating firing pressure, with the resulting destruction of this case. A second case, now approximately 60 per cent complete, was constructed by the same method and is subject to the kinds of fault which resulted in destruction of the first case.

As part of the large solid-propellant programme, Thiokol successfully fired a 156in diameter motor last February 27, using a nozzle of substantially the same design as the nozzles required

for the 260in motor. This successful test by Thiokol lasted 60sec and developed 3,200,000lb of thrust.

Aerojet-General, a second contractor undertaking the development of a 260in solid rocket motor, has successfully hydrotested its first case and is presently loading it with propellant for firing this summer. This company uses a different process and this contract is not affected by the termination of the development programme with Thiokol.

TITAN 3 AND AFTER

The Titan 3 family of boosters, of which the Titan 3C vehicle made its initial flight from Cape Kennedy on June 18, will give the US Air Force modular, off-the-shelf propulsion units for space work and research for many years to come, according to Gen B. A. Schriever, head of the Air Force Systems Command. Gen Schriever's observations were made recently in Albuquerque, New Mexico, and spelled out in greatest detail so far the future role of the Titan 3C.

Core of the Titan 3 series is the Titan 3A. "This modular, building-block design concept makes possible a series of vehicles that can boost payloads ranging from 5,000lb to 40,000lb to a variety of orbits," declared Gen Schriever. "To carry heavier payloads we can increase performance by adding a third-stage Agena vehicle; we can strap on two or four standard solid-propellant Minuteman motors, or increase the standard 120in solid motors developed by United Technology Center from five segments to seven," he explained. "Finally, 156in solid motors can be attached to the basic Titan 3 to provide even greater capability, and studies have shown a variety of upper stages can be added to the Titan 3, including the high-energy Centaur stage."

The Air Force is hoping that the combination of flexibility in the Titan 3 series together with proven reliability will yield substantial savings of millions of dollars. Storable propellants in the core and solid-motor, strap-on boosters will make it possible for most of the Titan 3 family to remain on the launch pad in a ready status for 30 days or more. "It is the first space booster that satisfies military operational requirements of extended readiness and the ability to respond almost instantaneously," Gen Schriever declared.

Early availability of the Titan 3C as an operational booster will be a great boon to the Air Force programme to establish a Manned Orbiting Laboratory (MOL) in space, Gen Schriever added. Development work leading towards an MOL will make maximum use of Apollo and Gemini spacecraft technology. The Gemini B or military version of the NASA Gemini spacecraft will employ 75 per cent of the design and engineering developed by NASA, 85 per cent of the flight experience, and about 40 per cent of the ground equipment. The first launch of a Gemini B will come late in 1967 or early in 1968.

Gemini B and/or other development vehicles will be used to test components and subsystems for the eventual "house trailer" size MOL. Room for much greater activity on the part of the crew must be available in the MOL than will be available in either Gemini or Apollo. This is necessary to maintain the well-being of the crew during extended spaceflights. Further, the military spaceflight programme must develop spacecraft capable to manœuvre during re-entry. "The use of ballistic re-entry vehicles with overwater recovery is not satisfactory for military purposes," Gen Schriever declared. Rather, the MOL eventually must be able to manœuvre and land within a prescribed area.

The USAF Spacecraft Technology and Advanced Re-entry Tests Programme (START) will investigate lifting bodies best suited for such a need. The radiation-cooled winged glider called ASSET which completed its sixth hypersonic flight in February was the forerunner of START.

The first phase of the START programme will see the SV-5 lifting body re-entry vehicle going through a series of tests. This vehicle is wingless and derives its lift from the fuselage. It has an ablative heat shield. Four tests are planned in 1966-67 with launches from Vandenberg AFB. The unmanned vehicles will follow ballistic trajectories with re-entry at orbital velocities and manœuvring flight down to aircraft speeds.

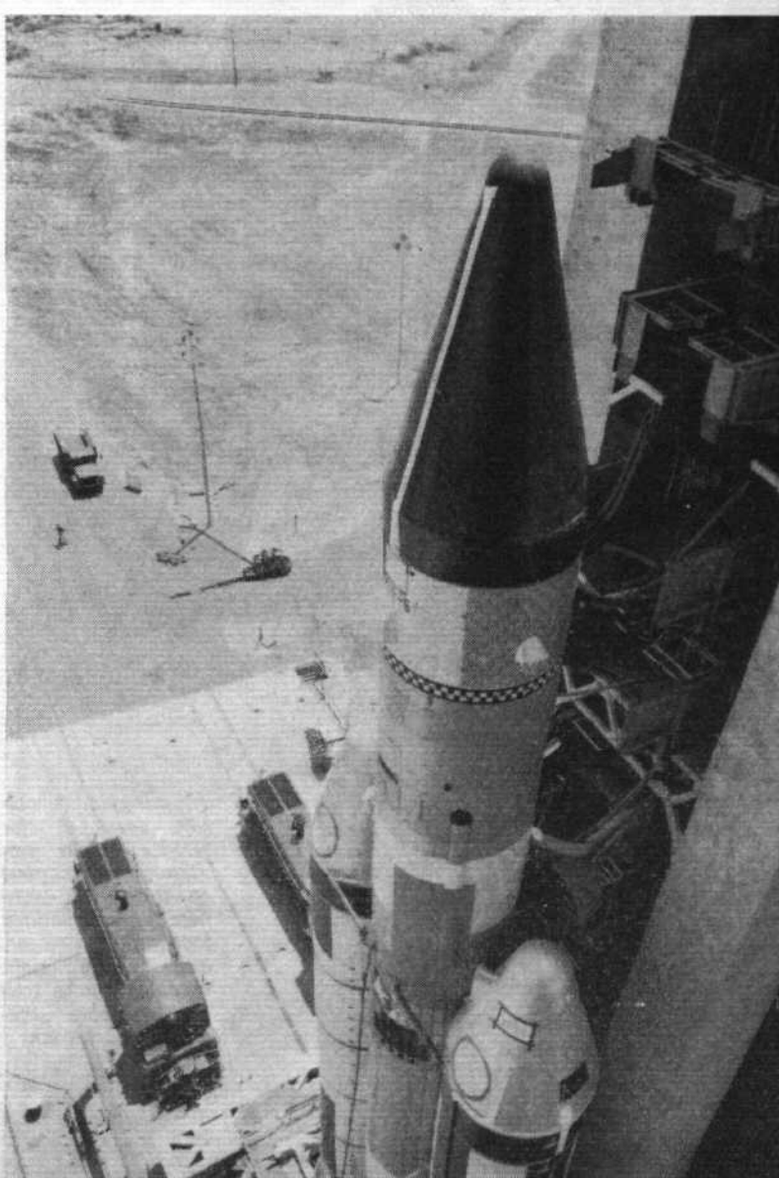
A later phase of the programme might provide additional data from Mach 2 to landing by using piloted SV-5s dropped from B-52 motherships. Data could then be obtained on the flight characteristics, aerodynamic stability and control. These flights could be co-ordinated with flight tests of other lifting bodies being investigated by NASA. As a side benefit, Air Force pilots would gain experience in the flight characteristics of a potential future spacecraft.

Gen Schriever declared that the Air Force is looking toward further economies in space boosters. He cited the Thor-Delta combination as costing about $2,500 per pound of weight put into low Earth orbit. The Titan 2/Gemini launch vehicle has a direct operating cost for the same orbit of about $1,200 per lb. The Titan 3 series will reduce this cost to $500 to $700 per lb and lower. "However, even greater savings are possible through the use of cheaper, expendable boosters and re-usable vehicles. Some studies made by the Air Force indicate that such advanced launch vehicle concepts might orbit payloads at $100 to $200 per lb.

"We visualize three general classes of advanced launch vehicle systems for the future," Gen Schriever said. "First, there is an advanced expendable booster that costs less than present boosters. Second, a re-usable or partially re-usable rocket that takes off and lands horizontally. Finally, a fully or partially re-usable vehicle powered by combinations of air-breathing and rocket engines which takes off and lands horizontally. The first two could be developed and produced in the near future, but the third appears to require a longer period. Other classes or vehicles such as re-usable nuclear vehicles, re-usable single-stage-to-orbit vehicles and hypersonic aerospace planes are further off," he declared.

Several programmes are under way to improve propulsion techniques for recoverable boosters, as well as problem areas concerned with recoverability of upper stages and spacecraft, such as vehicle separation aerodynamics, materials, refurbishment and cryogenic tank limitations. The Air Force and NASA are embarking on a programme to demonstrate very high chamber pressure cryogenic rocket engines whose performance will permit a 50 per cent increase in payloads for recoverable vehicles. "These engines will be throttleable, making for easier manœuvrability of the space vehicles during the recovery portion of the flight."

Titan 3C being readied for flight at Launch Complex 40 at Cape Kennedy. Its two million pounds of lift-off thrust is four times as great as that of Titan 2 (see "Titan 3 and After")



Spaceflight

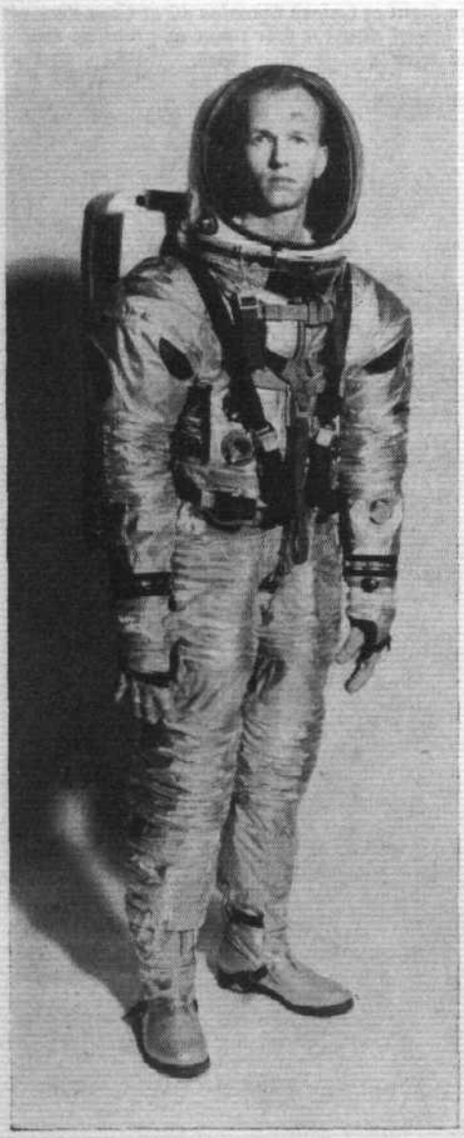
THE APOLLO SPACESUIT

The astronauts' spacesuit for the US lunar landing mission is the only operational equipment which must be designed to go all the way to the surface of the Moon and return to Earth. The Apollo suit, now being developed by crew systems division of the Manned Spacecraft Center, Houston, for use on the lunar surface is not a single garment, but an integrated series of garments. It is designed, the Houston centre states, to provide the astronaut with the best possible protection against the environment he will encounter on the lunar surface.

The suit, inevitably, is known not as a spacesuit but as an extra-vehicular mobility unit. It must shield its occupant against extremes of temperature from −250°F to +250°F. Micrometeoroids and the complete vacuum of space are two other hazards which it must withstand.

The well-dressed astronaut will wear the following assembly when he steps on to the lunar suface. The first-layer is a liquid-cooled undergarment. The best method of cooling the astronaut, it has been established, is by circulating cool water through small tubes which are in direct contact with the skin.

The second layer of the astronaut's attire is the pressure-garment or the actual suit assembly. This must be pressurized while the astronaut is on the lunar surface to protect him against vacuum. The soft pressure-garment tends to take a spherical shape when pressurized, so joints must be built into the suit to provide mobility.



The astronaut's spacesuit developed for NASA's Apollo programme and described on this page, worn here by a Hamilton Standard engineer, over whose right shoulder can be seen the portable life-support back-pack

Mobility can vary in different joints of the suit, and engineers must design each suit joint to give the greatest mobility for its corresponding human joint. For example, a knee-joint needs only a flexure or bending movement. It would not be acceptable as a shoulder-joint, which must make many complex motions.

Covering the pressure suit is a micrometeoroid protection garment. This is composed of lightweight materials arranged to provide as much protection from meteoroids as a thin sheet of aluminium.

The astronaut's attire is completed with a thermal overgarment composed of many thin layers of super insulation with a white synthetic fabric as an outer layer. Thermal mittens protect the hands and are provided with slit openings in the palms to enable specially insulated gloves to be used when tasks requiring finger dexterity must be performed.

The suit, including the thermal and micrometeoroid garment, weighs less than 50lb. The backpack which supplies oxygen and ventilation to the astronaut on the lunar surface weighs 60lb, and emergency oxygen and communications weigh 10lb.

While wearing all this equipment, the astronaut must be able to walk over the surface and perform many tasks. The suit unit was taken to Bend, Oregon, recently to be tested in terrain similar to conditions expected to be found on the Moon. The tests indicated that some joint areas, particularly in the thigh and ankle, need improvement to allow the man to move and perform assigned tasks more easily.

Engineers at Houston are further developing the suit to reduce the weight and bulk of the outer layers to provide more mobility, and several alternate approaches have been suggested. In one concept, micrometeoroid and thermal protection would be integrated as additional layers to the basic Apollo suit, as the Gemini extra-vehicular suit is constructed. A second approach combines the two types of protection into the basic suit below the waist, and the astronaut would wear a separate covering on the upper part of the body.

Protection for the astronaut's eyes must also be considered as part of the pressure-garment assembly. Without any atmosphere to scatter and cut down the power of the Sun's rays on the lunar surface, the astronaut will be exposed to visible, infra-red, and ultra-violet rays. Solar reflection from the space suit, the lunar excursion module, or scientific equipment may produce a blinding glare. Dark adaption problems will be created by the transition from light to shadow in sunlit areas.

As a solution to these visual problems, an adjustable visor has been designed to fit on the helmet. This can reflect 80-90 per cent of visible light, 60-80 per cent of infra-red rays, and nearly all of the ultra-violet rays. An inner and outer visor arrangement prevents fogging caused by temperature extremes.

While the Apollo suit is undergoing its development, the Gemini suit has been qualified for early Earth-orbital flights. With small modifications, Gemini suits will also be used for early Apollo Earth-orbital missions to allow design engineers to concentrate on developing the Apollo suit for lunar trips.

For micrometeoroid protection, a cloth material which will stop penetrating particles has been developed for Gemini. The Gemini suit has been qualified for vacuum and extreme temperature operation in the 35ft diameter vacuum chamber at the Manned Spacecraft Center.

Since the beginning of the US manned spaceflight programme the development work in suits has had two goals. First, to protect the man inside the spacecraft cabin in case of a loss of pressure. Second, to provide protection for the man venturing outside into space. The investment in developing pressure suits for Gemini and Apollo has already reached $12m.

Test equipment for UK-3 and other Earth satellites has been ordered for the Royal Aircraft Establishment from the M.E.L. Equipment Company Ltd. This follows a design study by M.E.L. for a data-sensing and extracting system for a satellite environmental testing facility. The work is largely connected with temperature sensors and ancillaries for operation between −180° and +180°C in the RAE's new full-scale environmental chamber. The satellite under test can be moved in two directions at right angles to each other in the chamber and rotated continuously for three turns about its own axis. Considerable attention has therefore been given to devising a flexible joint for connecting a large number of sensors on the satellite to the external equipment.

WESTLAND LEADS

In helicopters

TURBINE-POWERED

By adapting the well-proven S.58 airframe to gas-turbine power in 1957, Westland helped pioneer the change-over from piston-engined to turbine-engined helicopters. Its current range of multi-purpose, turbine-powered machines—'Scout', 'Wasp', 'Whirlwind Series 3' and single and twin-engined 'Wessex'—is the largest offered by any manufacturer.

Machines of the British Armed Services are playing a vital part in current Security operations in Malaysian North Borneo, the Aden Protectorate and Cyprus. Orders worth £12,000,000 (U.S.$ 33,600,000) have already been placed by overseas Military Forces.

In the civil field, the 'Whirlwind Series 3' is giving outstandingly reliable service in support of major offshore oil-drilling operations in the Arabian Gulf and the North Sea. Soon, it will be joined by the civil version of the highly-successful twin-engined 'Wessex'.

WESTLAND

the great name in HELICOPTERS

In hovercraft

Just six years ago, Westland's Saunders-Roe Division designed and built Britain's first hovercraft, the SR.N1.

Since its launching in 1962, the 27-ton SR.N2—the first serious attempt to produce a commercially-practical hovercraft—has covered some 13,000 miles and carried over 33,500 passengers.

The World's largest hovercraft—the 37-ton SR.N3—was delivered right on schedule to the British Interservice Hovercraft Trials Unit in June 1964, and is now being evaluated in a number of possible over-water and amphibious roles.

The World's first hovercraft production line of 7-ton SR.N5's was laid down in August 1963 without waiting for orders. Orders have been secured from the British Ministry of Defence and five overseas countries. An advanced version of this craft—the 9-ton, 38-passenger SR.N6—is now also in production and orders have been won in Norway and the United Kingdom.

The Company's hovercraft operating experience is unrivalled. To date, some 2,000 hours have been amassed with SR.N1, SR.N2, SR.N3, SR.N5 and SR.N6.

Westland has also published the first detailed proposals for a hovercraft ferry across the English Channel. Design work on a suitable craft—the 150-ton, 660-passenger SR.N4 is already in its final stages.

sustained

HOVERCRAFT LEADERSHIP

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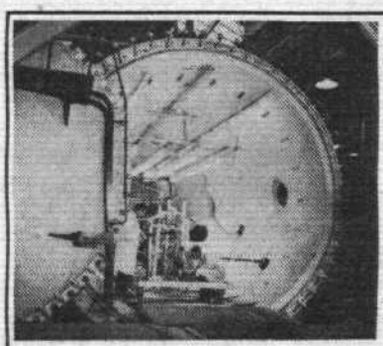

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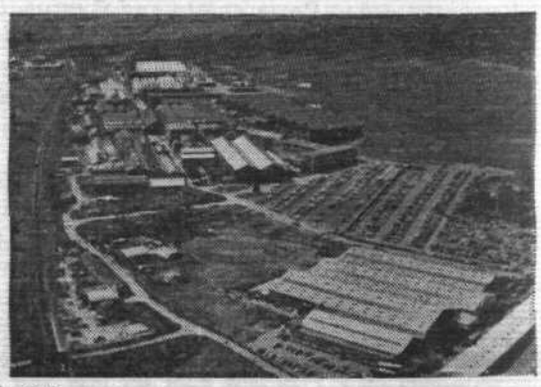

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Spaceflight

MAY ORBITS

The following list covers all the artificial Earth satellites known to have been launched during May 1965. It follows on from the "April Orbits" feature in our May 13 issue. Orbital elements quoted refer normally to the initial values.

May 6 1965-34. USAF triple launch from Cape Kennedy at about 15.00 GMT using a Titan 3A vehicle. Components: Transtage (34A) rocket; LES-2 (34B); tracking calibration sphere (34C). Initial orbits, 34A, 115 miles, circular in period 88.2min; 115-1,725 miles in 115.5min; 1,725 miles circular in 145.1min and finally 1,730-2,322 miles, inclination 32.07°, period 156.9min; estimated lifetime 50,000 years. Orbit 34B, 1,756-9,380 miles, 31.36°, 315.16 min; orbit 34C, 1,727-1,738 miles, 32.11°, 145.42min; lifetimes about 50,000 years.

May 7 1965-35. Cosmos 66 launched from the Soviet Union at about 09.31 GMT. Components: Cosmos 66 (35A) transmitted on 19.996Mc/s; rocket body (35B); two fragments (35C and D) which decayed after 2 days. Satellite orbit 125-175 miles, 65.01°, 89.32min. Satellite re-entered May 15. Orbit 35B, 140-173 miles, 65.02°, 89.5min; decayed May 23.

May 9 1965-36. Luna 5 launched from the Soviet Union at about 07.52 GMT. Components: Luna 5 (36A) 3,254lb test vehicle for lunar soft-landings ejected from orbiting platform (36B) in Earth orbit; one fragment (36C) decayed after one day. Trajectory of Luna 5 corrected en route; impact in Sea of Clouds 19.09 GMT, May 12; flight time about 83hr 17min. Orbit 36B, 94-135 miles, 64.78°, 88.16min; decayed May 10.

May 18 1965-37. USAF satellite launched from Vandenberg at about 18.02 GMT using a Thor Agena vehicle. Satellite orbit 123-205 miles, 75.02°, 89.8min; estimated lifetime 3 weeks.

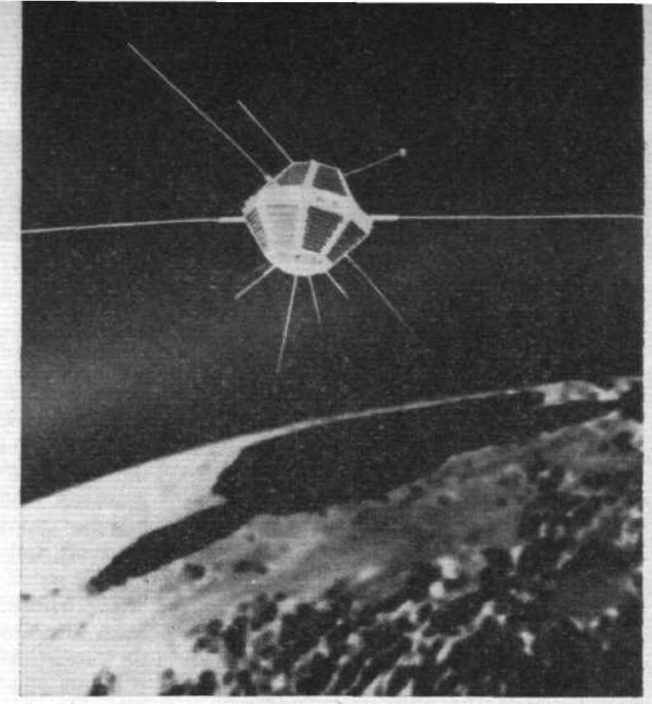
May 20 1965-38. USAF satellite launched from the Western Test Range at about 16.30 GMT using a Thor Altair vehicle. Main component 38A, Altair rocket with payload; three fragments (38B, C and D). Orbit 353-591 miles, 98.69°, 100.05min; estimated lifetime 30 years.

May 25 1965-39. Pegasus 2 launched by NASA from Cape Kennedy at 07.35 GMT using a Saturn 1 (SA-8) booster. Components: Pegasus 2 (39A); boilerplate Apollo command and service modules (39B). Satellite orbit 318-461 miles, 31-77°, 97.0min; estimated lifetime 15 years.

May 25 1965-40. Cosmos 67 launched from the Soviet Union at about 10.52 GMT. Components: Cosmos 67 (40A) transmitted on 19.995Mc/s; rocket body (40B). Satellite orbit 127-220 miles, 51.86°, 90.03min; estimated lifetime 8 days. Estimated lifetime of rocket 2½ weeks.

May 27 1965-41. USAF satellite launched from the Western Test Range at about 19.33 GMT using an Atlas Agena (?) vehicle. Satellite orbit 86-167 miles, 95.77°, 88.56min; est. lifetime 5 days.

May 29 1965-42. Explorer 28 (Interplanetary Monitoring Platform 3) launched by NASA from Cape Kennedy at 12.00 GMT using a Thor Delta vehicle. Components: Explorer 28 (42A); Altair rocket (42B). Satellite orbit 120-164,100 miles, 33.86°, 142.6hr; estimated lifetime 10 years; 42B similar.



Artist's impression of the ISIS-A satellite, the first of four which Canada is building as part of the International Satellites for Ionospheric Studies programme

LUNA 6: OFFICIAL COMMENT

The following official Tass communique was issued on June 10 concerning the progress of the Soviet lunar spacecraft:—

"The automatic Luna 6 station will pass at a distance of 160,000km from the Moon. During a correcting manœuvre yesterday, an engine was successfully switched on and it functioned. But it was not possible to switch it off. As a result the flight's trajectory deviated from the planned course.

"Twelve communication sessions were held with Luna 6 on June 8 and June 9. During these sessions control of the station's systems was effected on signals from the Earth, trajectory measurements were conducted and telemetric information received. During this period experiments were made for an improvement in the work of a number of systems of the station.

"The data received showed that the systems of radio control of the trajectory, radio control and independent control guarantee normal functioning of the station. It was established that the astral orientation systems made it possible to effect all necessary manœuvres of the station.

"The measurements made showed that the flight trajectory lies within the calculated deviations.

"Towards the end of the day yesterday, during a correcting manœuvre, the Luna 6 systems performed the orientation, launching and activation of the engine normally. But the command for switching off the engine was not complied with and the station's trajectory deviated from the planned course.

"The station will pass at a distance of 160,000km from the Moon. There has been stable radio communication with the station. The testing of the station's systems and the scientific experiments are being continued."

BRITTEN-NORMAN BN-2 ISLANDER (continued from page 1021)

considered possible. Even without the conclusion of licensing agreements production could be well on the way to a high rate by the end of next year. Plans have already been drawn up for a new hangar and an extension of the workshops at Bembridge.

Britten-Norman Ltd was founded as a partnership in 1952 and incorporated in 1954. It is the progenitor of a small group of companies with the same shareholders and directors, each company specializing in a particular field. The parent company at Bembridge is highly successful as designers and manufacturers of aerial crop spraying equipment, and air cushion vehicles and (now) aircraft have been a natural outcome of such precision engineering experience. Turning to the subsidiaries, Crop Culture (Aerial) Ltd was formed in 1956 and is engaged in international aerial spraying operations with nine partly or wholly owned subsidiary and associate companies operating in many parts of the globe. Aeronautical Services West Africa Ltd, the other main-group company, was incorporated in 1959 and is engaged in the sale and maintenance of aircraft and equipment in Ghana and Nigeria. Group annual sales in 1963 (excluding ASWA and Snow Aeronautical, in which B-N hold a 17 per cent share) amounted to over £1 million. The group has grown up almost entirely on the basis of overseas trade in the aviation industry. The BN-2 obviously stands to benefit not only from the accumulation of experience directed to getting the design as near as possible absolutely right from the start, but from the network of organizations for getting it launched.

To begin with at least, BN-2s will be bought mainly by widely located commercial operators, and therefore sales will be by the direct method. Nevertheless, Britten-Norman will have associated companies selling the BN-2 in nine countries, in seven of which complete after-sales service can be provided. For North, Central and South America, Jonas Aircraft & Arms Corp of New York (until recently Piper export distributors for most countries of the world and with whom B-N have a close trading relationship) will add the BN-2 to their existing line of utility aircraft.

Straight and Level

AN amazing Giant Soviet Plane arrived at Paris on the last day of the Saloon, reports Straight and Level's ace air reporter Nigel Nonstory.

Described by Western air experts as a Giant Soviet Plane, it is as long as 2,198 London buses parked end to end and as high as 346 semi-detached bungalows in Potters Bar or 1,300,000 plates of egg and chips piled one on top of the other.

I say that this plane, officially described by Soviet air experts as a Giant Soviet Plane, presents a serious challenge to Western planebuilders.

I report the following conversation at Paris between genial Ivan Fobovsky and a leading western airline chief:—

What is the operating cost?—The operating cost is very low.

What is the delivery date?—The delivery date is very early.

Will you give full technical information to the ARB for airworthiness certification?—The aircraft is very airworthy.

Can I have my technical reps in your factory?—Our factory is very technical.

Do you provide parts warranties and an over-the-counter exchange service, after-sales service and support and pilot and engineering training?—Our aircraft are ready for service after the sale.

Thank you. We are completely satisfied that this aircraft is exactly what we want, and never again will we buy our aircraft from western aircraft companies.

● Straight and Level's stand at this year's Paris Saloon was dominated by a fully sectioned working rig of myself strain-gauged to record the effects of constant conversions from English to metric units, francs and £ to $, and vice versa.

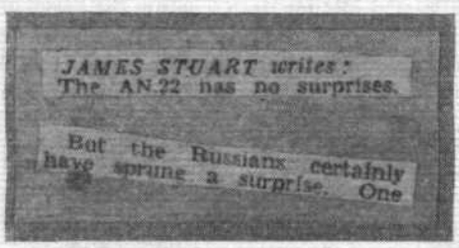
A special Cancellations Board showed the status of major British aircraft programmes, with a veeder counter clicking off the cancelled projects at half-hourly intervals, and a Major Rows Board showing the status of any rows raging.

The Ministry of Planes exhibit took the form of a Quiet Garden of Remembrance for the British aircraft industry decorated with an inflatable plastic model of Lord Plowden made by the Plastic Gnomes and Birdbaths Division of Scruggs Aircraft Ltd. The products of this division now account for some 95 per cent of that grand old aircraft company's turnover.

● Remarkable how the An-22 bears the Antonov family resemblance. Actually, it looks like an An-10 that has been treated with Plantoids.

● Paris, June 14, Reuter.—Mr Antonov cleared up one mystery of the show: What had happened to his giant 500-passenger air bus, the Antonov 22, which was supposed to fly in here this week? Mr Antonov did not know anything about it. "Why would anyone build such a plane?" he commented. The designer believed that his 132-seat An-10 may have caused reports about "a giant plane."

Give me Julian Washbrain every time.



From the London "Evening Standard," June 15

From a poster snapped in Shanklin. It reminds me of the Yorkshireman who put a notice in his shop window: "Fishing tickle for sale." Nearly everyone who came into the shop to tell him of the mistake bought something

● British Aircraft Corporation advertisement for the One-Eleven, 1964/1965: "*High-tailing it . . .*"

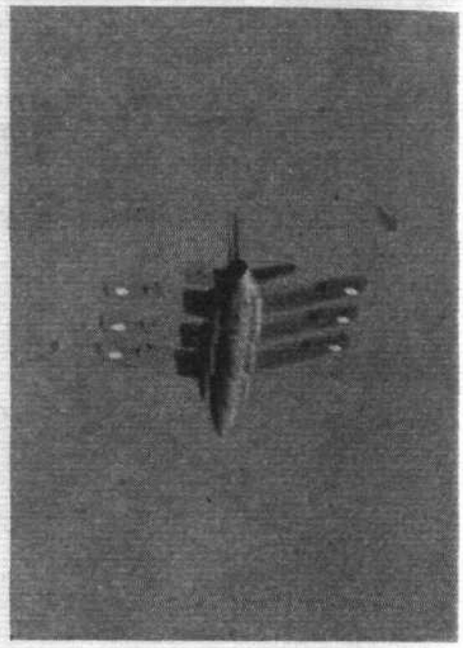
Douglas Aircraft Company advertisement for the DC-9, 1965:

"*High-tailing it . . .*"

● Pan American, in a recent demonstration of the way Early Bird can improve the flow of airline operations and reservations data between London and New York, took photographs of passengers boarding at London and presented them with prints at New York.

Early Bird, or some such comsat, will soon enable people in New York to have television conversations with their relatives or customers in Europe, or vice versa. In which case nobody will need to fly.

So if I were Pan American I wouldn't sell Early Bird, I'd buy it.



It'll never sell

A Gnat triplane that somehow got involved with the Red Arrows

● A union branch official was reported by the *Evening Standard* to have said about the BEA porters' strike, which ruined thousands of Whitsun holidays:—

"*This strike will hit the public. We don't like doing it but the public aren't going to feed our families for the next three years.*"

If the meal tickets of BEA's employees do not come from the travelling public, whence do they come? Why, from the taxpayer, silly.

The sole purpose of a State corporation is to provide employment, and to be financed by the State in order to be milched and mulcted by the unions. It is the duty of the travelling public to pay not only fares, but also taxes, and to have their holidays ruined to this end.

● A reader reminds me of the authorized version of the famous Masefield quotation, which we got slightly wrong in our leading article last week:—

"Passengers are the purpose of our business—not an interruption of our work."

● Nice comment on the model of the VFW.614, the German short-haul transport project with an engine pod on the top of each wing: "It looks like a B-66 coming out of a cu-nim."

ROGER BACON

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HERON MARK 2 for sale, radio config: VHF1 50kc/s spacing; VHF2 STR 12D; ILS Collins; VOR Collins; ADF 1; ADF 2 AD722. This aircraft is immaculate, flown 70hr since complete overhaul and refurnish by de Havilland. All enquiries to Technical Director, British Westpoint Airways, Exeter Airport, Devon. [6611

BOURNAIR offer choice of 18 1965 Cessna F172F from £6,493 duty paid and delivered. With each of these aircraft Bournair supply and fit free of charge King 95E radio! Bournair, Hurn Airport, Christchurch, Hants: Northbourne 2093. [6622

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AUSTER Mk.5, 4 seat. Recent £450 C of A, engine hours 450. £885. Morrison, Felthorpe, Norwich. Tel: Hevingham 282. [6693

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