October 13, 1958

Aviation Week

Including Space Technology

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•

Giannini Studies Plasma Jet Uses

McDonnell F4H-1 Fighter

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black boxes

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AVIATION CALENDAR

Oct. 20-21—Fourth National Aero-Com Symposium, sponsored by Institute of Radio Engineers, Hotel Utica, Utica, N. Y.

Oct. 20-22—1958 Annual Meeting, Assn. of The United States Army, Sheraton-Park Hotel, Washington, D. C.

Oct. 20-30—Sixth Annual USAF Weapons Competition, interceptor phase, Air Defense Command, Tyndall AFB, Fla.

Oct. 22-24—Fifth National Vacuum Symposium, Sir Francis Drake Hotel, San Francisco, Calif.

Oct. 22-24—Meeting of Aviation Medicine, sponsored by University of California, Miramar Hotel, Santa Monica, Calif. For details: Thomas H. Sternberg, M.D., UCLA Medical Center, Los Angeles 24, Calif.

Oct. 23—Jet Transportation Day, sponsored by Chicago Assn. of Commerce and Industry, Sherman Hotel, Chicago, Ill.

Oct. 23-25—1958 National Simulation Conference, sponsored by Institute of Radio Engineers Professional Group on Electronic Computers, Statler-Hilton Hotel, Dallas, Tex.

Oct. 27—14th Annual General Meeting of The International Air Transport Assn., New Delhi, India.

Oct. 27-28—East Coast Conference on Aeronautical & Navigational Electronics' Institute of Radio Engineers, Lord Baltimore Hotel, Baltimore, Md.

Oct. 27-31—National Metal Exposition and Congress, Cleveland Public Auditorium, Cleveland, Ohio.

Oct. 28-29—AGARD Eighth General Assembly, Copenhagen, Denmark.

Oct. 29-31—Air Traffic Control Assn., Annual Business and Council Meeting, Marriott Motor Hotel, Washington, D. C.

Oct. 30-31—1958 Electron Devices Meeting

(Continued on page 6)

AVIATION WEEK Including Space Technology

October 13, 1958
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AVIATION CALENDAR

(*Continued from page 5*)

sponsored by Institute of Radio Engineers, Shoreham Hotel, Washington, D. C.

Oct. 30-31—15th Annual Display, Aircraft Electrical Society, Pan Pacific Auditorium, Los Angeles, Calif.

Nov. 3-7—Fifth Institute on Electronics in Management, American University, Washington, D. C.

Nov. 6-7—13th Annual Symposium on Applied Spectroscopy, Hotel New Yorker, New York, N. Y.

Nov. 6-7—Quarterly Regional Meeting, Assn. of Local & Territorial Airlines, Honolulu, Hawaii.

Nov. 6-7—Fifth Annual Meeting, Institute of Radio Engineers Professional Group on Nuclear Science, Villa Hotel, San Mateo, Calif.

Nov. 6-7—National Specialist Meeting on Dynamics and Aeroelasticity, sponsored by Institute of the Aeronautical Sciences, Texas Section, Texas Hotel, Ft. Worth.

Nov. 9-12—13th Annual Convention and Logistics Forum, National Defense Transportation Assn., Sheraton-Jefferson Hotel, St. Louis, Mo.

Nov. 10-12—International Conference, Physics and Medicine of the Atmosphere and Space, sponsored by the School of Aviation Medicine, San Antonio, Tex.

Nov. 10-13—11th Annual International Air Safety Seminar, Flight Safety Foundation in cooperation with Airways Modernization Board's National Aviation Facilities Experimental Center, Atlantic City, N. J.

Nov. 10-21—12th Air Transportation Institute of the American University, Washington, D. C.

Nov. 11-14—19th Annual Convention, National Trades Assn., Pfister Hotel, Milwaukee, Wisc.

Nov. 12-14—Eighth Aircraft Hydraulics Conference, sponsored by Vickers, Inc., Park Shelton Hotel, Detroit, Mich.

Nov. 12-14—1958 Annual Meeting, Society for Experimental Stress Analysis, Hotel Sheraton-Ten Eyck, Albany, N. Y.

Nov. 16-21—Conference on Scientific Information, Mayflower Hotel, Washington, D. C. Co-sponsored by USAF Office of Scientific Research, National Academy of Sciences, National Science Foundation and American Documentation Institute.

Nov. 17-18—Sixth Annual Aircraft and Missile Division Conference, American Society for Quality Control, Biltmore Hotel, Dayton, Ohio.

Nov. 17-21—13th Annual Meeting and Astronautical Exposition, American Rocket Society, Hotel Statler, New York, N. Y.

Nov. 17-21—Eighth National Plastics Exposition, International Amphitheatre, and Plastics Conference, Hotel Morrison, Chicago, Ill.

Nov. 19-20—Northeast Electronics Research and Engineering Meeting, Mechanics Hall Boston, Mass.

Nov. 19-21—32nd Meeting, Aviation Distributors and Manufacturers Assn., Statler Hilton Hotel, Dallas, Tex.

Nov. 28-Dec. 4—First Electronic Computer Exhibition and Symposium, Olympia, London, England.

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58-16

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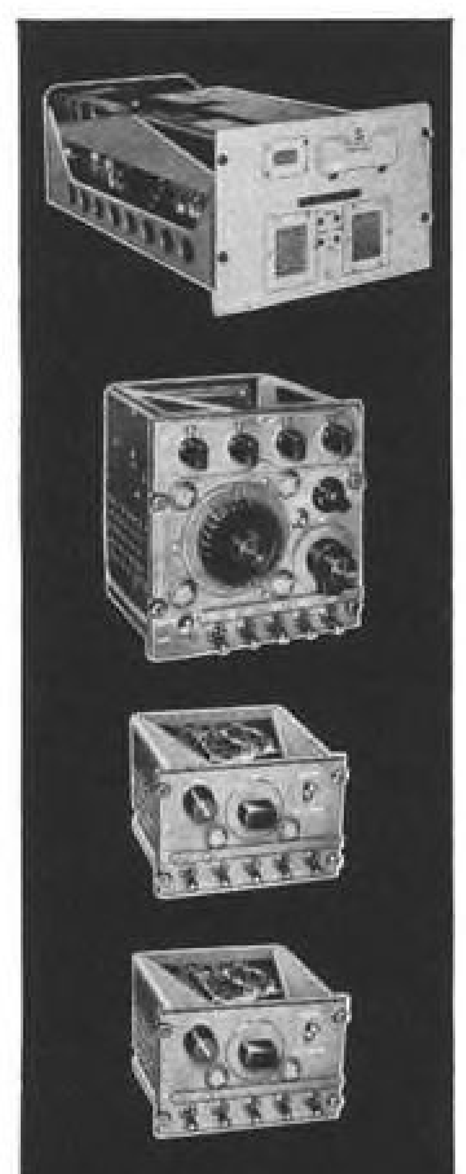

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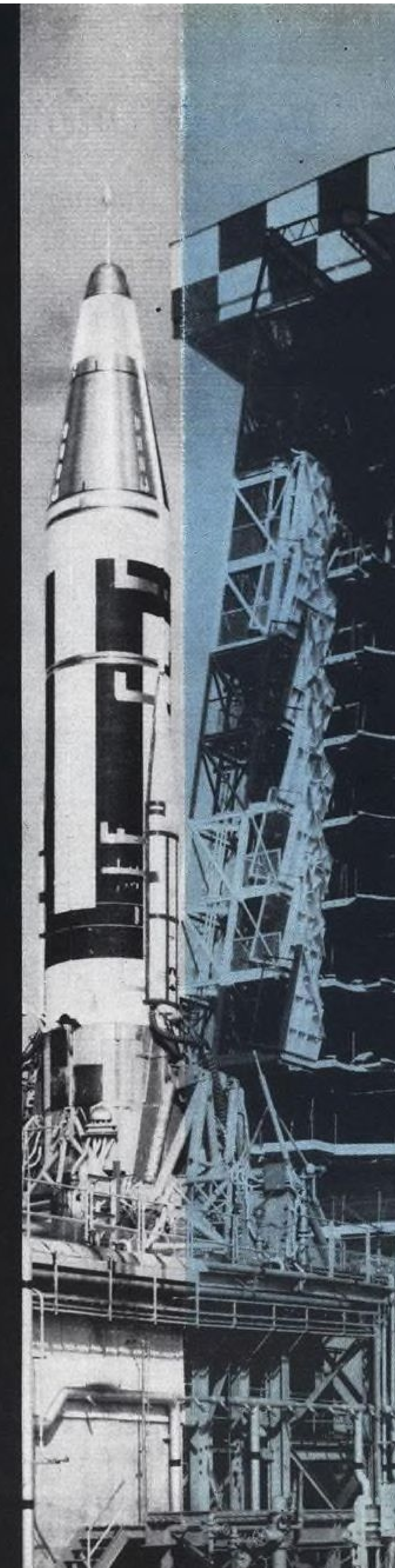

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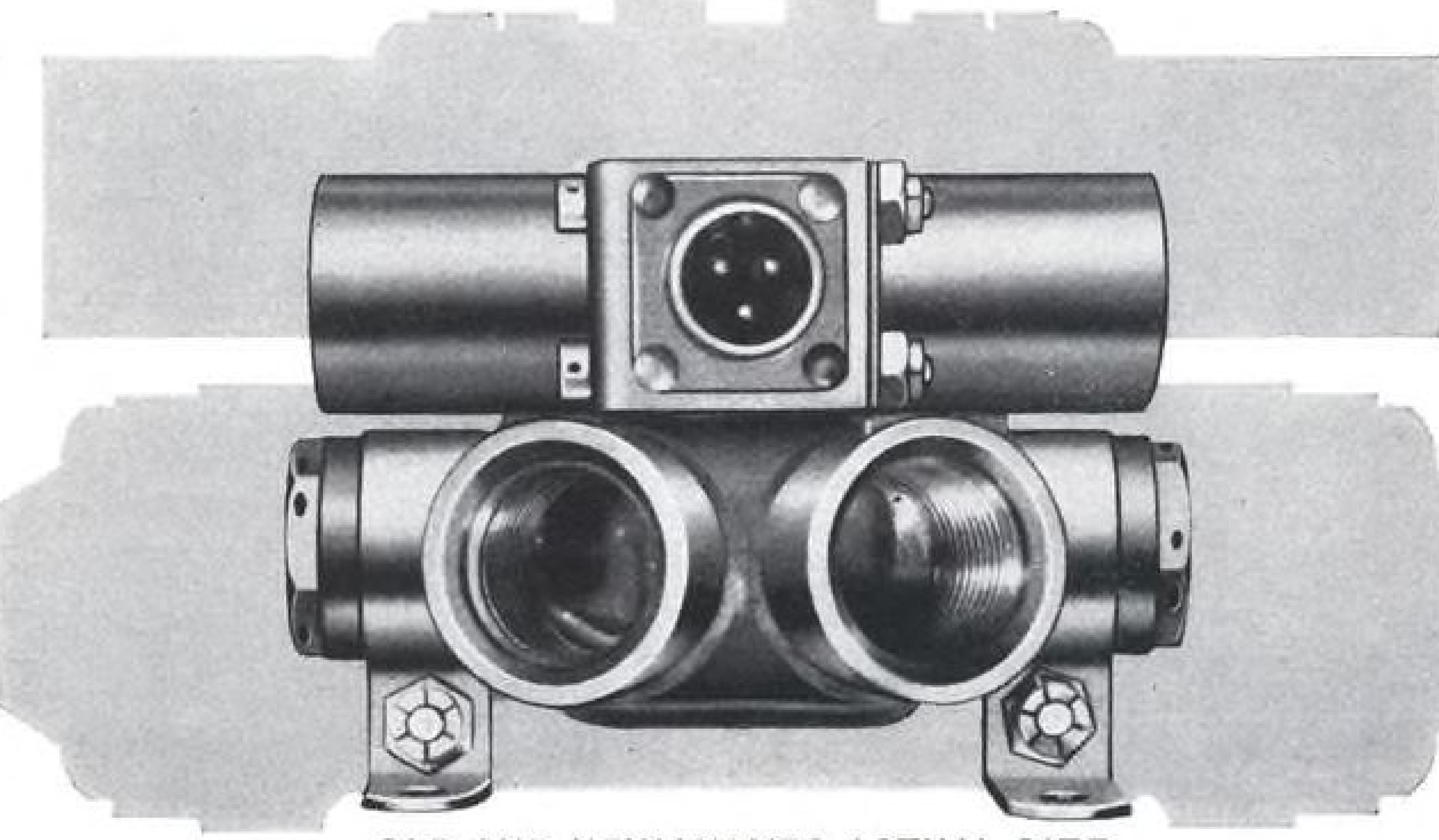

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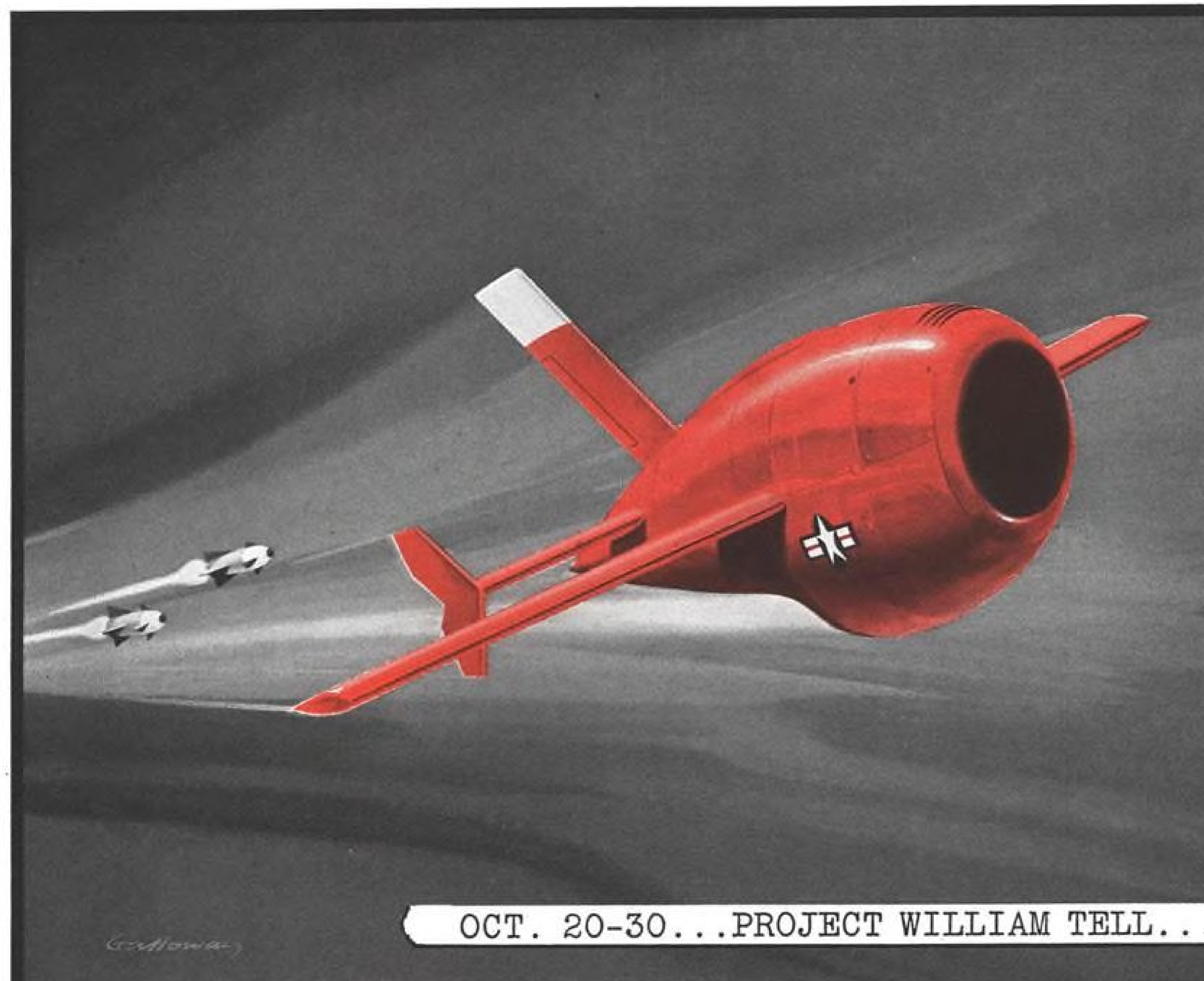
OCT. 20-30...PROJECT WILLIAM TELL...

October 13, 1958

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EDITORIAL OFFICES: New York 36—330 W. 42nd St., Phone: LOngacre 4-3000 (Nights LO 4-3035) **Washington 4, D. C.**—National Press Bldg., Phones: NAtional 8-3414, REpublic 7-6630 **Los Angeles 17**—1125 West Sixth St., Phone: HUntley 2-5450 **Dallas 1**—1712 Commerce St. Phone: RIverside 7-5117 **European Office**—1 rue du Temple, Geneva, Switzerland, Phone: 32-35-63

COVER: Overhead view of McDonnell F4H-1 all-weather jet fighter interceptor shows smooth area rule curve over greatest part of its fuselage, with only slight pinch at mid-section. Aircraft, now undergoing flight tests at Edwards AFB, is powered by two General Electric J79-2 engines which push it into Mach 2-plus range. For details and other pictures, turn to page 66.

PICTURE CREDITS
Cover—McDonnell; 26—Aviation Week; 29—Sikorsky; 30—Piasecki; 27, 31—Lockheed; 32—Schweizer Aircraft Corp.; 33—Atomic Energy Commission; 66, 67, 77 (top)—McDonnel Aircraft Corp.; 41—R. Stockwell; 48, 49, 51, 55—Giannini Plasmadyne Corp.; 77 (bottom) Chrysler Corp.; 79, 83, 112—Boeing Airplane Co.; 88—Kaman; 91—Rheem Mfg. Co.; 98—Schweizer Aircraft Corp.; 33—Atomic Energy Commission; 66, 67, 77 (top)—McDonnell

74,393 copies of this issue printed

EDITORIAL

A Fine Opportunity

Organization of the Federal Aviation Agency scheduled to become operative on Jan. 1, 1959, provides a fine opportunity for sweeping out many of the old cobwebs that have cluttered the civil aviation picture during the postwar decade and taking a fresh, technically modern and economically sound approach to what is becoming an increasingly acute problem. The entire civil aviation picture is badly in need of a new and well coordinated program aimed at alleviating the many technical and economic problems that threaten to curb its genuine growth potential.

President Eisenhower has made an excellent choice in naming Elwood P. "Pete" Quesada to head the new Federal Aviation Agency. Mr. Quesada, as special Presidential adviser on civil aviation policy during the past year, has made a substantial contribution to the work begun by his predecessor, Edward P. Curtis, and has shown extraordinary skill in working with the many varied facets of the civil aviation problem including Congress. We hope that this excellent choice of an administrator will be followed by the equally wise selection of James T. Pyle, present Civil Aeronautics Administration chief, as deputy to Mr. Quesada. "Jimmy" Pyle has brought a breath of fresh air to the musty CAA and has the vigor and courage to battle for the many breaks with tradition that are vital to aviation's progress.

Recruit Sound Personnel

One of the major problems facing the new Federal Aviation Agency is recruiting sufficient vigorous and technically sound personnel to match the pace of its administrator. Simply taking over the present CAA personnel lock, stock and barrel would doom the new agency to sterility from the start. There are able men in the present CAA organization but they are in a minority. On the whole, the CAA has become a classic example of how the civil service system can create a bureaucratic monolith that is interested primarily in preserving a status quo and shuns all progress and change. CAA's postwar record is a decade of utter futility in coping with the tremendous problems posed by aviation's rapid technical development. The fact that we are entering the jet age with a creaking traffic control system and grossly inadequate ground environment can be laid primarily at the doors of the former lighthouse keepers and OX-5 engine experts of the CAA whose technical education ended with the Jennie. The long delay in utilizing radar as a traffic control and approach system, the sorry episode of the slope line approach lights, the contractual red tape that drove industry out of the CAA equipment market and many other episodes familiar to all who have worked in civil aviation for the past decade show clearly that CAA personnel must be carefully screened before acceptance into the new Federal Aviation Agency.

The Federal Aviation Agency faces a tremendous task. For it not only must cope with the problems of the future but still has a sizable pile of problems from the past as a legacy from the musty CAA. If the extremely difficult problems of breaking through the many dead layers of the CAA personnel and selecting only the vigorous and technically competent people can be solved, Mr. Quesada will be off to a running start on the multitude of other problems facing his new agency.

In the technical area the airspace problem is probably the most acute facing the new Federal Aviation Agency. Thanks to a firm stand by Messrs. James Durfee, Civil Aeronautics Board Chairman, "Jimmy" Pyle, "Pete" Quesada, the problem of divided authority in airspace control has already been resolved and the new agency has a clear charter to exercise firm control to provide for both military and civil requirements. To do this job adequately the installation and operation of new traffic control and bad weather approach equipment must be pushed to the limit.

Federal Airport Program

Certainly a new federal airport program must also be formulated if ground environment is to be adequate for the military and civil aircraft already flying. The President's veto of the Airport Act passed by the past Congress should be rectified as soon as legislatively possible.

Virtually everybody devoted to the cause of civil aviation fought hard for the establishment of the Federal Aviation Agency. The selection of Mr. Quesada to head it has been widely endorsed by knowledgeable groups. All of us who have fought so hard to get this type of aviation agency and vigorous leadership must now fight equally hard to see that it is given whatever it needs to take full advantage of the fine opportunity that now lies ahead.

—Robert Hotz

WHO'S WHERE

In the Front Office

Geoffrey R. Simmonds, president and a director, Simmonds Aerocessories, Inc., Tarrytown, N. Y.

George W. Bruner, a director, Bernco Engineering Corp., Indianapolis, Ind. Mr. Bruner is vice president-sales and engineering.

William A. Mattie, a director, Eaton Manufacturing Co., Cleveland, Ohio. Mr. Mattie is vice president-administrative.

Joseph B. Black, vice president-operations, and **James T. Dresher**, vice president-finance, The Hiller Aircraft Corp., Palo Alto, Calif.

Vertol Aircraft Corp., Morton, Pa., has elected **James N. Davis**, vice president-government operations; **Hamilton W. Lord**, financial vice president; **Virgil J. Wiltse**, vice president-industrial relations.

Gerhard Neumann succeeds **Guy C. Shafer** as general manager of General Electric's Small Aircraft Engine Department, Lynn, Mass. **Donald C. Berkey** succeeds Mr. Neumann as general manager of the Jet Engine Department, Evendale, Ohio.

R. E. Kleint, vice president and general manager, Ultrasonic Testing and Research Laboratory, Van Nuys, Calif.

Capt. Hamilton O. Hauck (USN, ret.), director of the Technical Department, Guided Missiles Division, Fairchild Engine and Airplane Corp., Wyandanch, N. Y. Formerly, Captain Hauck was director of the Guided Missiles Division, Bureau of Aeronautics.

Charles B. Preston, general accountant, United Aircraft Corp., East Hartford, Conn.

Honors and Elections

Maj. Gen Bernard A. Schriever, commander of the USAF Ballistic Missile Division, has been named "Aviation's Man of the Year" and awarded the Air Force Assn.'s Gen H. H. Arnold Trophy. Also: **H. Julian Allen**, chief of the High Speed Research Division at the National Advisory Committee for Aeronautics, Ames Aeronautical Laboratory, was awarded the AFA's Science Trophy for 1958, and **Ralph J. Cordiner**, board chairman of General Electric Co., was awarded the AFA's Hoyt S. Vandenberg Memorial Trophy for 1958. The late **Capt. Iven C. Kincheloe, Jr.**, received posthumous award of the David G. Schilling Memorial Trophy for his contributions to flight.

Changes

Dr. Martin Schilling, programs manager and director of advanced development, Raytheon Manufacturing Co.'s Missile Systems Division, Waltham, Mass.

Thomas F. Rocco, corporate field service base manager for Aerojet-General Corp. at the Air Force Missile Test Center, Fla.

Joseph E. Mulheim, general manager, American Machine & Foundry Co.'s newly established Leland Electric Aircraft Products Division, Vandalia, Ohio.

Maj. Gen Frederick R. Dent, Jr. (USAF, ret.), manager, Engineering Projects Department, The Martin Co., Baltimore, Md.

(*Continued on p. 110*)

INDUSTRY OBSERVER

► Air Force planners fear USAF's Dyna-Soar orbital bomber project may be absorbed by the nation's new civilian space agency, the National Aeronautics and Space Administration, particularly if Defense Department's Advanced Research Projects Agency fails in its efforts to convince the Administration that man has a militarily useful role in space.

► First firing of an Air Force-Lockheed Sentry reconnaissance satellite from Cooke AFB, Calif., probably will not be made until spring. Original firing date of January has been postponed because of a funds shortage. An additional $10 million to $20 million would have been needed to meet the January date. First vehicle probably will be a stripped down version of the satellite.

► Competition for the prime contract for Navy's Eagle long-range air-to-air missile has been narrowed to two firms, and Navy's final decision should be made within the near future. Over 10 firms have submitted proposals in the competition, including Chance Vought, General Electric, United Aircraft, Westinghouse, Sperry, Radio Corp. of America-Convair as a team, Douglas El Segundo, North American, and Bendix-Grumman as a team. To help offset the effects of electronic countermeasures, guidance will include both radar and infrared units. Proposals by Douglas, Bendix-Grumman and North American included a guidance package developed by Sanders Associates of Nashua, N. H.

► Decision as to whether to award a contract within the near future for the Lockheed or McDonnell utility carrier configuration or to defer the selection until both aircraft have flown with four engines is now being debated at top Air Force levels. McDonnell is building a four-engine swept-wing prototype with a 4,000-6,000 lb. higher gross than the Lockheed design. Lockheed's Jetstar has accumulated a substantial number of flight hours with twin Bristol Orpheus 1/5 turbojets and will fly with four engines as soon as General Electric J85s, Fairchild J83s or Pratt & Whitney JT12s become available. Lockheed thus far has spent more than $6 million on its Jetstar project.

► Rolls-Royce S-3 engine, designated for use in de Havilland's Blue Streak ballistic missile, is almost identical to North American Aviation's Rocketdyne Division's sustainer for the Douglas Thor intermediate range ballistic missile. Only negligible changes in details have been made in adapting the North American engine to the British requirement.

► Soviet work on defense systems for its long-range bombers includes a study of the possibility of creating and maintaining a large degree of turbulence to the rear and sides of the aircraft. The planners hope to extend the turbulent area out to the point that interceptor aircraft normally release their relatively short-range air-to-air missiles.

► Ground communication system for Cooke AFB, Calif., ballistic missile base is being built by Kellog Switchboard and Supply Co., a subsidiary of International Telephone & Telegraph Co. Contract exceeds $2.4 million.

► First development rounds of Avro's Blue Steel air-to-surface missile are powered by de Havilland Double Spectre rocket engine (AW Sept. 1, p. 37) using kerosene as a fuel burning in concentrated hydrogen peroxide. Model of the missile shown by Avro has large-diameter exhaust corresponding to no currently announced British rocket powerplant. Final engine for Blue Steel is expected to be a high-thrust Armstrong Siddeley unit.

► Britain's Pye anti-tank missile is both roll-stabilized and steered by jet reaction. Booster charge is placed ahead of main sustainer, exhausts through a number of nozzles spaced around the periphery of the missile body.

► Russian oceanographic research vessel was tracked by Air Force and Navy in the area between Guam and Eniwetok during the recently-completed Project Hardtack, during which a nuclear device was exploded at high altitude. Observers said Soviet vessel was unusually well equipped with radar.

Washington Roundup

ABMA to NASA?

National Aeronautics and Space Administration may assume technical cognizance over part or all of the space activities of Army's Ballistic Missile Agency in Huntsville, Ala. NASA is currently evaluating the work of the agency, which could find itself with time on its hands if the Jupiter IRBM program is canceled or sharply curtailed. Formal Defense Department approval for the civil space agency to absorb much of ABMA's work and talents probably will be granted in the near future.

Quesada: Ahead of Schedule

Past showing by Elwood Quesada, newly named administrator of the Federal Aviation Agency, in keeping well ahead of his own schedule as well as that set by Congress, has convinced most observers that the independent agency will be fully prepared to swing into efficient action by Jan. 1, effective date of the Federal Aviation Act of 1958.

Despite the prodigious organizational task ahead, Quesada is determined to tie up all legislative loose ends before moving into the functional phase of the agency's responsibilities. For example, the act calls for recommendations to Congress for personnel requirements with respect to security and national defense on or before Jan. 1, 1960. Quesada hopes to have these recommendations ready when Congress convenes for its next session. Meanwhile, his staff is kept busy outlining basic staff requirements and laying the groundwork for the organization's over-all structure.

Defense Information

The security classifications on "millions" of Defense Department documents originated before 1946 will finally and automatically be canceled on Dec. 2. All "top secret" classifications will be downgraded to "secret." Defense Department announcement noted the high cost of storage and protective measures required for high classification documents that have been piling up since the Civil War.

The National Archives has published two volumes listing the types of information on World War II that will be declassified or downgraded. The documents range from single sheet messages to bulky, bound operation and technical manuals. These include documents on the controlled materials plan, production and procurement, inventories of military facilities, equipment and materials developed by technical services (such as Office of Scientific Research and Development) and training films.

Documents that will be excluded from the declassification include those relating to intelligence and counter-intelligence, electronic countermeasures, counter countermeasures and documents originated by international groups or foreign governments.

'Wait-and-See'

Airline industry has adopted a "wait-and-see" attitude toward James N. Juliana who replaces Robert Kunzig as executive assistant to the chairman of the Civil Aeronautics Board. Some criticism that Juliana comes into the position without any airline experience generally is being ignored by most airline officials close to CAB since, as they point out, few top appointees to the Board have ever come directly from the airline field.

It is felt, however, that Juliana's extensive experience in government may be of some help in easing many of the Board's internal administrative problems. Prior to his appointment, Juliana was chief counsel to the minority membership of the McClellan Senate Permanent Investigations Subcommittee. He has been associated with the committee for about four years and was its executive director at the time it was headed by the late Sen. Joseph McCarthy.

Contractor Data

Defense Department will issue a new regulation this week designed to facilitate the negotiation of contracts requiring contractors to furnish technical data. It will include a detailed definition of contractors' proprietary data and spell out safeguards for the protection of data developed at the contractor's own expense. The regulation also will require that "proprietary data" be specified in contracts.

Air Force Counsel

Max Golden will take over as general counsel of the Air Force replacing John A. Johnson, who is accepting a similar position with National Aeronautics and Space Administration (see page 31). Golden has been serving as deputy for procurement and materiel programs to Air Force Secretary James H. Douglas. Previously, he had been assistant and, later, associate general counsel of USAF.

Supplemental Row

Supplemental Air Carriers Conference and the Independent Airlines Assn. which once worked together under the IAA heading, are now moving in opposite directions to the detriment of both. IAA has joined with American, United, National and Northwest airlines to block SACC's application for an exemption to conduct military commercial air movement contracts on grounds that supplemental carriers ferry mileage rates are too high. The objectors want their own "live" rates, which range from 20 to 50 cents or more less per mile, used as a bid basis. Meanwhile, the independents also face heavy opposition from other carriers in realizing a renewal of their domestic commercial charter exchange rights and extension of these rights to include overseas authority.

Space Agreements

Limited international agreements that eventually could be welded into a universal code governing the actions of nations in space efforts is being urged by George J. Feldman, chief counsel for the House Committee on Atsronautics and Space Exploration. Speaking at a Federal Bar Assn. meeting last week, Feldman said not enough facts are known about space to justify the formulation of a universal code but that temporary or limited agreements could serve as stepping stones to such a plan. He said limited agreements could be made on use of radio frequencies, cooperation on some international projects such as relay or postal satellites and the exchange of tracking data and navigation and signal codes.

—Washington staff

Soviets Plan Manned Orbit for Early '60

First U. S. attempt to place manned capsule into orbit may trail Soviet efforts by year or more.

New York—Soviet Union probably will put a man into space by January, 1960. The U. S. will follow with its first attempt from nine to 21 months later under present planning.

Air Force crash program to shoot a manned recoverable capsule into orbit sometime next year (AW April 7, p. 26) apparently has been largely scrapped on instructions from the Defense Department despite the Soviet plans, with the Man-in-Space project moving over to the National Aeronautics and Space Administration and, to a lesser degree, Defense's Advanced Research Projects Agency.

Estimate of the time the first man would be in space was made by Brig. Gen. Don Flickinger, USAF director of life sciences, at a meeting of the Society of Automotive Engineers here.

U. S. Program

The U. S. program was outlined by Roy W. Johnson, director of the Advanced Research Projects Agency.

Gen. Flickinger had estimated that the U. S. could put a man in space between March and May of 1960 at the very earliest and said a more likely date would be between December, 1960, and June, 1961.

Johnson, who had conferred with top Administration officials shortly before outlining the program, said the first attempt would be made within 24 to 36 months.

NASA, Johnson said, has $40 million transferred from ARPA and ARPA still has $10 million to devote to the project.

He added, however, that another $20 million to $25 million is still needed during Fiscal 1959 to meet the deadlines for the present program.

The ARPA director told AVIATION WEEK that his agency would like to contribute the first and second stage vehicles for the Man-in-Space program. The $10 million remaining with ARPA is related to these rockets.

Its active participation in the program is still in doubt, however. If ARPA fails in its present efforts to convince the Administration that there are militarily useful reasons to put man into space, the program may be placed entirely in the hands of the National Aeronautics and Space Administration.

Johnson said the first MIS shot would attempt one complete orbit. The second shot, if the first is successful, would try for a 24-hour orbit.

Industry proposals under consideration include a joint Convair-Avco project designed to place a single crewman into shallow orbit and then return him to a pre-selected landing area. Braking of the satellite would be by a metal parachute which should, its developers believe, land the capsule at normal cargo parachute speeds.

Earlier, at a speech at the dedication of the CBS Laboratories Research Center in Stamford, Conn., Johnson said the total U. S. program for space research would total approximately $600 million during Fiscal 1959.

In other fields, he said ARPA "is examining programs in the field of maneuverable satellites and of winged space vehicles" and "looking for weapon systems that may be applied to one of our major military problems, limited war."

He said his agency also is looking "into areas which may provide breakthroughs in non-lethal weapons."

Meanwhile, Air Force met last week with NASA to detail biomedical information that Gen. Flickinger and his group had acquired while the MIS program was still under USAF direction. It is expected that Air Force, along with other military and university groups, will be assigned some of the biomedical research work as the program progresses.

Breathing System

Initially, NASA is evaluating various space capsule nose cones proposed for the MIS program. This area appears to be wide open once again. The problems here, as with the rest of the program, are primarily matters of systems engineering and reliability.

The biomedical requirements for a comparatively elementary MIS orbital capsule mission can be met now, Gen. Flickinger believes.

The breathing and ventilating system proposed by Gen. Flickinger is essentially a replenishment arrangement with an operational capability of 48 hours which might be extended. In addition, there would be an emergency system actuated by the closing of a visor that would provide the pilot with enough pressurized air for 120 min. Since an orbit would take about 90 min., 120 min. would give the pilot enough time to go around once and come in on the most favorable approach.

A completely closed ecological system is fine in theory, Gen. Flickinger said, and the ARDC human factors group has one set up on a small scale. But, he added, even if it could be counted on to work in space, the weight trade-off is completely out of line at least for the immediate future. It would require 400-500 lb. payload per man for a closed system, he estimated.

Payload limitations are still fairly restrictive. Chemical rockets presently under development, on the drawing board or in test, are capable of placing a 10,000-lb. payload into orbit, according to Gen. Flickinger, who believes this would be more than adequate for the first MIS mission. A gross payload of 2,800 lb., half of which would be the biomedical package, would serve to put a man into orbit. The 10,000-lb. payload would allow more time in orbit.

No Companion

It would not, however, enable him to have a human companion—a condition which Flickinger says could considerably lessen the anticipated psychological problems of space flight.

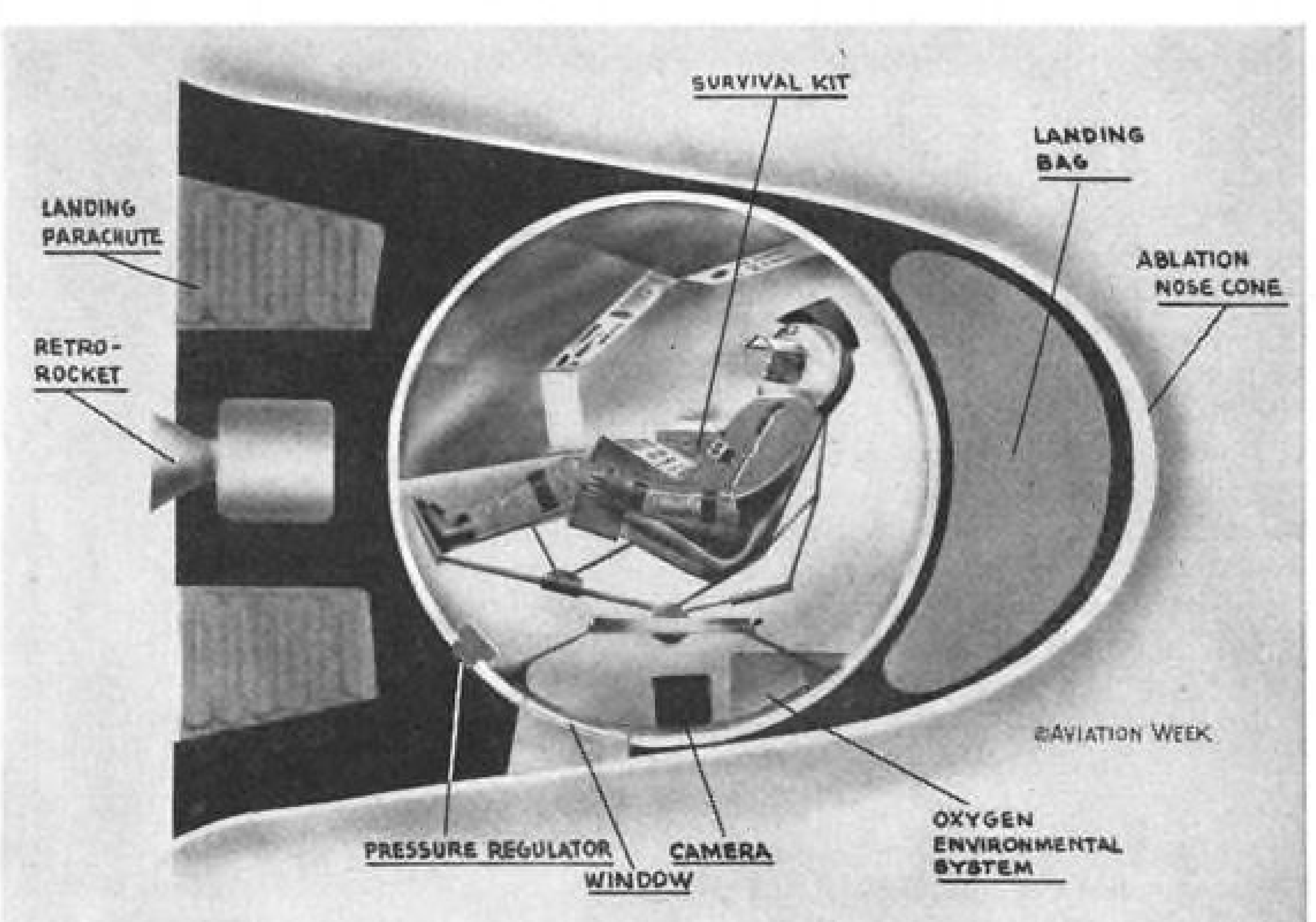
There are, of course, many other problems involved in putting a man in space and getting him back safely. Among those mentioned by Flickinger:

- **Weightlessness.** It is believed that human physiology can withstand prolonged periods of weightlessness but there is no way of proving this other than in actual orbit.
- **Radiation.** Long-term effect of ambient space radiation, the heavy particles that impact within the body, doesn't worry human factors researchers, but the recently discovered "van Allen layer" of ionization above 560 mi. does. This radiation hazard, approximately 1,000 times greater than predicted, was unforeseen. Future unmanned satellites will provide more information about this area. But, meanwhile, it should not interfere with the first MIS missions which will be below the critical altitude.
- **Gravity.** In semi-supine position and with protective equipment such as an anti-G suit, pilot can withstand launch acceleration and retain a certain amount of movement if all boosters kick off as planned. It is a debatable point, Flickinger said, as to whether he should be given any control functions. With the help of Navy human factors group at Johnsville, the Air Force was able to let a man fly under the G-trajectory and reentry forces required for space flight.

The amount of deceleration and/or heat that the pilot must accept during re-entry will be fairly large and uncomfortable. But all effects will be well within the reversible change area.

- **Tracking.** Limited to certain parts of the orbit, tracking will be difficult and may prove critical, particularly during re-entry. It is estimated that it will be possible to see or to talk to the pilot only about 10 min. out of each pass. Thus, ground control will have to make quick decisions as to whether to bring him in or to let him go around again.
- **Empty field myopia.** Air Force has found from work with volunteers submerged in tanks that man becomes helpless in two hours without a visual reference. Given a point of reference, he can function up to 15 hr. Researchers feel they can solve this problem with optics.
- **Safety.** As in previous talks, Gen. Flickinger stressed the two-pronged safety requirements of vehicle reliability and escape mechanisms. To emphasize his point, he showed a movie of a large missile toppling over and exploding on launch. There will be only 0.1 sec. to get the man off the rocket, he said, in case it explodes.

The large, recurrent problem—and the one without any presently demonstratable answer—is justification of the MIS program in the first place. It will cost $1 million per pound of payload to put a man in orbit for only 48 hr., Gen. Flickinger said, and the value of having man in space still is not known. But it is inevitable. And once man gets into space, Flickinger believes, there are bound to be some very useful results from his being there, both from a civil and military point of view.



MANNED RE-ENTRY vehicle, as shown in artist's conception, consists of space capsule and ablation nose cone. Inflatable landing bag between capsule and cone is designed to absorb some impact force. Reactions of pilot will be telemetered to physiological and environmental display on the ground.

Prototype P3V-1 Flies

Prototype of Navy anti-submarine warfare airplane is military version of Lockheed Electra turboprop transport, shown above on proving flight. Designated P3V-1, prototype is powered by Allison T56-A-10W engines, rated at 4,500 eshp. each. Tail sting houses magnetic anamoly detector unit to seek out submerged metallic objects. Navy has awarded Lockheed $10,000,000 pre-production contract.

Emphasis on Space

Washington—Air Research and Development Command is reorganizing its Ballistic Missile Division to place new emphasis on space projects.

In the reorganization, BMD's Military Space Systems Office at Inglewood, Calif., is being elevated to a position equal with that of the Ballistic Missile Systems Office, which has responsibility for development of long-range ballistic missiles. The Military Space Systems Office will be headed by Col. Richard D. Curtin and will have responsibility for military space systems and the bio-science aspects of space flight. The Ballistic Missile Systems Office is headed by Col. Charles H. Terhune, Jr.

Russians Plan Satellite Recovery, Lunar Shots, Manned Space Flight

Moscow—Soviet scientists claim they have nearly solved problem of returning an artificial satellite to earth. This was among further details on Russia's satellite program disclosed here on the anniversary of the launching of Sputnik 1.

According to a report in Sovetskaya Aviatsia, a Soviet rocket fired to an altitude of 279 mi., Aug. 27, was used in a preliminary test of a Russian solution to satellite stabilization problems.

Prof. V. Dobronravov said the rocket not only was devoid of transversal rotations but also of rotations around its longitudinal axis. Dobronravov said returnable Sputniks must be guided ones capable of changing movements according to a special prearranged program.

"Besides the stabilization system the Sputnik should have engines with extra supplies of fuel", he said. These engines then would be switched on at definite intervals conforming to the position of the Sputnik in orbit, permitting it to "glide down through the entire atmosphere and land at a definite predetermined point on earth's surface."

Dobronravov said the Soviet satellite program is aimed at two immediate developments: one, launching of guided and returnable satellites including manned Sputniks and two, launching of Sputniks to the zone of the moon.

Use of phrase "zone of moon" is taken here to indicate initial Russian attempts to launch a moon rocket will be similar to U. S. efforts in that the plan calls for orbiting rather than impacting. Dobronravov said the necessity and advisability of sending a human into space still is being discussed, with most Russian scientists favoring it.

Long range program for Soviet space research was laid out by President A. N. Nesmeyanov of the USSR Academy of Sciences. He said earliest Soviet plans include launching of eternal Sputniks which will circle earth with an almost unlimited life; launching of an orientated Sputnik; return of a Sputnik or part of it to earth.

He said the Soviet program also is directed toward manned Sputniks, rocket flights to the moon and other celestial bodies and launching of Sputniks with very high apogee orbits.

After this, the Academy president said, will come creation of an interplanetary satellite station on which considerable number of men could remain for some time. He said creation of such a space station could be the starting point for travel to Mars and Venus.

"The time is not far off when we will change from artificial earth satellites to interplanetary rockets," Nesmeyanov predicted.

Improved Test Units Asked by Defense

Washington—A Defense Department spokesmen has challenged avionics designers to develop automatic test equipment that can predict how much longer a system or component can be expected to perform reliably.

This is one of three areas of future test equipment development that was termed "essential and inevitable" by Edward J. Engoron, director, maintenance engineering, Office of the Assistant Secretary of Defense (Research and Engineering), in a talk at the Second Annual Joint Military Industrial Electronic Test Equipment Symposium. The two other areas cited by Engoron:

- **Standardization:** Wherever possible, complex specialized weapon system test equipment should be built around standardized sensing and measuring units. Engoron also called for greater uniformity of functional module sizes, read-out features and cabling to minimize logistics and training problems.
- **Automation:** Defense Department is encouraged by the development of automatic sequential test equipment for weapon systems, much of it financed by private funds. Although automatic fault-isolation and read-out can do much to speed readiness checks of weapon systems, Engoron cautioned against going overboard with automated testers where the added cost and complexity is not justified.

He also warned designers to keep the education and skill level of military maintenance personnel firmly in mind when designing test equipment. Only 55% of military technicians have graduated from high school and less than 3% have college degrees, he said. Engoron also reported that only 16% of the military electronic technicians re-enlist.

An Advisory Group on Electronic Test Equipment to recommend long-term research and development programs in the field of weapon systems test and check-out equipment may be formed soon, Engoron reported. The group would function under the auspices of the Office of Electronics, Office of Assistant Secretary of Defense (Research and Engineering).

Convair Uses CL-44 as Basis For Early Warning Bid

Convair Division of General Dynamics Corp. is submitting a team proposal in Air Force's competition for a new early warning contract. With Convair San Diego acting as systems manager, the system is centered around Canadair's CL-44 turboprop. General Electric would provide the radar installations, Hughes Aircraft the communications equipment, Litton Industries the computer and North American Aviation's Autonetics Division the navigation equipment. Other entries in the competition include Boeing, Douglas and Lockheed.

Bristol and Aerojet Form Joint Company

New York—Aerojet-General Corp. and Bristol Aeroplane Co. have formed a joint company, Bristol-Aerojet Ltd., which will engage in development, manufacture and testing of solid rocket motors, including propellant formulation.

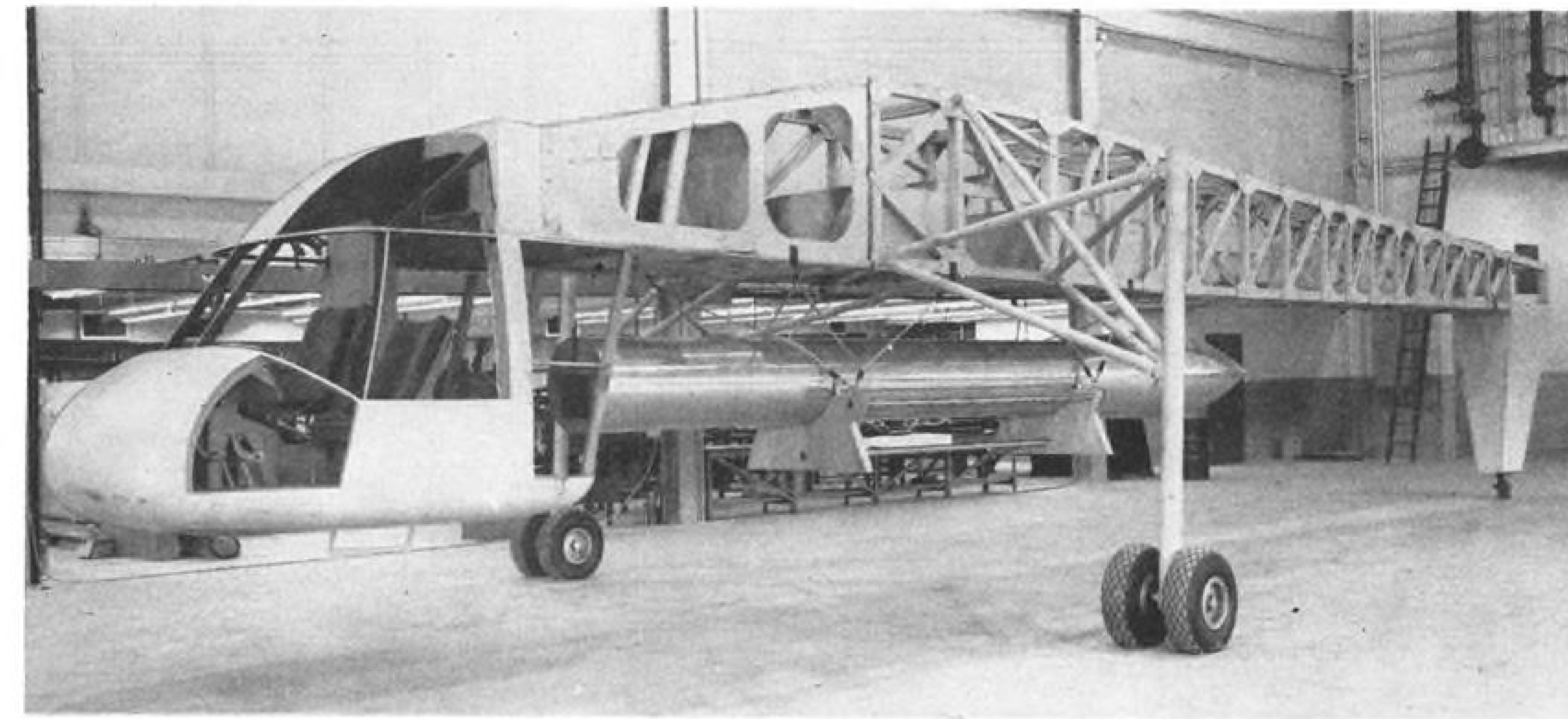
Under a joint agreement Bristol-Aerojet will have exclusive rights to exploit Aerojet solid rocket products in the United Kingdom and the British Commonwealth. Territory is expected to be extended to include friendly European countries. Bristol-Aerojet factory will be in England.

Aerojet-General is making rocket motors for Polaris and Minuteman. Bristol makes rocket motor cases for most British missile programs.

First chairman of the board of directors will be Sir Reginald Verdon Smith who is chairman of the Board for Bristol Aeroplane. Other directors are Rear Adm. Sir Matthew Slattery, chairman, Bristol Aircraft Ltd., and chairman and managing director, Short Bros. and Harland; Walter Strachan, now general manager of Bristol Aircraft Co.'s Weston Division; Sir Alwyn Crow, Aerojet-General British representative, and W. E. Zisch, vice president and general manager of Aerojet-General.

X-15 Rollout Set

Rollout ceremonies of North American Aviation's X-15 research aircraft will be held Oct. 15 in the company's Los Angeles Division. Principal speaker will be Vice President Richard Nixon. Prior to the rollout, a symposium will be held for discussion of the X-15 program.



DUMMY HONEST JOHN missile slung under the tail boom of Sikorsky S-60 mockup shows load-carrying capability of the crane.

Sikorsky Building S-60 With Own Funds

Stratford, Conn.—Flying crane helicopter of six-ton cargo capacity is being built here by Sikorsky Division of United Aircraft Corp. which expects to start flight tests early next year.

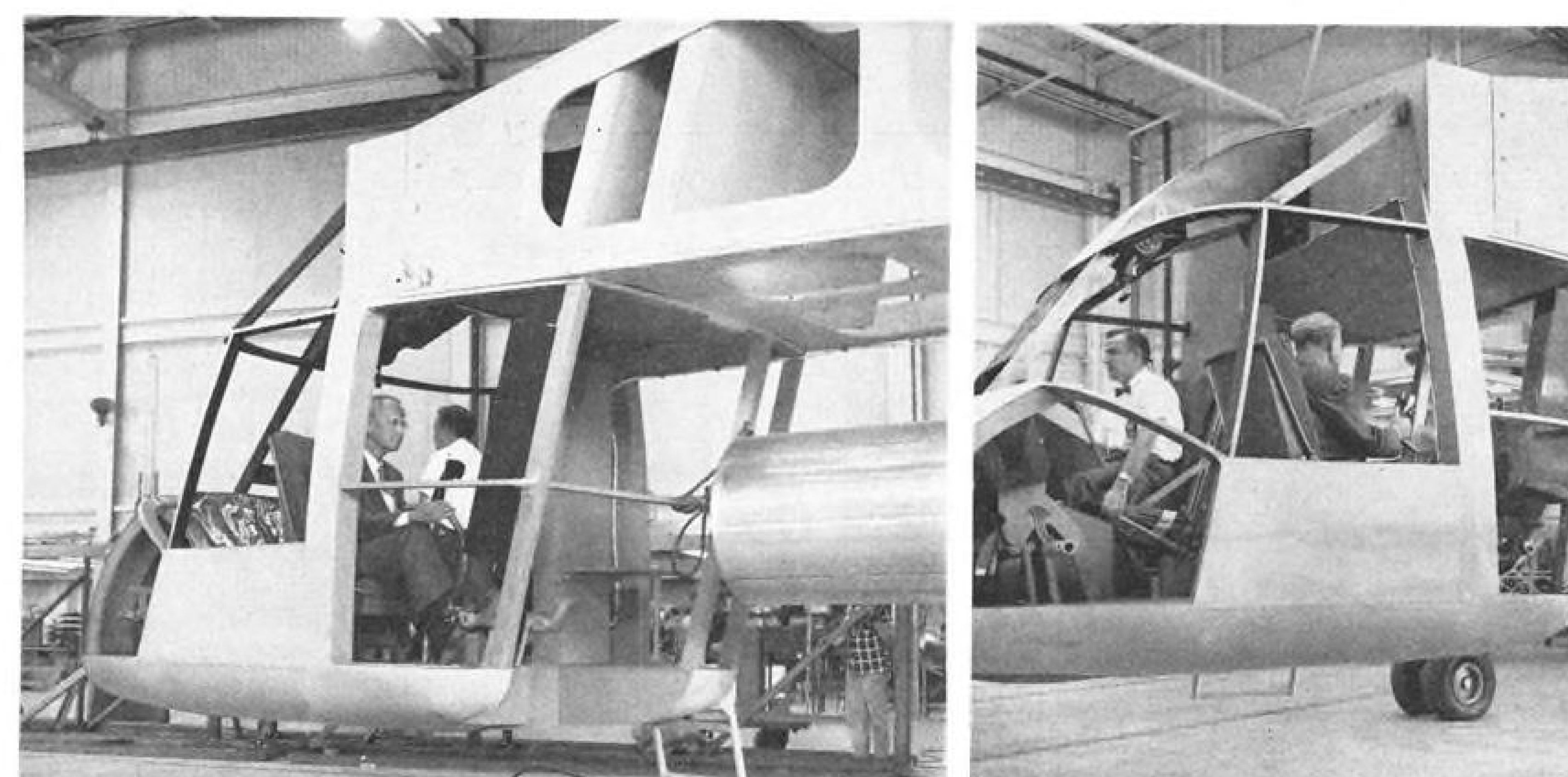
Sikorsky is building two prototypes of its new S-60 flying crane, developed entirely with company funds. Initial aircraft will be powered by twin Pratt & Whitney R2800 2,100-hp. piston engines; future versions with gas turbine powerplants are in the planning stage.

Indications are that Sikorsky considers the S-60 as the first step in a future family of even larger flying cranes for both military and civilian applications. One such version now in the design stage here considers a flying crane three times the size of the S-60 having a payload capability five times greater. Gross weight of this giant would be on the order of 100,000 lb.

Tether Coupler

Flying crane concept is based on Sikorsky contacts with operational service of its various other models which have indicated that, in the case of the military particularly, more and more work hours are being expended using helicopters carrying their loads externally. Preference for this type of loading has engendered criticism of lack of direct vision for the flight crew, which in turn has led to development of a tether coupler; by means of this equipment a man on the ground can control the helicopter remotely for accurate positioning during loading and unloading.

Sikorsky engineers feel that this approach offers only a partial solution to the basic problem of true cargo helicopter development; that design of a crane type which would strip the ma-



PILOT'S SEAT SWIVELS 180 deg. to provide him with optimum view while flying S-60 or manipulating crane's hoist. Separate sets of controls are provided for either operation. In the seat swiveled rearward is Sikorsky engineering manager Michael E. Gluhareff.

Piasecki Flying Jeep Makes First Flight

Prototype Piasecki VZ-8P aerial jeep has made its initial flights at Philadelphia International Airport site of the Piasecki Aircraft Corp. plant. Designer Frank Piasecki is at the controls. Several changes have been made in the configuration compared with the mockup (AW Mar. 10, p. 25). The rear duct has been raised to reduce airflow interference effects from the front duct and the depth of the annular passage in the duct has been reduced. The research vehicle has hovered in ground effect and begun experiments in forward flight. Cuniform control vanes with tufts are visible beneath forward duct.

chine to its bare essentials would also provide valuable gains in payload capacity and extend versatility. In the S-60, they point out, by using basic twin engine S-56 (HR2S-1 and H-37A) powerplant and dynamic components on a flying crane structure, a payload gain of approximately one ton is realized using the same power, by deletion of the S-56 cabin weight and vertical drag. Additional savings will be realized because simplified structure will lower production costs, they point out.

S-60 will have a basic empty weight of approximately 19,000 lb. Rotor system has a capability of lifting 36,000 lb. On short flights of approximately 10-15 mi., the S-60 will carry payload of approximately 16,000 lb.; on 20-mi. missions it will haul some 11,000 lb. Full load cruise speed will be 100 kt.

Highlight is an entirely new concept of cockpit design; the pilot and copilot seated in a cab having considerable transparent area. Pilot, seated on left, has a swiveling chair, permitting him to turn 180 deg. to supervise loading and unloading operations while operating a separate set of controls. Copilot will act as safety man, while pilot concentrates on the load.

First pictures of the full-scale mockup show that basically the S-60 structure comprises the control cab and a simple truss tail boom under which cargo of a wide variety of shapes and sizes can be carried. Initial details and views of S-60 configuration were shown in Aviation Week Dec. 10, 1956, p. 27 and June 2, 1958, p. 27. Main and tail rotor heads, blades, transmission parts and drive shafts of the S-56 will not only permit longer periods between overhauls initially than would be normally possible using all-new components but would also result in lower operating costs because of their greater availability.

Turbine-powered versions of the S-60 consider use of either two Allison T56s, two or four Lycoming T55s, two or four General Electric T64s, four or even five General Electric T58s or J85s or Fairchild J83s. Pratt & Whitney JT-12 is another turbine considered. Indications are that a turbine-powered S-60 would not be available before 1962.

Bloodhound Contract?

London—British government decision to standardize on the Bristol-Ferranti Bloodhound surface-to-air missile is believed imminent in aviation circles. Placing of second round missile contract is expected this month and its value to be between $15 million and $45 million. Reliable sources predict that most of the contract will provide for research and development of the Mark 2 Bloodhound which is not yet ready for production. But an additional order for more missiles cannot be ruled out.

According to some sources, the decision in favor of Bloodhound is primarily based on the unsatisfactory performance of the English Electric Thunderbird. The greater financial need of the Bristol company for the contract plays a secondary role.

Ballistic Supply Missile Developed by Convair

Washington—Ballistic supply missiles capable of lobbing supplies and medical equipment to besieged infantry units have been developed for Army by Convair Division of General Dynamics Corp. Present range of the missile is approximately 10 mi.

Designated the Lobber by Convair, the missile also can be adapted to combat missions, carrying limited payloads of napalm, chemicals, high explosives or small nuclear warheads.

Development of the supply missile was reported last week in separate speeches by Lawrence B. Richardson, senior vice president-engineering of General Dynamics, and Maj. Gen. A. T. McNamara, Army quartermaster general.

Richardson said the missile can deliver rations, ammunition, medicines, communications equipment and other supplies "accurately and in quantity."

Lobber and its launcher, he said, can be handcarried in the field by a team of three men. He told a meeting of the Ninth National Noise Abatement Symposium in Chicago that quick-disconnect Lobber payload sections can be pre-loaded at supply depots and that 70% of every missile can be re-used.

Convair said it plans to extend the Lobber program to the development of missiles capable of conveying substantially larger payloads. Range of the missile also will be extended.

New Posts Created in NASA Organization

By Ford Eastman

Washington—Organization of the newly established National Aeronautics and Space Administration (AW Oct. 6, p. 31) is well under way, but active direction of space projects transferred from the Defense Department probably will be assumed at a relatively slower pace.

T. Keith Glennan, NASA administrator, says that the future status of current projects is not yet clear and that the agency will move slowly for a long time to come in its effort to piece together a national space program.

Organizational plans, however, moved ahead last week with the announcement of three top-management positions in principal areas of activity—space flight development, aeronautical and space research and business administration. The appointments are:

• **Dr. Abe Silverstein,** director of space flight development. Dr. Silverstein had been associated with the National Advisory Committee for Aeronautics, which formed a nucleus of NASA, since 1929 and had served as associate director of the Lewis Research Center, Cleveland, since 1952. Eugene Manganiello, assistant to Silverstein, will take over as associate director of the Lewis Research Center.

• **John W. Crowley, Jr.,** director of aeronautical and space research. Crowley joined NACA in 1921 and for the last 12 years has served as associate director for the organization.

• **Albert F. Siepert,** director of business administration. Siepert has served as executive officer of the National Institutes of Health since 1948. He also has held administrative posts with the Farm Credit Administration, Home Owners Loan Corp., Alien Property Custodian and U.S. Public Health Service.

• **John A. Johnson,** chief counsel effective Oct. 27. Johnson, who has been general counsel for the Air Force since 1952, entered government service with the State Department in 1946 and transferred to the Air Force general counsel's office in 1948. He succeeds Paul G. Dembling, National Advisory Committee for Aeronautics general counsel who has been acting counsel since the agency was absorbed by NASA.

Silverstein, whose responsibilities include all space flight operations and direction of NASA's Wallops Island, Va., rocket launching station, will be assisted by Homer E. Newell, Jr., as assistant director for basic sciences; Abraham Hyatt, as assistant director for propulsion, and Newell Sanders as assistant director for advanced technology.

Newell will join NASA from the Naval Research Laboratory where he was program coordinator for project Vanguard. He also was executive secretary of the Technical Panel on Rocketry of U.S. National Committee for the International Geophysical Year.

Hyatt has been chief scientist and research analysis officer of the Navy's Bureau of Aeronautics. He was associated with projects to develop high energy fuels and research which led to the development of Navy's Douglas Skystreak and Skyrocket research aircraft, the Lark and Polaris missiles and vertical-takeoff aircraft.

Sanders, who joined NACA at Langley Laboratory in 1938, is currently chief of the Physics Division at Lewis Laboratory where he supervised jet engine noise research, instrument development and high-speed automatic data processing and computing.

Assistant directors named for the Aeronautics and Space Research Division under Crowley are Ira H. Abbott, aerodynamics and space mechanics; Addison M. Rothrock, propulsion, and Richard V. Rhode, materials, structures, loads and operating problems.

Abbott, who has been assistant director for research for NACA since 1947, has supervised research programs in aerodynamics, including fluid mechanics, high-speed aerodynamics, stability and control, internal flow and propellers for aircraft, helicopters and seaplanes.

Rothrock has been NACA's assistant director for research in Washington since 1947 and in charge of the propulsion research program. Previously, he supervised research in high-performance aircraft fuels and lubricants at Lewis Laboratory, becoming director of research at Lewis in 1945. He joined NACA in 1926.

Rhode joined NACA in 1925 and was named chief of the aircraft loads division in 1945. Since 1950, he has been assistant director for research, aircraft construction and operating problems.

Another appointment announced by Glennan was the naming of Dr. John F. Victory as assistant to the administrator. Victory had served as executive secretary of NACA and was its first employee when it was created in 1915.

As for space programs initiated previously and later transferred to NASA, Administrator Glennan said there would be no immediate change in status. He added that NASA will take over technical cognizance and responsibility for the programs but that preparations and firings of the lunar probes and satellite vehicles still would be conducted by the Air Force and Army.

Glennan says the planning done thus far on the program has been good and that NASA probably will accept the plans and carry them out.

At the same time, Glennan said he is not yet prepared to comment on the future of the Vanguard satellite program beyond the IGY.

Another area within the NASA in which procedure has not yet been clearly defined is in procurement. NACA was not involved in any large-scale procurement program such as NASA is authorized to undertake and, therefore, Glennan indicated, policy and procedures must be established.

First Australian C-130 Flies

First of 12 Lockheed C-130 turboprop transports ordered by the Royal Australian Air Force makes its maiden flight at Marietta, Ga. Delivery of initial five aircraft is scheduled for December to Sydney's Richmond Air Base. Royal Australian Air Force crews now are undergoing flight transition at Sewart AFB, Tenn.

EXPERIMENTAL Schweizer 1-30 has Continental A65-12 engine generating 65 hp.

Schweizer Builds 1-30 Lightplane After 25 Years in Glider Market

Elmira, N. Y.—Schweizer Aircraft Corp., which has been producing gliders and sailplanes for the past 25 years, has entered the manufacture of powered aircraft with a light single-place 1-30 sport airplane.

The 1-30 will be sold as a complete unit or in Civil Aeronautics Administration-approved kit form (AW June 23, p. 15). Cost of the latter, minus engine, could run about $2,000. Schweizer has not settled on price, beyond stating that the airplane "will be lower priced than currently available two-place airplanes." The 1-30 itself will not be available before next spring.

The experimental model is powered by a Continental A65-12 four-cylinder engine generating 65 hp. at 2,300 rpm. at takeoff. Engine dry weight is 171 lb. Airplane empty weight is but 700 lb. Useful load is 380 lb.; maximum gross weight is 1,100 lb.

Wings and empennage of the 1-30 are based on the Schweizer 1-26 sailplane design, reinforced for greater loading and quickly removable for towing and garage-type storage.

Airplane is of all-metal construction with fabric covering on the rear portion of the fuselage and the control surfaces. Fuselage is a combination of monocoque structure in front with steel tubing in the rear. Landing gear is an aluminum alloy cantilever gear with rubber compression shock absorbers. About 35 hr. have been flown on the 1-30. During tests at Elmira, in zero wind, the airplane was off the ground in 150 ft. Rate of climb ran to 1,000 fpm. Top speed was 110 mph. Wing area of 160 sq. ft. and use of spoilers instead of flaps produced normal landing roll of 225 ft. (zero wind) and high short-field approaches. Approach speed is about 55 mph.

The 1-30 has also towed three different types of sailplanes, including a 900-lb. two-place trainer, to altitudes up to 5,800 ft.

Schweizer, which since World War II has also been producing major assemblies and parts for aircraft manufacturers, feels there is a definite need for an efficient and economical lightplane tailored to a low budget. Company based its design on the following factors:

- **Sailplane approach.** Through selection of sailplane airfoil sections, basic wing design and clean detail design, it is possible to get an airplane with high efficiency and performance with much less horsepower and lower over-all costs.
- **Quick disassembly.** Ability to take the wings off the airplane and tow the aircraft home behind the car eliminates the expense of hangar or tie-down costs.
- **Kit purchase.** In kit form, airplane will be offered with or without a 65 hp. engine. The kit plan has worked out well in sailplanes, and Schweizer has delivered about 75 of its 1-26s in this manner (AW July 14, p. 98).
- **Flight characteristics.** Sailplane wings and spoilers enhance slow flight in the 1-30. Small fields would present no problem to this airplane. In its experimental model, Schweizer has been using both Sensenich and McCauley wood and metal propellers.

Design and engineering work already has started on a two-place version of the 1-30. The present airplane has been fitted with special ballast tanks and tested with an additional 330 lb. of load, with the same engine. Schweizer is considering a 90 hp. engine for this version, though the airplane has not been flown yet with this.

While the company has made application for CAA certification, tests will be pending until final configuration of the airplane has been set.

Schweizer 1-30

SPECIFICATIONS

Span	40 ft.
Length	20 ft. 3 in.
Height (on ground)	6 ft. 2 in.
Wing areas	160 sq. ft.
Aspect ratio	10
Empty weight	700 lb.
Useful load	380 lb.
Gross weight	1,100 lb.
Engine: Continental A65-12, four-cylinder, 65 hp. at 2,300 rpm.	

PERFORMANCE

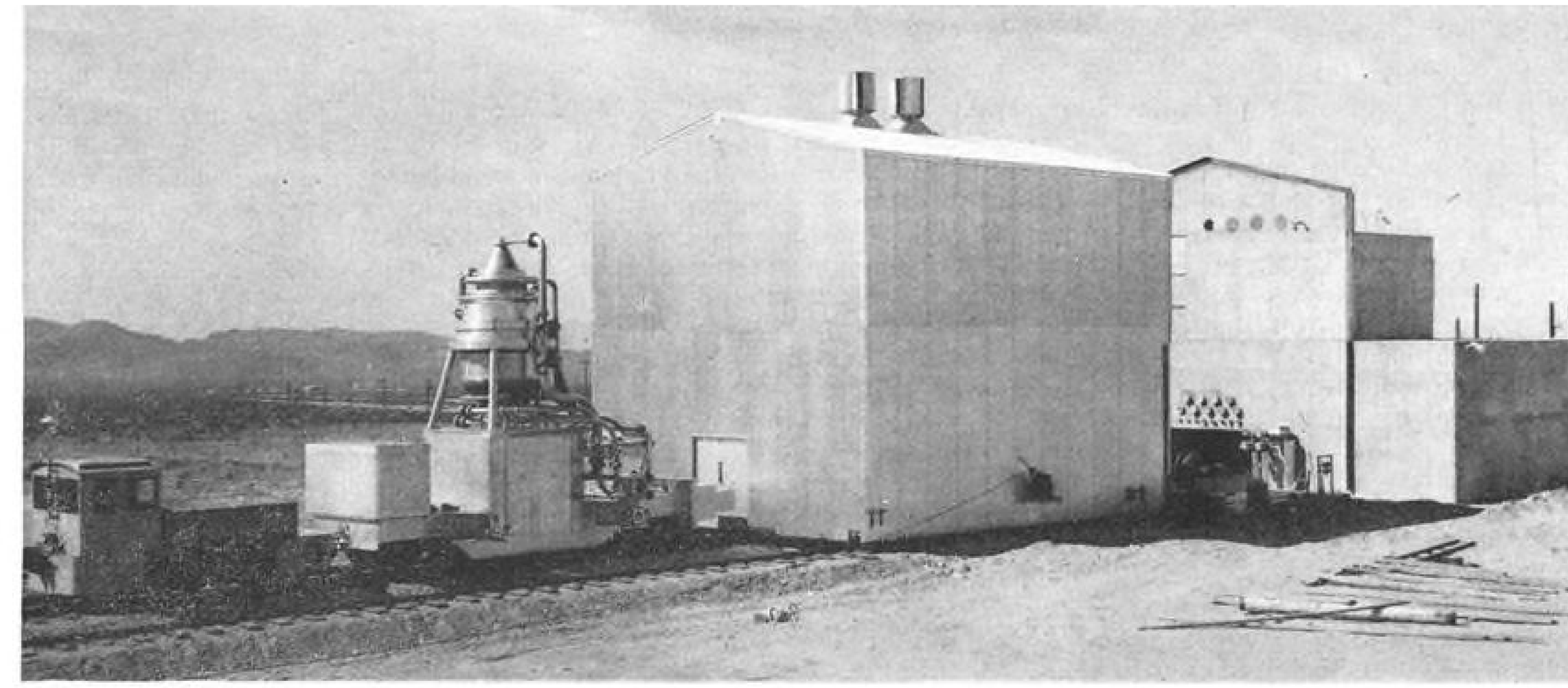
Cruise speed	100 mph.
Maximum speed	110 mph.
Stall speed	38 mph.
Approach speed	55 mph.
Rate of climb*	700 to 1,000 fpm.
Takeoff run (zero wind)*	150 to 250 ft.
Landing roll (zero wind)	225 ft.
Fuel capacity	13 gal.
Range (normal fuel)	350 mi.

* Varies with type of propeller.

Peking Group Designs Eight-Seat Transport

Geneva—An eight-place light transport—the Peking No. 1—has been designed and built in 100 days by teachers and students at the Peking Institute of Aeronautical Engineering. Airplane was test-flown Sept. 24.

Developed as part of a combined work and study program, the plane is expected to cruise at about 190 mph. and has a range of about 621 mi. Configuration is conventional, and will remind observers of the old Boeing 247 twin-engined airliner of the early 1930s. Engines are apparently the Russian ASh-621A rated at 1,000 hp. each. These engines power the Antonov An-2 being produced in China.



MOCKUP of Kiwi-A, first Project Rover reactor, is shown at Jackass Flats test area. Remotely controlled locomotive (left) will take reactor to the Maintenance, Assembly and Disassembly Building to be studied. Kiwi-A was designed by Los Alamos Scientific Laboratory.

Nuclear Rocket Facility Near Completion

By Russell Hawkes

Jackass Flats, Nev.—Installations to house and operate the first experimental reactors in nuclear rocket Project Rover and nuclear ramjet Project Pluto are nearing completion here in the "401 area" of the Atomic Energy Commission's Nevada test site.

First hook-up of Kiwi-A, first Project Rover reactor, to test connections and instrumentation probably will be next month. Cold assembly tests will be made sometime in the first quarter of 1959. Project Rover scientists will not estimate the date of the first hot run with the reactor. They say studies have not progressed far enough to make this possible.

First experiments in Project Pluto will be made with a very small reactor which will be subjected to external heating but will not simulate ramjet dynamics. A hot run is expected in November. No dates have been set for the initiation of Tory II, the first reactor which will resemble a ramjet.

Both projects offer vast theoretical advantages over chemical propulsion plants but both are at early stages in the research cycle and are operating under priorities which are "not the highest." They are classed as feasibility studies. First reactors built for the projects will be used in experiments to gather data on reactor control and behavior of materials subjected to high temperatures, radiation flux, extreme gas velocities and, in the case of Pluto, rapid oxidation.

Nuclear rockets and ramjets are essentially heat exchangers in which the heat of nuclear reaction is transferred from the reactor to the propellant or engine air stream. An efficient exchanger is necessary to the survival of the reactor as well as to the generation of thrust since failure to eliminate heat from the reactor at an acceptable rate will cause temperatures to reach destructive levels.

Thrust production will be unimportant in the first phases of the projects. "Hot box" reactor used in first experiments of Pluto will not even simulate ramjet operating parameters except those which directly influence reactor operation.

Propellant gases being tested in Kiwi-A will roar out of the tailpipe under high pressure from a two million cu. ft. tank farm near the test cell. Considerable thrust will be produced but there are no present plans to measure it and no effort has been made to design an efficient nozzle since thrust is of small concern at the present stage of research. Exhaust orifice need only simulate back pressure caused by the nozzle.

Project Rover initial studies were begun in early 1955 by the University of California Radiation Laboratory at Livermore, Calif. and Los Alamos Scientific Laboratory which also is operated for AEC by the University of California. In 1957, the Radiation Laboratory effort was redirected toward nuclear ramjets and it now is running Project Pluto. Scientific Laboratory continued with Project Rover.

Kiwi-A and the follow-on Rover reactors, for which planning is well advanced, use solid fission fuel, movable moderator control rods and differ from conventional practice only in the use of gas cooling. Gaseous and liquid fuels and radical control techniques are being studied but so far none have been considered worth a full-scale test.

High power density, large range of operating temperatures, rapid changes in reactivity and sensitivity to engine dynamics makes reactor control a more complicated problem than in conventional power reactors. Analog computer-based Kiwi-A control system compares temperature, power level and propellant flow rate data measured at the reactor with command values and sends corrective signals to the powerplant controls. Effect of power excursions during starting and stopping upon hydrodynamic flows and structural materials must be understood as well as effects of continuous operating conditions.

Materials must usually have melting points above 2,000C to be useful in the rocket and Kiwi-A should yield data on chemical and physical properties of materials in this range. Scientific Laboratory scientists also would like to find out how fissionable fuels can be combined with structural or dispersal materials and how these behave in an operating reactor.

A number of pure gases and combinations will be used as coolant-propellants in Kiwi-A experiments. Among these will be helium and hydrogen at low enough density so that exhaust should dissipate without chemical combustion. To simplify experiments, reactor shell and other parts of Kiwi-A will be water-cooled. Quantity of fission products exhausted is expected to be so low that measurement will be one of the most difficult tasks of the project. Weight of fission products created during the critical lifetime of one fuel load of Kiwi-A would be on the order of $\frac{1}{10}$ lb. or less. A 20 kiloton bomb releases about two pounds of fission products. The reactor is unshielded and will emit radiation at a high level during operation. This will prevent anyone from approaching the reactor while operating and will induce activity in nearby materials because of their capture of radiated neutrons.

As much equipment and instrumentation as possible has been located in the shielded test cell. About 1,000 control and data pick-up leads are passed through a shielded quick disconnect plug which inserts in a hole in the test cell wall as the flatcar upon which the reactor is mounted is backed up to the cell wall.

After the reactor is shut down the test cell can be entered for maintenance of the equipment there. The reactor itself, mounted upon a flatcar, must be remotely disconnected and towed 2 mi. to a shielded Maintenance, Assembly and Disassembly Building by an electric locomotive operated by radio commands from the control point located about a mile and half from the test cell and the Maintenance, Assembly and Disassembly Building. Remote manipulators will be used by workers in the Building to take the reactor apart, dispose of the most heavily contaminated parts and prepare the rest for as much post mortem study as possible. Failure of an important component of Kiwi-A will end the test since the hot reactor cannot be approached at the test cell. Remote repair at the test cell was considered but abandoned.

Remote control signals and data from the operating reactor are transmitted over a buried cable net capable of handling several hundred signals. Information about reactor power level, propellant flow rate and reactor temperature is displayed before the master controller at the control point. Tests can be conducted manually or by automatic sequencing.

Pluto ramjet project could lead to building of a continuously cruising air-breathing missile which could break out of its pattern and strike a target on command. It would be an extremely difficult target for the enemy to neutralize since it could be held in readiness over virtually any point on the earth. Atomics International Division of North American Aviation is associated with Radiation Laboratory in the project. First "Hot box" runs are expected to yield data for use in early design.

Nuclear ramjet poses especially difficult reactor design problems because of variations in density and composition of atmosphere which must act as coolant and propellant, threat of oxidation and transient conditions caused by Mach number changes and variations in the internal flow pattern. Hot box will operate with a power output of only a fraction of a watt and will be heated externally by a system of electric ovens and blowers to see the effect of a high temperature, oxygen-bearing environment upon reactor operation. Low power level will keep contamination low to permit inspection and changes of components in the test device.

First Pluto reactor to simulate ramjet duct will be Tory II. No effort will be made to duplicate external flow or work out a shock positioning technique. Tank system and blowers will be able to supply continuous internal flow. Radiation Laboratory scientists are aware that the project will face an uncommonly difficult wind tunnel design problem when it becomes necessary to test a complete working ramjet.

Test durations must be comparatively long to include reactor starting and stopping sequences and simulate reasonably long ramjet operation. Closed circuit tunnel is out because radiation contaminated air cannot be recirculated. Tory I was a paper study which was abandoned.

The 28 mi. by 40 mi. area which contains both Rover and Pluto test installations is located on the western edge of AEC's Nevada Test site and includes a 12 mi. by 40 mi. plot transferred to AEC from USAF's Las Vegas bombing and gunnery range in 1956. About $10 million has been spent on construction in Rover Phase I and another $10 million is funded in Fiscal Year 1959 for Phase II.

Industry Rumbles As Germans Ready New Fighter Study Group

Further delays in West Germany's decision on purchasing jet fighter-interceptors now are seen as a sixth study mission begins preparations to leave for the United States.

The group is tentatively composed of military representatives from West Germany's Defense Ministry and eight engineering experts from Dornier, Heinkel and Messerschmitt. Mission is to study aircraft production techniques and new equipment for the three American types—Grumman F11F-1F Super Tiger, Lockheed F-104A Starfighter and Northrop N-156F—still under consideration by the Germans as the main component of their future air strength.

In the meantime, industry representatives who have been working with the Germans for at least two years are beginning to hear strong rumblings of discontent from their home governments. These sources are thoroughly annoyed with continued German vacillation, the frequent visits of yet another mission and the general reluctance of the Germans to commit themselves on any specific orders.

Said one source: "If we all pooled the money we've spent educating the Germans, we could have bought them an Air Force!" This exaggerated comment reveals an underlying common complaint. Many observers here believe the Germans are simply using the foreign manufacturers for a quick course in modern aircraft design.

Said an American: "We spend hours taking them through factories, giving them cockpit checks and flights, making presentations, eating and drinking with them at night, and we don't even get a thank-you note after they go home."

There is growing resentment in France, whose aircraft industry has little to look forward to except a big German order, where once there was bright hope of French-German alliance in weapons development and standardization. Some French officials are ready to make the purchase of the Dassault Mirage III the test case on cooperation. "If they don't buy the Mirage," said a French source, "I'm ready to give up. We'll never be able to work with them."

There is strong opinion that the real difficulty is that final decisions on equipment purchases must be made by persons who are not experienced or familiar with modern weapons systems. Badgered by political pressure and confused by hundreds of technical evaluations, these high-level Germans are simply floundering.

But the real overriding reason is that even if Germany had the airplanes now, there wouldn't be enough pilots to fly them. Major portions of German air power are sitting on the ground in long-term storage because there are no available pilots. Recruiting is difficult; there is no real "young tiger" group aching to become Luftwaffe pilots.

German industry sources, queried by Aviation Week about this latest mission, were aware of it, but lacking in detailed instructions. They believed they would be better informed in several weeks. But non-industry sources close to the situation report that the mission has just now been asked to submit its clearance requests.

The group is expected to leave Germany in November, and knowing the sanctity in which Europeans hold the Christmas holiday period, are expected to return home before then. Allowing for the holidays and the resulting pileup of unfinished business which will be waiting for the mission when it returns, there seems little likelihood that the group's final report will be completed before early February.

Thus no final decision—if in fact there is ever to be one—is really expected now before March of next year.

Idlewild Rules May Affect 707 Economy

PanAm fears N. Y. Port Authority noise limitations may hurt 707's competitive position with Comet 4.

By Glenn Garrison

New York—Pan American World Airways is objecting to Port of New York Authority restrictions on operation of Boeing 707 jet transports at Idlewild. These rules may severely hamper economic success of the 707's transatlantic service and its competitive position against the Comet 4.

Both jets have been cleared for operation at New York but strings are attached in the form of mandatory operating procedures. Pan American is negotiating with the Port Authority for changes in the rules, but the airline will abide by them at least for now.

Pilots and Civil Aeronautics Administration controllers also are expected to object to the rules from a traffic control standpoint.

Announcement of the clearance and the restrictions was made by the Port Authority Oct. 4, and British Overseas Airways Corp. began scheduled transatlantic jet service the same day. BOAC is now running weekly schedules with the de Havilland jet.

Pan American is worried about the economic effects of the restrictions and is trying to determine whether they will allow a money-making operation. The airline expects to go ahead with daily jet service to Paris and Rome beginning Oct. 26 as planned (AW Sept. 29, p. 29).

"We don't like them but we'll live with them." said PanAm of the restrictions. The airline's transatlantic jet inaugural is set for Oct. 26 and, under the restrictions, changes for nonstop east bound flights are "very few".

PanAm is studying the specific effects of the rules in various operating conditions and expects to develop new procedures which will equal or better the Port Authority procedures in achieving noise reduction. At the same time, Pan American's proposals will permit the jets to operate "without prejudice" to their capabilities. These procedures, the airline says, will be developed jointly with Port Authority and other carriers.

The Port Authority regulations have not been formally accepted by Pan American.

Main problem for Pan American with regulations is the weight restrictions they will cause. It appears certain that almost all flights in both directions will have to make stops.

BOAC, on the other hand, should be able to operate its smaller Comets nonstop on most eastbound flights. The speed advantage of the Boeing jet thereby will be compromised.

Pan American is also unhappy with the night-hours restriction, maintaining that it is "irrational" for an airline to offer jet service by day and only piston service at night, in view of the fact that the jet operation as proposed would be equal to or better than propeller aircraft in regard to noise acceptability.

Elwood R. Quesada, recently appointed Federal Aviation Agency administrator, who flew the jet at Idlewild last week, said he hopes the Port Authority restrictions will be eliminated.

The authority's restrictions, based on technical reports from its noise consulting firm, Bolt, Beranek and Newman, set up these mandatory procedures:

- **Takeoffs between** 10 p.m. and 7 a.m. will be made from the two preferred runways only.
- **Runway 25,** which takes the jets out over Jamaica Bay, is the preferred runway and must be used when wind conditions permit and crosswind component is not in excess of 20 kt.
- **Next choice** is Runway 22, and following takeoff a right turn must be made "as soon as practicable" to avoid flying over communities.

If neither of the above runways can be used, other runways will handle the takeoffs, but 15 deg. turns and power reduction procedures are called for, and takeoffs must be conducted so that the aircraft will reach not less than 1,200 ft. of altitude over any community.

The following specific piloting procedures to be used in takeoffs from Runways 13R-31L and 07 were set by BOAC, and Pan American will be required to follow "substantially the same" procedures:

- **Initial takeoff** with 8,000 rpm. power setting and 20 deg. flap.
- **Acceleration to** V_2 plus 15 kt. during climb, this speed to be maintained until the communities are reached.
- **At the boundaries** of the communities, power reduction to 7,350 rpm.

The preferred runways are 8,200 ft. and 8,000 ft. respectively in length. Runway 13R-31L is the airport's longest, 9,500 ft.

BOAC says the restrictions will pose no problem with the Comet 4, which operates at a maximum gross weight of 158,000 lb. Under the worst conditions of temperature and wind, the carrier says, slightly over 6,000 ft. of takeoff runway will be needed.

PanAm's 707-121 grosses 247,500 lb. maximum and for consistent year-round operation at this weight some 11,500 ft. of runway would be needed, according to Scott Flower, assistant chief pilot (technical), Atlantic Division.

The airline's specifications for its jet indicate a 10,200 ft. takeoff runway requirement on a standard 59F day at the maximum gross; 8,000 ft. at 220,000 lb.; 6,600 ft. at 200,000 lb. On a 30F day, requirements drop to 9,500 ft., 7,600 ft. and 6,200 ft. respectively.

But even if the runway is long enough for a full-weight take-off, the jet must face the problem of getting to 1,200 ft. over a community where required. Lowering this altitude requirement probably will be a major change the airline will seek in the rules. One source suggested 900 ft. as more suitable.

The procedures, according to the Port Authority, will result in takeoffs over water about half the time. Such takeoffs involve the preferred but shorter runways, as noted above. This means Pan American will be forced to pass up the 9,500 ft. takeoff runway half the time in favor of the 8,200 ft. or 8,000 ft. runway.

Runway 13L-31R, the longest strip, is now being extended to 11,200 ft. with completion scheduled this year. Runway 25, the first choice under the rules, will be extended from 8,200 ft. to

Made in England?

New York—Pan American World Airways will be operating its Boeing 707 jet transport at New York International Airport under rules which were designed for the Comet 4.

Port of New York Authority approved proposed operating procedures submitted by British Overseas Airways Corp. for its de Havilland Comet. Pan American did not submit a proposal. It was advised by the Port Authority of the rules under which it could operate—i.e., substantially the same as the approved BOAC proposals.

One U. S. airline official commented to Aviation Week that the Port Authority procedures should be given a "Made in England" tag.

10,000 ft. by April 30, 1959. Pan American pilots are not expected to take happily to the added cockpit load of adhering to the specified piloting procedures. Another problem is traffic control. For example, the runway at a given time may not be the same runway the jet is required to use. The jet pilot then will ask CAA permission to use the preferred runway; if the controller agrees, the jet may have to wait while inbound traffic is cleared. In practice, it seems unlikely that CAA will agree under most conditions.

CAA, of course, will clear the jets for use of any of the procedures only when conditions are such that safety is not a concern. The right turn requirement, obviously, will not be practicable where there is a conflict with inbound traffic. The Port Authority, in fact, notes that the operating procedures are subject to CAA-imposed limitations as to traffic control and other factors.

American Airlines conceivably could be faced with a similar situation Jan. 11 when its jet schedules are expected to start.

The airline said it has no intention of accepting or rejecting any operating procedures until it gets some of its own 707s and works out safe and suitable flight procedures. American's jets will be test flown at airports where they will operate before procedures are nailed down.

National and Delta Cutback Jet Orders

Washington—Cutbacks in orders for turbojet transports have been made by Delta Air Lines and National Airlines at an estimated loss to the manufacturer of $25 million.

The cutbacks, involving a total of five Douglas DC-8 turbojets, are expected to be followed by further adjustments in equipment orders by other carriers because of failure to obtain necessary financing under favorable conditions. Delta and National were the two carriers referred to by Dr. Paul Cherington in his report to the White House when he noted that cutbacks on orders have "already occurred" (AW Aug. 11, p. 28).

National Airlines has cancelled outright three of the six DC-8s initially ordered from Douglas. Delta has placed two of the eight it has on order on an option basis "to be exercised at a later date . . . if appropriate."

Annual reports to the stockholders of both Delta and National for Fiscal 1958 disclosed that neither company has completed financing for its jet program. According to its report, Delta now has firm commitments for six DC-8s and 10 Convair 880s requiring total payments of $74 million.

National now has three Douglas DC-8s and 23 Lockheed Electras on order at an estimated cost of $59 million. The company told its stockholders that it had discontinued the payment of cash dividends "to conserve cash in order to meet the commitments for the purchase of turboprop and jet-powered planes."

The company also said it is carrying short-term notes totaling $14,500,000 as "non-current liabilities since they represent interim financing while negotiations are in progress for long-term borrowings."

Delta said it is negotiating with a group of insurance companies for a $25 million long-term credit. The company, in its report, added that funds from the insurance credit, coupled with a "slight increase" in borrowings under its present bank credit agreement for $30 million, can be expected to cover the purchase commitments.

During the General Passenger Fare Investigation, the carrier told the Board it planned to retire five DC-7s by the end of 1959 and five additional DC-7s by mid-1960.

National Airlines will offer a substantial portion of its piston-engine fleet for sale in the used-plane market next year as one means of meeting payments on its Lockheed Electras which are scheduled for delivery beginning in April. Sale will include four Lockheed 1049Hs and four DC-7Bs purchased during company's 1958 fiscal year.

CAB Awards 4 Florida Routes

By Robert H. Cook

Washington—Civil Aeronautics Board last week issued a formal order in the Great Lakes-Southeast Service Case awarding new routes to Florida for Northwest, Delta, Capital and Trans World Airlines.

At the same time, the carriers announced tentative plans for schedule, service and equipment changes necessary to permit their entry into this market area during the forthcoming winter season.

Effective Nov. 29, with an interim 30-day period allowed for filing of appeals, the Board's decision granted the following authority:

• **Northwest Airlines** authorized a Chicago-Florida route in addition to existing service provided by Delta and Eastern. The route will extend from Chicago to Miami via Tampa-St. Petersburg-Clearwater with nonstop service permitted between the Florida points and Chicago. The decision also makes it possible for the carrier to provide single-plane service, stopping at Chicago, between these cities and Milwaukee, Minneapolis-St. Paul or cities to the west on the Northwest system.

• **Delta Airlines** to operate a Detroit-Florida route formed by an extension of its Route 54 northward via Dayton, Columbus and Cleveland, thus making the carrier competitive with Eastern on this Florida route. Indianapolis and Louisville also were added as intermediate points on Delta's Route 54 with a CAB stipulation that flights for the new extension must begin or end either at or below Atlanta. The carrier was permitted to add Orlando, Tampa-St. Petersburg-Clearwater and West Palm Beach to its existing service at Miami and Jacksonville.

• **Capital Airlines** authorized a Florida entry by approval of a Buffalo-Cleveland-Pittsburgh-to-Florida route, providing the first one-carrier Buffalo-Florida service and competition with Eastern's Cleveland-Pittsburgh-Florida service. Granting of the new route was accomplished by extending the Capital system from Atlanta to Miami via Jacksonville, Tampa-St. Petersburg-Clearwater and West Palm Beach and from Pittsburgh to Buffalo by way of Youngstown, Akron-Canton, Cleveland and Erie. Subject to several CAB restrictions, the carrier will not be permitted to provide single-plane service from Toledo, Detroit, Chicago, or Milwaukee or the Twin Cities to any points south of Atlanta. In addition, Capital may not offer "local service" between Buffalo and Cleveland or provide single-plane service between cities south or north of Atlanta on its present Washington, Baltimore, Philadelphia and New York route.

• **Trans World Airlines** granted a St. Louis-Florida route via Nashville, Atlanta and Tampa-St. Petersburg-Clearwater. The decision permits TWA to conduct single-plane service from Florida to any point on its system west of St. Louis, providing that the flights stop at St. Louis.

Most observers feel the TWA award will have a far reaching effect since it allows the airline to offer a one-stop transcontinental service to the Florida market area and provides reasonable grounds for the carrier to later apply for nonstop authority on this route.

Trans World has not firmed its scheduling for the new route but expects to begin service by mid-December using Constellations between St. Louis and Miami with a three-a-day frequency for Tampa.

Northwest expects to begin Florida service on Dec. 1

Capital Airlines announced it also is prepared to inaugurate Florida service on Dec. 1.

Delta Airlines spokesmen offered an estimate of from 30 to 90 days from the effective date of the CAB order before the airline will begin "token" Detroit-Florida service.

Panagra Makes Subsidy Request; Fear of Latin Fare Battle Grows

Washington—Fear of an all-out price war in the South American air market grew last week as Pan American Grace Airways asked for $6.8 million in subsidy payments to offset losses spurred by the cut-rate fares offered by its foreign competitors.

Pointing out that it had been off the subsidy lists since December, 1948, Panagra told the Civil Aeronautics Board that the fare cutting tactics of non-member carriers of the International Air Transport Assn. became so "acute" last year that the carrier is finding it difficult "if not impossible" to compete.

Compounding this problem, Panagra said, is a decline in passenger revenues from $10.8 million during the first eight months of 1957 to $8.9 million for the same period of this year plus a system load factor decrease from 60% down to 53%. In addition, the carrier reported a $1 million increase in operating costs for 1957 as compared with the previous year.

Predicting that the situation may become even worse, the airline pointed out to the Board that it competes with 13 IATA members subscribing to fare levels suggested by the organization and 10 non-member airlines which set their own individual fares to meet competition. This ratio will change for the worse in the near future, Panagra said, when four more non-IATA airlines enter the competitive picture.

In addition, the airline said, many IATA members may be forced to follow the lead of an IATA member, LAN of Chile, which recently announced plans to lower fares to meet non-IATA competition.

Modern equipment, such as Douglas DC-6s, Vickers Viscounts and Lockheed Constellations, along with high frequency schedules and luxury service at roundtrip fares as little as half the tourist rates charged by IATA carriers on the same routes, have combined to place the low-fare practitioners in a strong competitive position, Panagra said in its petition. Inauguration of jet service by U. S. airlines also will provide the low-price competitors with an opportunity to re-equip with the lastest piston engine aircraft, the carrier said.

Panagra observed that, while intervention by South American governments could do much to stave off an uncontrolled price war, chances for such relief are not particularly strong as indicated by the carrier's experience in Bolivia and Ecuador. Panagra service was inaugurated in these republics during World War II at the request of the State Department. In 1958, the airline succeeded in reducing its service to a more economical level in Ecuador but public demand resulted in pressure from the republic's president to reinstate a major portion of the lost service.

Now in the "critical stage" of transition to jets by mid-1960, the carrier will spend $27 million on new equipment and has signed credit agreements with six banks for $18 million of the total needed. Advance of the latter sum over the next two years is contingent upon the airline's retaining a satisfactory earnings level during this period.

Of the total amount of subsidy requested, the carrier estimated it will need $2.3 million to break even during the coming year; $1.7 million to cover income taxes, and $2.7 million for a 12% return on investment.

Jet Runway Criteria Announced by CAA

Washington—Civil Aeronautics Administration today announced new airport criteria that will provide airlines, manufacturers and airport operators with runway standards for the operation of jet transports for the first time.

In a revised technical order, CAA said the new design standards for runways were developed to give the industry a better correlation between the design of airports and the design of transport aircraft. Essentially, the order designated runway dimensions and strengths that will be required for the operation of transports expected to be introduced into service during the next five years.

Airports designed for local service operations will require a runway length of 4,200 ft. and a width of 100 ft. Minimum runway length for any airport equipped with ILS is 5,000 ft., however. Taxiway width has been set at 50 ft. and landing strip width has been established at 400 ft. with a pavement loading of 30,000 lb.

Second category of airports—trunk operations covering flights which do not exceed 1,000 mi. in stage length—will require runways 6,000 ft. in length. Width of the runway must be at least 150 ft., width of taxiway 75 ft. and landing strip width has been set at 500 ft. Pavement loading is 60,000 lb.

Continental airports serving nonstop flights of up to 2,000 mi. will require runways with a minimum length of 7,500 ft., a width of 150 ft. and pavement loading of 75,000 lb. Taxiway width should be 75 ft., landing strip width 500 ft.

For intercontinental airports, those required to serve the longest range nonstop flights of all four categories, a 10,500 ft. runway 150 ft. wide is required. Taxiway and landing strip widths are the same as the continental category, but pavement loading is set at 100,000 lb.

Runway lengths were established for standard temperature plus 41F deg., sea level elevation and no gradient. Runway length will be increased for airport elevation at the rate of 7% for each 1,000 ft. of elevation above sea level. Also, runway length will be increased at the rate of 20% for each 1% of effective runway gradient.

Pan American Defends Plan for Jet Lease

Washington—Pan American World Airways last week denounced Eastern Airlines' objections to a proposed Pan American-National equipment lease and stock transfer agreement as a "naturally outraged" reaction to any competition to Eastern's "monopolistic efforts" in the New York-Florida market.

Answering requests filed by Eastern and Northeast Airlines that the controversial plan be rejected by the Civil Aeronautics Board (AW Sept. 29, p. 30) attorneys for Pan American said Eastern had expected to strengthen its position in this market with Lockheed Electra turboprop transports by the end of this year but was "foiled in this predatory design." Eastern has asked CAB to seek federal court intervention to stop the agreement between Pan American and National. Further noting that Northeast apparently "tagged along" in this request, Pan American scored the smaller carrier for its failure to provide improved service and jet equipment which, it said, Northeast promised two years ago upon receipt of a New York-Miami route.

Meanwhile, Capital and Continental Airlines, as predicted by Aviation Week (AW May 12, p. 45), are expected to announce equipment lease terms under which Continental will lease three Viscount 812s for use on Capital's newly-awarded Florida route (see page 38), beginning Dec. 1.

Hard core of Eastern's objections to the Pan American-National lease plan was centered around contentions that a stock exchange agreement between Pan American and National would result in domination and control of National by the international airline. As filed with the CAB, the agreement originally called for the mutual exchange of 400,000 shares to be approved by a November stockholders' meeting and an option permitting Pan American to purchase an additional 250,000 shares at a later date.

Swissair Orders 880s, Leases to SAS

By David A. Anderton

Geneva—Swissair has purchased five Convair 880-25 jet transports and has an option for six more (AW Oct. 6, p. 47). Deliveries are scheduled for the end of 1960.

Two of the airplanes will be leased to Scandinavian Airlines System for a period of four years as one phase of a new interline agreement between the two operators.

The aircraft will be powered by four General Electric CJ805-3 turbojets rated at 11,200 lb. thrust each and equipped with suppressors and thrust reversers. First engine order is for 38 powerplants of which 18 are spares.

Under other terms of the interline agreement, Swissair will lease four Sud Aviation Caravelles from SAS for a four-year period beginning in the summer of 1960.

Four Caravelles involved are additional orders placed with Sud Aviation. SAS thus now has 16 firm orders placed for the Caravelle which brings the French company's order backlog to 49.

Pooled maintenance and overhaul has been planned in the agreement, with Swissair assuming responsibility for both lines' Convairs and their General Electric engines, and SAS handling the Caravelles and the Douglas DC-8s and DC-7Cs which both lines have bought.

Thus both airlines will enter their jet eras with common fleets and a complementary route structure that will see the shorter-range Caravelles on internal European runs, while the Convairs take over the medium-range routes to the Middle and Far East and South America. Douglas DC-8s will handle the North Atlantic routes, and there is some technical belief that the Convairs could be used as backups for that route because of their calculated ability to make the Shannon-New York leg non-stop during the winter months, the governing condition for Atlantic flights.

Both airlines will be operating airplanes with identical interiors and cockpits. They will be able to effect economies in spares orders and handling, in maintenance and overhaul, in mechanic training and tooling, that would not be possible if the two operators were to buy and operate their fleets separately.

European Impact

Observers here believe the Swissair-SAS cooperation is going to have tremendous impact on other European carriers. The terms of the agreement work out to the financial advantage of both airlines, in a time when every operator has become increasingly cost-conscious and is looking for ways to save every possible cent.

Paradoxically, this is the first time Swissair has bought an airplane which had a higher cost per ton-mile than some of its competitors, one parameter where the Convair 880 suffered by comparison. The deciding economic factor was the low number of passengers required to break even on operating costs.

For a typical route of 2,500 naut. mi., 33 passengers out of the 85 paying capacity of the Swissair Convairs are enough to make the break-even point. The calculations are based on an assumption of 10 cents per passenger-nautical mile as income, which is conservative on the Far East routes, not conservative on the South American runs but a reasonable average. Air Transport Assn. cost formulas were used in the study, modified for 10 year depreciation of the aircraft and assuming 50% engine spares. For the very short range of 250 naut. mi., Convair shows a break-even number of passengers at about 50.

Particular model bought by Swissair is the Convair 880-25, engineering model 31, which is the long-range overall version of the plane. Identical specifications control the layout of the airplanes destined for both operators. Interior seating will provide space for 30 first-class passengers and 56 seats of economy class configuration, five abreast and at 34-in. pitch. Swissair will block one of the economy seats for an extra cabin attendant, making total space for 85 fare-paying passengers.

Four lounge seats will be provided in the first-class cabin, for a total of 90 seats in the airplane. Swissair does not plan to sell these seats even though they are stressed for passenger handling.

Specification data for the Swissair Convairs shows a ramp weight of 204,000 lb., a takeoff weight of 203,400 lb., a landing weight of 155,000 lb. and a zero fuel weight of 126,000 lb. Manufacturer's weight empty is 90,029 lb., operator's weight empty is 96,000 lb., largely due to galley equipment and stores. Fuel capacity is 92,900 lb.

Airplane will have leading-edge slats for improved short-field performance, will be first Convairs so equipped.

Convair quotes a Mach 0.8 cruise speed at 35,000 ft. for the airplane.

Aeroflot Tu-104A Loads at Vnukovo Airport

Aeroflot Tu-104A is pulled into loading position at Moscow's Vnukovo Airport prior to daily departure for Prague. Passengers now are loaded from both ends of the airplane. Truck pulls Tu-104 nearly to the runway before engines are started, to eliminate dust disturbance.

U. S. Demonstrates DME-T Advantages

By Philip J. Klass

Indianapolis—Usefulness of distance measuring equipment-Tacan (DME-T) in combination with VOR to provide more precise navigation and more effective traffic control was demonstrated here in the air and on the ground for representatives of 30 member nations of the International Civil Aviation Organization.

Demonstrations were part of a four-day U. S. symposium intended to acquaint ICAO members with VOR-DME-T and to gain support for the system which the U. S. will propose as the international standard short-range navigation aid at next February's ICAO meeting in Montreal (AW Oct. 6, p. 45).

U. S. Position Clarified

The symposium appeared to have clarified the U. S. position on short-range navigation aids for many ICAO representatives. Uncertainties had been raised as the result of several years of internal controversy here between civil DME and Tacan compatible distance measuring equipment (DME-T) and because of the lack of a well-defined U. S. position at last fall's Sixth Communications Division ICAO meeting in Montreal.

U. S. seeks the continuation of VOR as an international standard, extension of its use to en route as well as terminal areas and the substitution of DME-T for the older civil DME adopted by ICAO in 1951.

In a statement which evoked favorable comment from foreign visitors, Civil Aeronautics Administrator James T. Pyle said the U. S. does not expect other nations to install VOR-DEM-T facilities "beyond those required to discharge that nation's self-assumed obligation to furnish air navigation service."

This "install it only if you need it" philosophy appeared to make friends, if not converts, for the U. S. position.

Questions raised by United Kingdom representatives during the symposium indicate the tack the British are likely to use at next February's ICAO meeting in their efforts to establish Decca as an international standard.

The British are expected to direct their opposition primarily at the adoption of DME-T rather than VOR which already is heavily implemented by many ICAO nations and airlines. Several hundred VORs are already installed outside the U. S., approximately 600 are already planned.

British will claim that accuracy of VOR-DME-T is not adequate to provide parallel routes with lateral separation in high density areas such as London; that the more accurate, hyperbolic Decca system is required. U. S. will emphasize that many U. S. airports already are handling considerably more operations per day than London using only VOR; that the addition of DME-T will greatly increase traffic capacity by reducing longitudinal aircraft separation now required and by providing many more holding fixes outside the terminal area.

Britain will stress the inherent compatibility and easy transition from short-range to long-range navigation aids if Decca is used for the former and a sister-system, known as Dectra, now in trial use over the North Atlantic, is employed for the latter. Although the U. S. has not disclosed its official position on long-range navigation aids, it is expected to lean heavily upon self-contained Doppler radar systems.

On the subject of easy transition and compatibility, the U. S. will emphasize the fact that transition from en route short-range navigation aid to instrument approach aid favors VOR-DME-T because airliners can use VOR receivers for instrument approaches since ILS is widely used around the world, including the United Kingdom. Addition of a low-power DME-T at an airport, providing the pilot with a continuous indication of his distance from touchdown, will greatly ease problem of instrument approach with high-speed jets, the U. S. will emphasize.

The United Kingdom, which plans to use airborne Doppler radar in conjunction with Dectra for long-range navigation, questioned whether the use of such a self-contained navigation aid does not eliminate the need for DME-T for international carriers. In answer, Air Transport Assn's Milton Arnold said U. S. airlines are now studying and evaluating the relationship of DME-T and Doppler radar and conceded that a self-contained navigation aid "might decrease the need for DME-T."

In an effort to establish that combined use of both Decca and VOR is feasible, Wing Commander H. I. Wood of Britain's Ministry of Transport and Civil Aviation asked whether U. S. military aircraft would be permitted to fly the federal airways if they used navigation devices other than Vortac. In reply, D. D. Thomas, director of CAA's Office of Air Traffic Control, said they would, providing they could fly the same tracks as civil-military aircraft employing Vortac.

Visitors also commented favorably on the pictorial type presentation employed by Decca and showed considerable interest in several experimental pictorial-type displays developed some years ago under CAA sponsorship for use with VOR-DME-T.

CAA officials emphasized that the present state of the avionic art would permit design of considerably smaller pictorial displays by U. S. manufacturers if user interest warranted; that VOR-DME-T was equally adaptable to either pictorial or present symbolic (cross-pointer) type display. (The report that Britain is developing a cross-pointer type indicator for use with Decca suggests that both types of displays have their advocates.)

Two significant new developments in VOR and DME-T ground stations were unveiled at CAA's Technical Development Center during the symposium:

- **"Doppler" VOR,** which employs new technique that greatly improves accuracy of ground station at sites with mountainous, wooded terrain but requires no change in airborne VOR receivers. Initial tests at Charleston, S. C. in adverse terrain showed that the new technique reduced VOR station errors to one seventh its previous value, to provide an over-all system error of 0.9 deg. Even better accuracy appears likely with refinement of the new technique, CAA says.
- **Small, low-cost DME-T station,** which includes dual equipment and provisions for automatic changeover from one transmitter to the other in event of failure, is expected to sell for less than $20,000 in production quantities of around 200 units. The station, originally developed by International Telephone & Telegraph Co. for use on Navy submarines, can deliver 12 kw. when operating as a DME-T, or 1½ kw. when operating as a full Tacan which provides bearing and distance information. New DME-T is small enough to be installed in an existing VOR station.

Manufacturer's Displays

Symposium visitors spent considerable time examining a variety of airline, private-flyer VOR-DME-T and military Tacan sets displayed by more than a dozen avionic manufacturers in a CAA hangar. Visitors appeared to be impressed by the miniaturized construction, much of it transistorized, and the quality of private flyer equipment.

One representative, whose country leans toward Decca, told Aviation Week that he was impressed by the amount of government and industry effort that apparently had gone into development and implementation of VOR-DME-T for all segments of aviation.

AIRLINE OBSERVER

▶ Watch for Northeast Airlines to announce that its offices in Washington —where James W. Austin, president, and Nelson B. Fry, vice president of sales, and other sales officials are now headquartered—will be closed and moved to New York City.

▶ **Federal Aviation Agency will provide a total of 15,000 new jobs during 1959. Size of the agency, once it is fully implemented, is planned at 40,000 persons.**

▶ Russian Il-18 Moskva turboprop transports, originally scheduled to go into airline service several months ago, are being used for regular cargo flights between Moscow and Sverdlovsk in western Siberia. The 880-mi. route is considered a short stage run by western observers for an aircraft rated with a nonstop range of 3,100 mi.

▶ **Introduction on July 1 of positive control of aircraft on one transcontinental airway at altitudes between 17,000 ft. and 22,000 ft. coupled with positive control of all aircraft above 24,000 ft., has resulted in an average of 22,400 IFR operations each day. This is an increase of 5,000 IFR flights daily since July 1. Airlines report satisfaction with the system and say no unusual delays have occurred since positive control was introduced.**

▶ Post Office Department this month began weekly payments for air mail services to domestic airlines. Although carriers presently receive mail pay on a monthly basis, three years ago periods of six months to two years had elapsed before final payment was made by the Post Office.

▶ **Railway Express Agency's application to serve as an international air freight forwarder has been denied by the Civil Aeronautics Board as "not in the public interest." In its decision, the Board noted that the request would have been disapproved in any event since Railway Express is wholly owned by the railroads and thus owes a primary loyalty to the railroads.**

▶ Civil Aeronautics Administration has awarded a $15.6 million contract to Federal Telephone and Radio Co. for the purchase of components for 196 complete Vortac ground stations. New equipment consists of dual transponder beacons, test monitor and control equipment and an antenna for each Vortac station. Contract brings total of stations to be equipped with the Vortac components to 328.

▶ **American Airlines plans to begin Boeing 707 jet transport service between New York and Los Angeles on Jan. 11. New York-San Francisco service through Chicago will start Jan. 25 and by mid-summer Dallas, Boston, Baltimore-Washington (Friendship Airport) will have 707 schedules.**

▶ Czechoslovak Airlines has announced plans to begin experimental helicopter feeder service in 1960. The aircraft will deliver passengers from remote points "to the central transportation network." Czechoslovakia already has a number of large, Russian Mi-4 helicopters that could be used for the service.

▶ **Aloha Airline of Hawaii has signed a contract to buy three Fairchild F-27 turboprop transports with an option to purchase an additional two in 1960. The airline plans to use the Federal Equipment Loan Guarantees Act to help obtain long-term financing for the planes. In addition, the company plans to reduce the par value of the 930,000 shares of stock outstanding from $1 per share to 25 cents. This will be followed by the issuance of 4 million shares of preferred stock, 6% non-cumulative, convertible to common stock at 25 cents per share.**

▶ Civil Aeronautics Administration has now purchased 20 French developed scan conversion systems to provide television type radar displays for air traffic controllers. First delivery of the equipment will be completed within 90 days, and the three first systems will be installed at New York Idlewild, Washington National and Chicago Midway. Intercontinental Electronics Corp. is the supplier.

SHORTLINES

▶ **Allegheny Airlines** reports 60.8 million passenger miles for September, the heaviest September figure in the company's history. The airline carried 602,000 lb. of cargo, including air express and air freight, for a 30% gain over September, 1957.

▶ **Chicago Helicopter Airways** carried 11,579 passengers during September, a 60.3% increase over the 7,223 passengers flown during the same period of 1957.

▶ **KLM Royal Dutch Airlines** will begin new twice weekly service to Tripoli, Libya, from Amsterdam using Vickers Viscount 803 aircraft. The new service, which begins on Nov. 1, will connect with flights from New York and Houston at Amsterdam. KLM also is picking up options on three more Douglas DC-7C airliners to be delivered before the end of 1958.

▶ **Piedmont Airlines** has received two of its Fairchild F-27 aircraft on order and plans to put them into service by mid-November. The carrier has orders for eight of the turboprop transports.

▶ **Resort Airlines** has received an extention of the time limit to begin service to the Florida-Caribbean area from the Civil Aeronautics Board. Scheduled to begin service in September, Resort may now reschedule it for July 1.

▶ **Trans-Canada Air Lines** is re-introducing its emigrant and family fare plans on Oct. 15. Fares will continue through March 31. The low-cost emigrant fare between London and Montreal is $173.90 economy as compared with the regular economy fare of $247. TCA, which will offer a total of 10 flights a week across the Atlantic during the period, has scheduled a family fare plan that will enable a family with two children to save $450 on an economy class Montreal-London round trip.

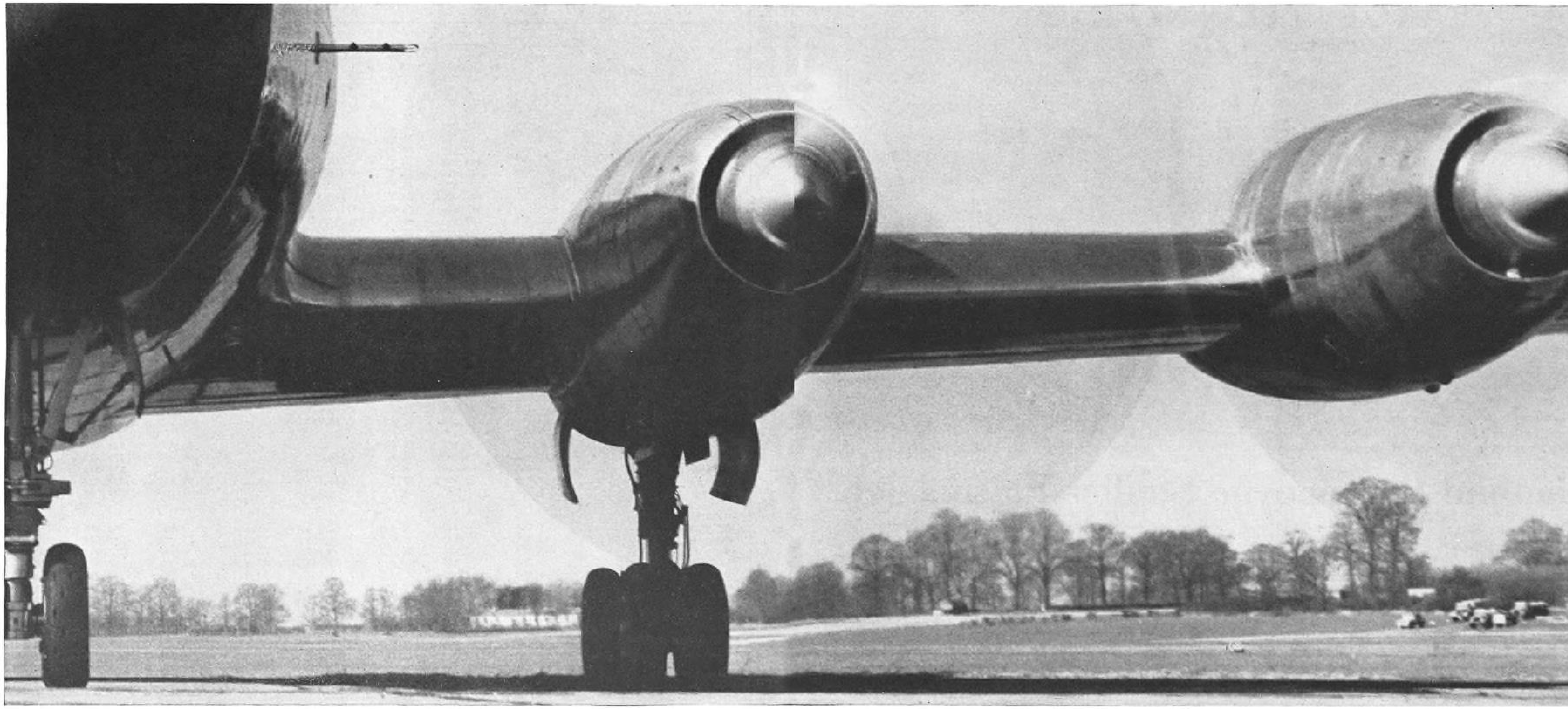
▶ **United Air Lines** has awarded contracts for 680 million gal. of kerosene jet fuel to five U. S. oil companies. The contracts vary in length from three years for Shell Oil, Standard Oil of Ohio and Standard Oil of California to four years for Phillips Petroleum and five years for Esso Standard Oil. All contracts become effective Jan. 1. United also has begun construction of a $475,000 jet engine test cell facility at its maintenance base at San Francisco International Airport. Western Knapp Engineering Co., of San Francisco, is expected to complete the new building next June.

Airline Traffic—August, 1958

	Revenue Passengers	Revenue Passenger Miles (000)	Load Factor %	U. S. Mail	Express	Freight	Total Revenue Ton-Miles	% Revenue to Available Ton-Miles
DOMESTIC TRUNK								
American	641,732	473,271	70.4	1,597,168	947,496	9,170,992	57,165,220	60.9
Braniff	165,068	75,305	58.0	296,062	202,471	656,766	8,389,498	48.5
Capital	346,123	136,735	58.5	507,678	312,825	404,506	14,329,943	48.4
Continental	84,222	46,225	53.5	100,544	48,258	221,123	4,808,587	45.9
Delta	224,596	111,699	58.1	373,899	298,033	1,173,705	12,583,672	53.8
Eastern	657,687	358,308	53.41	866,357	528,148	1,327,841	37,191,738	47.95
National	117,530	68,893	52.5	234,141	48,341	425,447	7,359,372	43.9
Northeast	105,622	34,820	46.7	79,907	28,884	99,078	3,535,271	38.6
Northwest	154,157	124,025	64.1	447,336	248,414	1,011,846	13,591,432	55.4
Trans World	422,506	397,802	71.5	1,107,727	750,977	2,539,569	42,509,189	64.0
United	630,508	495,009	68.4	2,286,058	1,004,961	6,450,553	57,242,360	60.2
Western	126,230	69,950	56.8	211,707	91,419	370,374	7,304,533	46.5
INTERNATIONAL								
American	13,412	12,627	66.1	9,138	594	247,171	1,575,996	63.3
Braniff	4,504	8,660	55.3	7,176	...	107,046	1,052,301	48.4
Caribbean-Atlantic	24,583	1,710	65.90	...	...	2,632	183,402	71.29
Delta	5,569	6,795	58.4	7,830	...	37,355	799,810	50.3
Eastern	43,155	60,520	57.81	71,182	...	137,680	6,417,740	58.28
Mackey*	10,270	2,101	45.6	...	90	...	...	...
National	10,670	7,224	71.0	9,166	3,873	47,823	826,012	61.4
Northwest	19,692	43,072	69.2	1,139,589	26,335	950,839	6,617,605	73.8
Pan American								
Alaska	6,073	6,521	71.1	27,256	...	173,023	857,460	63.0
Atlantic*	135,134	192,621	67.7	1,245,995	...	...	...	...
Latin America	120,098	129,280	71.7	375,687	...	4,391,949	16,738,612	68.1
Pacific	26,345	94,878	77.7	1,200,416	...	1,717,401	12,765,291	74.7
Panagra	10,410	13,311	50.5	68,865	...	441,038	1,965,528	54.0
Resort*	...	...	...	...	...	...	...	...
Trans-Caribbean	8,411	17,443	88.8	...	...	34,752	1,620,805	87.3
Trans World	37,192	109,322	63.1	944,795	...	698,650	12,973,825	62.0
UMCA	150	49	35.5	...	...	1,811	7,059	46.8
United	12,988	32,264	75.9	143,818	...	99,233	3,534,993	73.4
Western	1,596	2,481	44.7	840	...	3,309	274,288	48.6
LOCAL SERVICE								
Allegheny	48,266	8,526	49.9	10,373	20,854	23,857	869,077	49.6
Bonanza	15,258	3,530	44.6	4,685	2,251	11,495	356,562	43.2
Central	13,377	2,491	35.1	5,859	3,052	9,967	257,544	31.6
Frontier	20,759	5,267	47.6	14,761	7,833	68,876	598,679	56.8
Lake Central	16,108	2,508	39.4	3,201	17,231	...	260,274	43.3
Mohawk	38,802	8,000	50.0	8,220	14,280	15,897	802,103	50.1
North Central	72,857	12,867	50.7	24,211	40,515	...	1,286,101	51.6
Ozark	37,184	6,227	46.2	9,914	21,258	23,484	649,529	48.9
Pacific	35,163	7,627	53.3	9,297	5,188	13,010	754,787	51.5
Piedmont	37,652	8,022	56.3	14,551	16,775	13,093	812,224	56.0
Southern	18,641	3,401	38.7	7,691	11,403	10,675	355,547	39.2
Trans-Texas	20,590	4,657	38.7	13,236	8,319	32,640	500,638	39.9
West Coast	24,052	4,366	52.88	3,906	3,410	19,252	433,784	51.43
HAWAIIAN								
Hawaiian	56,100	15,839	75.0	4,328	...	135,698	1,543,204	69.7
Trans-Pacific	25,314	3,373	63.4	748	...	7,019	278,638	62.2
CARGO LINES								
AAXICO*	...	...	...	...	...	...	...	...
Aerovias Sud Americana*	...	...	...	...	...	718,105	718,105	78.7
Flying Tiger	11,246	48,576	100.1	31,044	18,367	8,153,090	13,060,098	91.4
Riddle								
Domestic	...	...	...	17,116	37,067	1,638,333	1,692,516	77.6
International	...	...	...	...	...	622,744	622,744	81.9
Seaboard & Western	1,435	5,893	100.0	167,593	...	1,776,140	2,533,713	59.6
Slick*	2,000	10,929	94.58	...	...	149,402	1,242,392	...
HELICOPTER LINES								
Chicago Helicopter	11,411	218	41.3	1,258	...	...	22,031	29.3
Los Angeles Airways*	3,477	127	59.4	3,879	...	...	18,203	64.4
New York Airways	11,251	209	51.6	1,585	838	472	22,769	48.9
ALASKA LINES								
Alaska Airlines	8,182	4,740	50.5	56,436	3,196	303,494	852,730	48.4
Alaska Coastal	7,875	681	63.9	3,703	...	5,129	78,022	65.6
Cordova	1,685	332	62.4	4,562	...	24,441	63,456	65.1
Ellis	7,254	457	67.0	2,025	...	2,913	51,238	75.1
Northern Consolidated	3,104	1,001	62.3	22,236	...	84,051	214,101	68.2
Pacific Northern	15,851	16,082	68.0	99,339	6,784	346,029	2,189,175	73.2
Reeve Aleutian*	...	...	...	...	...	...	...	...
Wien Alaska	6,644	2,309	27.7	38,387	...	305,781	580,082	66.6

* Not available.

Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.



BRISTOL PROTEUS

builds up overhaul life—now tops 1,600 hours

Never before has an aero-engine proved its reliability so rapidly, so conclusively as the Bristol Proteus 705 turbo-prop.

The Proteus first entered airline service *less* than 18 months ago. Yet already its life between overhauls has risen to 1,600 hours—authoritative evidence of this turbo-prop's mechanical excellence and exceptional reliability.

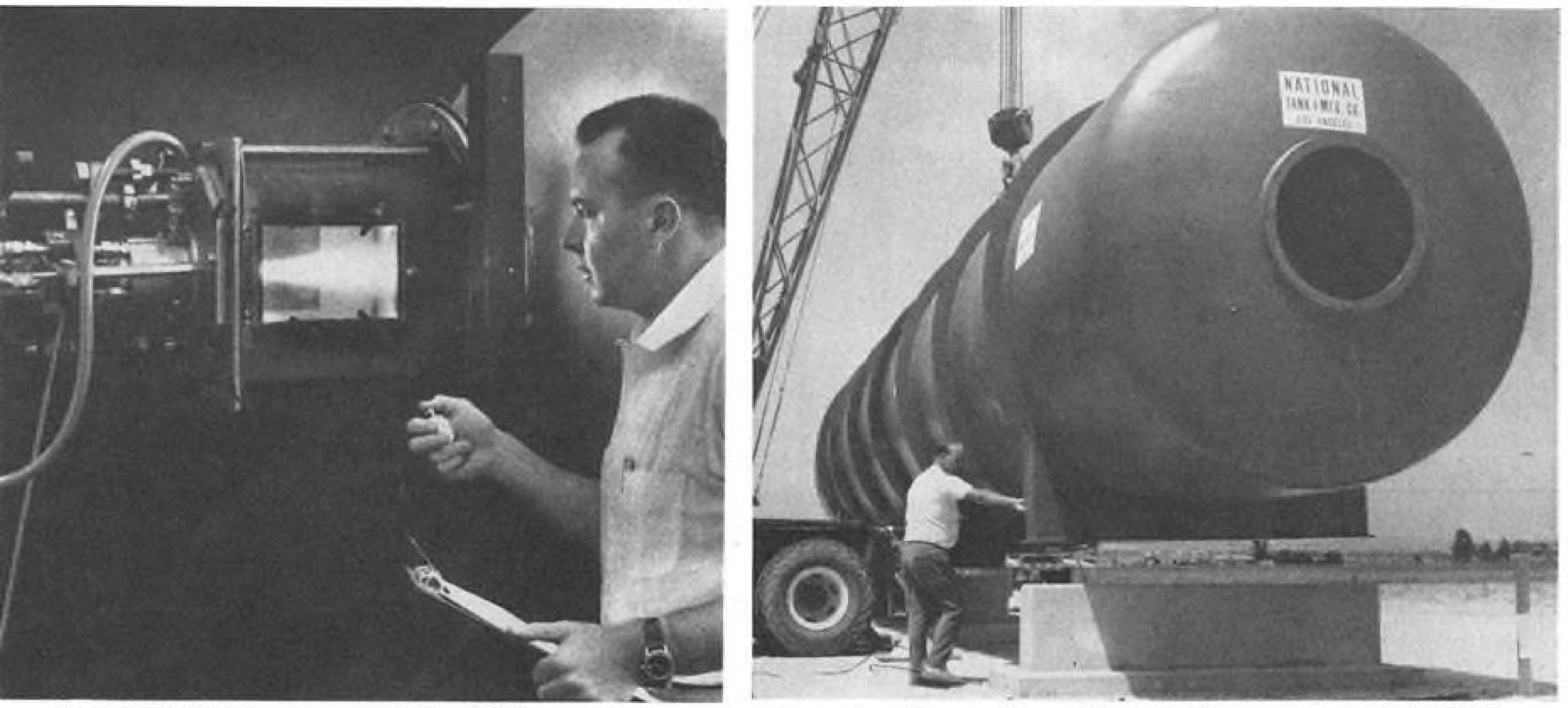
More power for less fuel. Further, the Proteus is the most powerful turbo-prop in commercial operation. And it has a lower specific fuel consumption than any gas turbine in civil or military service. But development does not stop here. There are now new versions—the 760 series—designed to give *even more* power at an *even lower* specific fuel consumption.

Flexible, efficient, quiet. The Proteus features the Bristol-pioneered free-turbine system. This system gives flexibility in choice of power and propeller speed, produces remarkable efficiency over a wide range, and results in very low noise levels.

Over 2 million miles a month in service. The Bristol Proteus powers the magnificent Bristol Britannia—currently setting new standards of fast, smooth comfort, and flying *well over* 2 million miles a month on world-wide routes.

Bristol Siddeley

ENGINES LIMITED



COMPARATIVE size of present (left) and future (right) hyperthermal tunnels is illustrated here. Material ablation rate is studied (left) in a 100 kw. plasma jet pilot model hyperthermal tunnel. Unit can generate Mach 3 jets at stagnation temperatures up to 12,000F. Jet diameter is about 1 in. Vacuum chamber (right) is for a new 1,000 kw. hyperthermal tunnel being erected at Plasmadyne for Army Ballistic Missile Agency high temperature research program. This hyperthermal tunnel will have a plasma jet 4 in. in diameter.

Giannini Plasmadyne Studies Plasma Jet

By Irving Stone

Santa Ana, Calif.—Frontiers of high-temperature physics are being advanced here by Giannini Plasmadyne Corp.'s science specialists accumulating basic and applied research data in plasma jet phenomena to unravel critical problems associated with space technology.

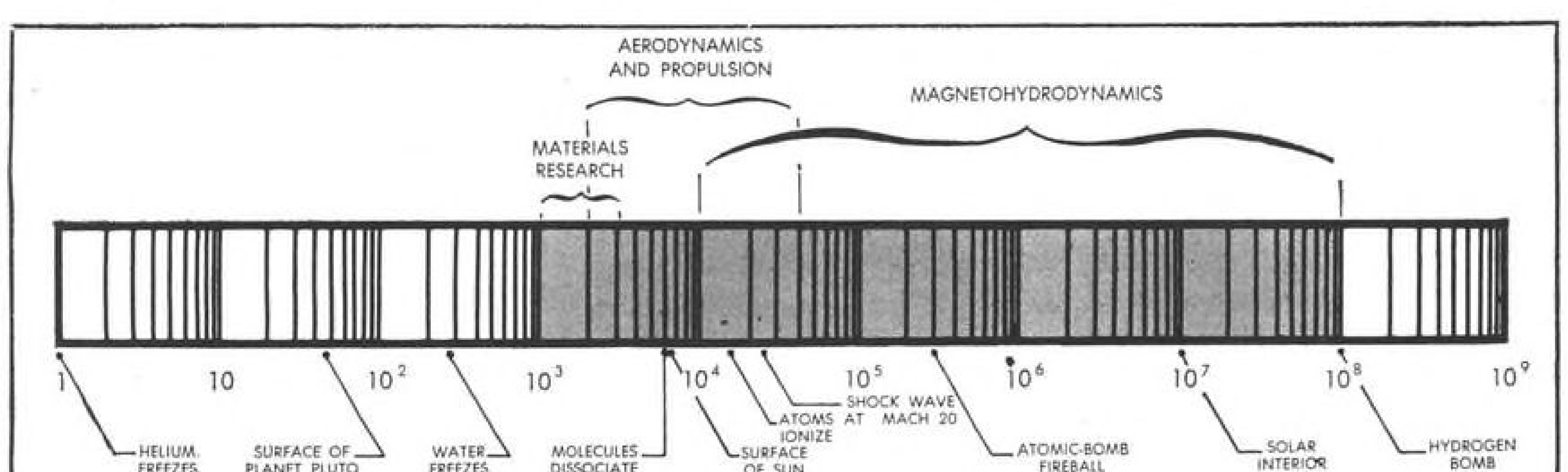
Plasma is a neutral mixture of ions, electrons and some neutral atoms. Mixture occurs at temperatures above 10,000F, depending on the specific gas used.

General Electric Co. (AW July 14, p. 71) and Thermal Dynamics Corp. are two other companies working in the plasma jet field.

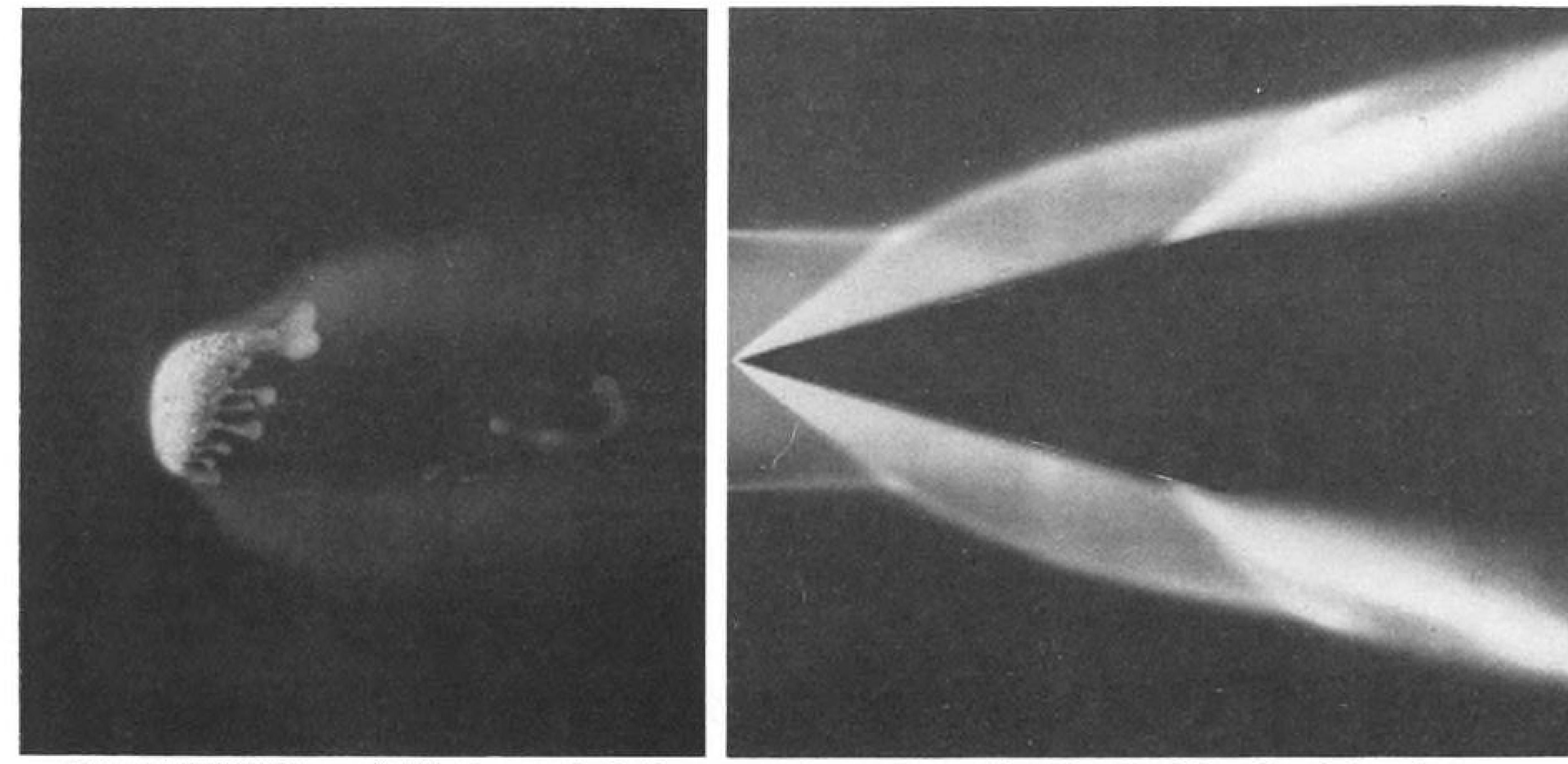
Characteristics of plasma jet indicate a large potential as a space vehicle propulsion unit, high-temperature high-velocity tunnel tool, and a device for creating new combinations of materials to withstand extreme operating conditions of re-entry vehicles.

Plasmadyne's research is carried out in these laboratories:

- **Aerodynamics and propulsion.** Emphasis is being placed on technologies of plasma jet propulsion units and their power sources and systems analyses of both propulsion devices and power sources for specific space missions.
- **Magnetohydrodynamics** (AW May 12, p. 48) and high energy physics.
- **Materials technology.**
- **Upper atmosphere instrumentation.** This laboratory activity does not use the plasma jet as a research tool but is concerned with the study of environmental phenomena in the high layers of the atmosphere, where space traffic will be encountered. Many of these laboratory studies are in fields where comparable free-flight experiments so far have yielded only a limited amount of information. Various phases of Plasmadyne's research and development work are supported by Army Ballistic Missile Agency and Air Research and Development Command installations comprising Air Force Office of Scientific Research's Directorate of Advanced Studies, Wright Air Development Center and Rome Air Development Center.



APPROXIMATE temperatures (degrees Kelvin) apply to fields of materials, aerodynamics and propulsion, and magnetohydrodynamics.



FIBERGLAS-MICARTA cone (left) is shown at simulated re-entry condition in Giannini Plasmadyne Corp.'s hyperthermal plasma jet tunnel in Santa Ana, Calif. A shock wave is visible as heated glass melts and flows back. At right, a copper wedge in the test section of the plasma jet hyperthermal tunnel produces shock waves visible in direct luminosity. The tunnel is operating at Mach 2.4. Stagnation temperature of the plasma jet is approximately 12,000F. Plasma is a neutral mixture containing ions, electrons and some neutral atoms.

Applications

While Plasmadyne's plasma jet equipment originally was developed for its own research program, the company recognized the need in the general research and industrial fields for a high-energy-density heat source, such as the plasma jet, which could be operated continuously with high uniformity of test results and bypass the inherent disadvantages of the carbon-arc image furnace and solar furnace. It developed the "Plasmatron" as a research tool for industry segments, government agencies, universities and institutes.

This equipment embraces four general categories:

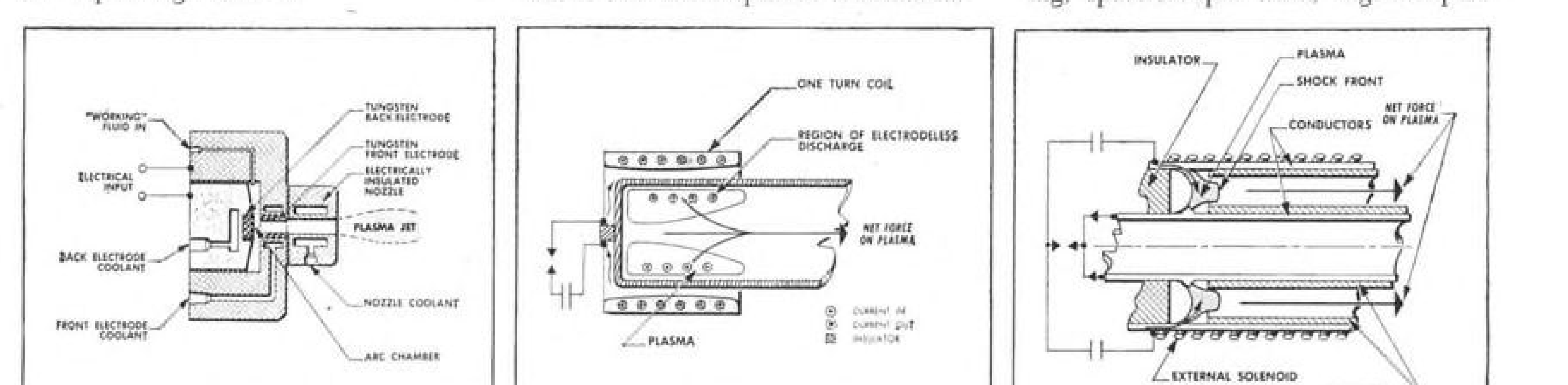
- **General plasma jet** research unit.
- **Research unit** with spray attachment for depositing material.
- **Wind tunnel** incorporating plasma jet.
- **Materials test chamber** embodying plasma jet.

With the plasma jet, temperatures up to 25,000F (14,500K) can be attained on a continuous basis, as well as power densities of 250kw./sq. cm. Plasmatron equipment prices range from $4,500 up, depending on the power rating of the plasma jet system.

Organizations which have purchased plasmatron units include:

- **Aircraft Nuclear Propulsion** Division, General Electric Co.
- **A. O. Smith Corp.**
- **Aro Inc.**
- **American Cyanamid Co.**
- **Bendix Products Division,** Bendix **Aviation Corp.**
- **Boeing Airplane Co.**
- **Cambridge Research Center,** Air Research and Development Command.
- **Convair San Diego Division,** General Dynamics Corp.
- **Douglas Aircraft Co.**
- **Esso Standard Oil Co.** (La.).
- **Kirtland Air Force Base.**
- **National Advisory Committee** for Aeronautics, Ames Laboratory.
- **Norton Co.**
- **Owens-Corning** Fiberglas Co.
- **Rice Institute.**
- **Sandia Corp.**
- **Standard Oil Co.** of Ohio.
- **Stanford Research Institute.**
- **University of California.**
- **University of Dayton.**

General fields of research interest for using this equipment include electric propulsion research, aerodynamic testing under high Mach number conditions, heat transfer, materials testing and research, high-temperature spraying, material cutting, melting and welding, spectroscopic work, high-tempera-



BASIC device designed for use in both high temperature plasma jet and propulsion studies is shown in Giannini schematic drawing at left. An electrodeless magneto-plasma device is in the center. A coaxial magneto-plasma device that utilizes electrodes is shown at right.


HIGH SPEED rotating mirror camera (left) is used to study high energy spark discharges in a controlled environment chamber. Optical equipment and associated precision drive mechanisms (right) are being assembled for upper atmosphere studies. Radiation measurements in the light spectrum are expected to reveal turbulence due to fluctuations in the refraction index. This instrumentation program is concerned with the study of environmental phenomena in the high layers of the atmosphere, where space traffic will eventually be encountered.

ture chemistry and general high-temperature research.

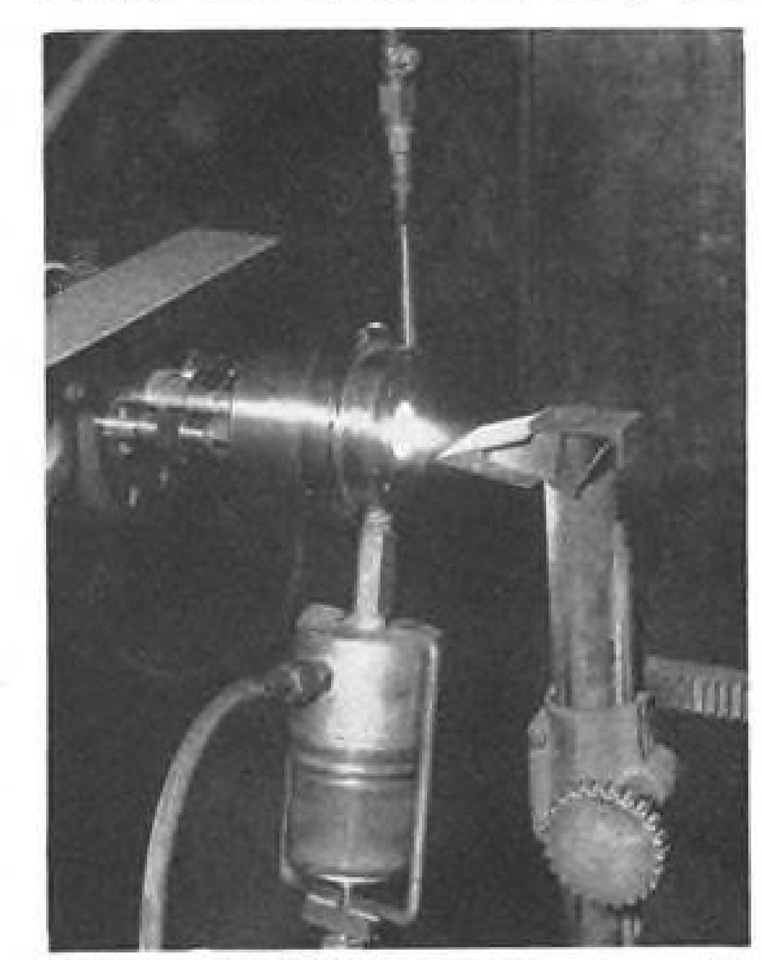
Plasmadyne's Aerodynamic and Propulsion Laboratory is intensively pushing these activities:

• **Study and development** of aerodynamic test devices such as wind tunnels incorporating the plasma jet. This involves simulation of high-temperature flight conditions on scale models. Pilot-scale hyperthermal wind tunnel already has been developed and is being refined, and plasma jet calibrated. Tunnel operates in the 100-kw. range. At a true jet Mach number of 2.5, it has a free jet diameter of about 1 in. Stagnation enthalpy is up to about 10,000 Btu/lb. of air, corresponding to flight speeds of about 22,000 ft. per sec. This research tool creates, in the laboratory, body surface conditions comparable with those in free flight. It is being used to study re-entry ablation and for measurement of transport properties and other characteristics of gases. Also being checked are the present physical limitations of simulating certain extreme high-temperature, high-density flight conditions in a plasma jet or any continuously operating tunnels. Operation of the plasma jet tunnel spans a time period ranging from seconds to minutes, equivalent to re-entry conditions, as compared with millisecond tunnel types such as shock tubes. Being pushed to completion is a 1,000 kw. (one megawatt) tunnel, being advanced as another stepping stone in the development of high-temperature equipment for aerodynamic and propulsion studies. It is expected that within the next few years, military research and development requirements will call for test jets of five to 10 megawatt capacity. The 1,000-kw. tunnel's continuous rating will permit use of even higher power levels for short duration runs. The facility will have several nozzles with jet diameters of 4 to 6 in. for very high heat flux rates (steep re-entry simulation), and much larger jet sizes at higher Mach numbers and lower gas densities, for simulation of high altitude flight. Tunnel will incorporate a 35,000-gal. vacuum tank and vacuum pumps with 6,000 cfm., displacement at 0.1 mm. Hg. pressure. High-pressure air supply is to be added in the near future. Rectifiers can be connected to give highly regulated direct current at 0 to 20,000 amp. and 50 to 1,000 v.

• **Transport properties** (heat transfer, electrical conductivity, diffusion coefficients, etc.) of gases and other characteristics such as relaxation times and recombination rates at high temperatures. This is both a theoretical and experimental study, targeted to produce a clear understanding of re-entry conditions. Experiments utilize air, nitrogen and argon—air because it is a free-flight medium and nitrogen because it will be encountered in space and has very similar properties to air, but is free of oxygen.

Also, it has been found that nitrogen is not inert at very high temperatures, especially in the dissociated state (N instead of N_2).

Argon is being used because it is truly inert, hence isolates the heat transfer from chemical effects. Measurements of transport properties, as well as relaxation and recombination rates,




WEDGE section (left) is coated by plasma jet spray of molybdenum disilicide on molybdenum titanium alloy. Coating increases resistance of wedge surface to abrasion and oxidation. Plasma jet (right) is vaporizing a stainless steel plate. Used as a cutting tool, Plasmatron quickly vaporizes metal, minimizing heat transfer to surrounding material. By using argon as a working fluid, cut is blanketed by inert envelope of gas to prevent oxidation.

Typical Results of Thrust Experiments Using a Continuous Arc Plasma Jet

	ARGON			HELIUM	
Electric power input, kw.	40	61	46	80	80
Mass flow rate, gr./sec.	1.6	3.0	4.66	1.29	.70
Specific enthalpy, million Joules/kg.	14	10	4	47	76
Thrust, Newtons (.224 lb.)	2.2	6.3	8.9	7.5	3.7
Thermal efficiency, power, gas/power, input	.55	.52	.41	.75	.66
Specific impulse, sec.	140	214	195	590	535
Nozzle length, in.	none	1	1	½	none

still are in an initial stage, because these measurements are very difficult and require, among other things, a precise, uniform and very accurately calibrated wind tunnel jet.

• **Interaction** between high-temperature gas and body surface. This involves aerothermalchemistry and purely physical processes. This study, also a theoretical and experimental investigation, is expected to lead to understanding of re-entry body ablation bodies. Plasmadyne already has conducted a substantial number of experiments on ablating bodies. An important phenomenon uncovered is that starting with a blunt graphite body in a high-temperature high-density air plasma jet, the body sublimes into a needle-sharp conical configuration instead of keeping its blunt shape while ablating. The sharp conical shape is retained as the body continues to ablate, so that it remains a stable configuration. This could be an important consideration in re-entry bodies, particularly in vehicles with wings, where drag would be very materially reduced through successive sharpening action on the leading edge. On the other hand, the effect of the resulting sharp leading edge could be disadvantageous for low-speed lift, as in the landing phase of a winged vehicle. The same phenomenon of ablation progress from blunt to pointed configuration also has been found to occur in an inert gas jet, but the ablation rate is roughly 20 times slower. Graphite ablation process in air is one example of aerothermalchemistry because of the oxidation (burning) involved in the boundary layer. In inert gas the result is a purely physical phenomenon—transition from solid state to vapor (sublimation). The argon experiments are the simplest to compare with theory, and also lay the foundation for the much more complicated case of using air as the fluid medium.

• **Aeromagnetic phenomena.** This involves interaction between ionized gas and magnetic fields. Possible application of information accumulated in this study might result in the ability to change the ratio between drag and heat transfer of a re-entry body by changing the shock wave configuration and/or boundary layer velocity profile, to reduce heat transfer. Also, aeromagnetics might possibly be utilized to produce lift on a body. Another possible potential is the conversion of kinetic energy of the oncoming air into electrical current for auxiliary power. Theoretically, this conversion even might be used to accomplish change of ratio between drag and heat transfer of a re-entry body and production of lift, by magnetic means. Aeromagnetic studies also may lead to the production and acceleration of a plasma by electromagnetic means. Plasmadyne has conducted preliminary experiments on interaction between

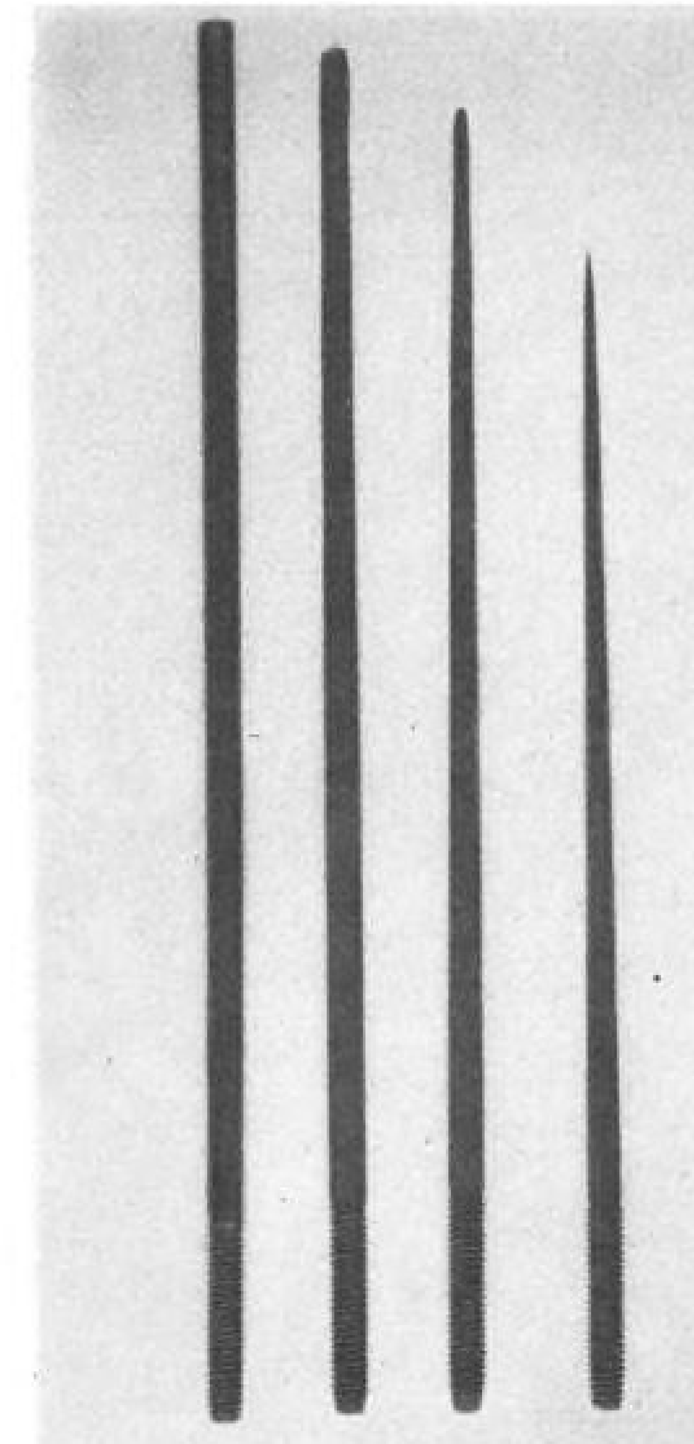
Plasmadyne Organization

Giannini Plasmadyne Corp. is an example of a small, specialized organization contributing to the over-all fund of knowledge in the regime of high-temperature phenomena, to accelerate progress in space technology and related activities.

Company has expanded from a group of 40 people in March, 1958, to approximately 90 personnel presently.

Originally formed as Giannini Research Laboratory, the company was activated in April, 1956, later changed its name to Giannini Plasmadyne Corp. Some key personnel include:

• G. M. Giannini, president.
• R. H. Goodwin, vice president, general manager.
• A. C. Ducati, vice president, development engineering.
• D. F. Howard, director, government relations.
• Dr. R. D. Buhler, manager, Aerodynamics Propulsion Laboratory.
• Dr. R. W. Waniek, manager, and Dr. V. H. Blackman, Dr. P. G. Thiene, and Dr. H. G. Loos, Magnetohydrodynamics Laboratory.
• H. C. Sullivan, manager, Materials Technology Laboratory.
• D. G. Van Ornum, manager, Upper Atmosphere Instrument Laboratory.
• S. H. Brown, manager, Manufacturing and Product Engineering.



GRAPHITE rods of ¼ in. dia. are shown before (left) and at 1-min. intervals after (to right) ablation tests in a plasma jet hyperthermal tunnel using air about 12,000F for a working medium. Needle point resulting from ablation is contrary to blunt shape assumed by most other materials studied.

strong (pulsed) magnetic field and the argon plasma jet.

• **Study and development** of propulsion components. In the field of power sources, Plasmadyne is looking at basic physical principles which might be used to generate electricity. These include fission, fusion, chemical and mechanical processes, as well as various types of radiation and high energy particles in space as external power sources. Overall optimization of electrical propulsion systems applied to space flight missions are also being investigated. In these studies hypothetical simplified missions are created, such as a trip from earth orbit to and around the moon and return. Object of the studies is to find the optimum specific impulse range and, eventually, the optimum propulsion system for these typical missions.

Planet, Satellite Trips

In addition to lunar missions, near-planet trips and earth satellite missions are being studied. Analyses include variations in powerplant specific weight, structural weight, shielding requirements and vehicle size. Result is an optimum specific impulse for each

"No Sweat"

Here, in a tape recorded interview, Herman "Fish" Salmon, one of America's top test pilots gives you his personal experiences test flying the new Lockheed Electra:

• "**When we take a pilot** up for his first flight, he's most always surprised to find there are no complicated systems on the Electra—it's as easy to fly as a single engine plane—no sweat!

• "**He has settled down** and is finding how easy the Electra flies—I reach up and cut the fuel on number one engine. They most always ask—'Have you feathered an engine?' Yaw is very mild even with a fuel failure. The Negative Torque System takes over. This permits less than about 650 pounds of drag as the propeller blade angle quickly goes to steep pitch, (almost the same as auto-feathering).

• "**In other airplanes** we would then have to go through nine different steps to clean up the cockpit. Electric system off, engine oil off, cooling air to nacelle off, cooling air to generator off, fuel off, bleed valves off, fire extinguisher armed, feather the propeller both manually and electrically. On the Electra—pull! —and it's all done. One lever does all the work. Then, I'll accidentally-like, reach up and cut number 2 engine. They are both out; we're flying on number 3 and 4 engines—even then there's no tendency for the pilot to work hard, no tendency to make wrong decisions. There are no complicated systems. One pull—we're safe.

• "**As far as pilot comfort** is concerned, we talk in the cockpit like we might in my living room. After 6 hours in the air, we're no more tired than after an hour in another airplane. We're not 'balls of snakes' when we get out.

• "**Actually, changing rpms** is the big factor in producing annoying noise. We have this problem licked from the start with Electra's Allison Prop-Jets. They turn at constant speed throughout the flight, which makes them unique. To keep the airplane from being a ground nuisance, we have a ground idle speed which cuts the engine noise to about one-half normal engine noise. There is no popping or backfiring at the terminal during engine starts.

• "**At take-off, the noise** dissipates slightly as forward motion is attained. You taxi out to the runway. In the final turn into position, there's some increase as you go from ground idle to full rpm and the power comes on. The passengers won't hear any big noise increase. Release the brakes, and the plane accelerates very rapidly, noise goes down because of the motion.

• "**In fact, the lack of noise** is deceiving. At first, you figure no noise...no power. But you check your air speed indicator and you see you're doing 100 knots!

• "**Our climbing speed is fairly high** —210 knots is recommended airline climb out. Since there's no particular problem around the airport, we don't have to pull it up in the air at high angles to get rid of noise.

• "**Let's say there's a stack up to** 20,000 feet when we file our flight plan. We might have to wait for say 45 minutes before take-off to get a 20,000-foot cruise altitude. With the Electra we don't have to wait on the ground until clearance can put us up at our desired cruise altitude. We can economically fly to an intermediate destination at a minimum altitude. Say at a four or five thousand foot slot. Then, with traffic lighter, we can climb out to a higher cruise altitude.

• "**Fuel management is no problem.** Electra has 4 engines, 4 tanks. This follows the simple flight station concept —to keep everything in the cockpit clean. The take-off and landing weights are close together. You can take-off, land at an en route stop, have passengers deplane, unload luggage and be on your way again in minutes. No refueling.

• "**We're in the same engine configuration** from take-off through cruise, approach and landing. When you want to go, push forward. When you want to slow, pull back. No mixture controls, no prop rpm levers, no carb heat controls.

• "**In testing, we've made jet penetration approaches,** clearing down 4,000 feet per minute. In fact, we've let down from 25,000 feet to the deck in 6 minutes. Beautiful part of this is there's no engine chilling, no wait for temperatures to equalize.

• "**Control response and power response on approach** is very precise. Very easy applications of power put you back onto the glide slope. There's no surge of noise to annoy passengers with power changes. No need to build up rpms...no overshooting and then settling. Naturally, a pilot can do a much more precise job of flying with less work.

"After six hours in the air in the Electra, I'm no more tired than after an hour in another airplane."

• "**In a descent,** the props act like dive brakes. We pull them back to idle, letting the plane down rapidly. That's why the dive flaps on the original design were later eliminated. We can meet all specs and get all the performance on the props alone, without a lot of complex machinery.

• "**No sweat on go-arounds.** If you overshoot the runway, Electra's constant-speed engines enable you to apply take-off power right now...no steps...no moving complex levers. All you do with the throttle is to change the fuel opening. Fuel added is immediately converted to prop power. These Allisons are unique in this respect—we don't need to develop engine rotational speed before obtaining power. This cuts power response delay to a minimum. You need power, you push forward...and get it!

Test Pilot Salmon tries a roomy Electra passenger seat. Note the individual intercom overhead.

• "**A bonus with these Allison Prop-Jets:** Immediately as you push throttles forward, the props wash air over the wing. This gives you an increase in air speed over the wing even before the airplane starts to accelerate!

• "**On touch down,** if we're in a hurry, Electra can stop in about 900 feet. We put the props into flat pitch, then reverse...slowing the plane to around 40. At this speed, reverse thrust is less effective, so you start to use your brakes. Another bonus here is that reverse props quickly dissipate wing lift so you get solid contact of the tires on the runway.

• "**It's always beautiful.** You fly this airplane, weighing 113,000 pounds, easy as a single place plane. This is a pretty broad statement, but I've flown all types. Electra has a different feel than others I've been in. The turbulence is not real sharp but not wishy-washy either. It's rather like a surfboard.

• "**Cockpit visibility** is way over what the specs call for. If you can see better, you do a better job. It's light and airy and has a roomy feeling. You can sit three across, which gives you six eyes to watch with.

• "**Instruments are the same as on other jets.** Basically they're simple. Some turbo-props have trimmers and their engines are otherwise complicated. On the Electra we don't use any differential power.

• "**Even if you lose** all hydraulic power which is very unlikely with three pumps, 2 sources of supply, 2 independent systems, you can fly it manually. It's work, but nothing dangerous about it.

• "**Electra is unique.** It combines all the modern features a pilot appreciates. He's not going to feel he will have to wait around an airport for passengers to load and baggage to get on. He will know when he's going to work and when he's coming home. If you have a maintenance problem pull out a black box, put in a new one and you're on your way. As for the propeller... some people who've yet to fly the Electra say a prop's old-fashioned. But this airplane combines the best prop characteristics with a jet engine. Once you've flown it, you know—the prop *makes* the plane."

"Once you've flown it, you know: The props *make* the plane."

• **A flier since 1931,** *when he began barnstorming at 18, "Fish" Salmon tested the P-38, B-17, the Constellation and Super Constellation, F-94, T-33; made the first flight on ramjet power; flew the first F-104A Starfighter flight.*

Now being delivered and soon to enter scheduled service with these leading world airlines: Aeronaves de Mexico • American Airlines • Ansett/ANA of Australia • Braniff Airways • Cathay-Pacific Airways • Eastern Air Lines • Garuda Indonesian Airways • KLM Royal Dutch Airlines • National Airlines • Northwest Orient Airlines • PSA—Pacific Southwest Airlines • Qantas Empire Airways • Tasman Empire Airways • Trans-Australia Airlines • Western Airlines.

LOCKHEED

AIRCRAFT CORPORATION

California Division
Burbank, California

mission and a set of parameters. With this information, payload-to-gross weight ratios are established.

Plasmadyne also is stressing the study and development of electrical thrust generators. Among these are the thermo plasma or arc jet; magneto plasma jet (electromagnetic accelerator); electrostatic (pure ionic) source; and exotic methods for the very far future, with characteristics of very high specific impulse and very low thrust, such as the photon rocket and electromagnetic deflection of high energy particles such as interstellar dust.

Plasmadyne is concentrating on thermo plasma and magneto plasma propulsion because these are in the specific impulse range most likely to have practical application in the next 10 years.

Thermo plasma scheme heats the gas by electrical discharge (either with or without electrodes) to create the plasma. This is known as Joule or ohmic heating and uses the resistance of the gas for heating. This heat or random energy is converted into thrust in a more or less conventional expansion nozzle. Specific impulse is seen to be of the order of 500 to 2,500 sec. although a clear cut upper limit has not been established.

Difficulty with the thermo plasma system lies in the containment of the high-temperature gas and in the conversion of gas random energy to directed energy. This involves problems of excessive heat transfer to the containing vessel and, in particular, to the expansion nozzle. It appears that, for the near future, the thermo plasma system probably will be limited to specific impulses considerably below 2,500 sec.

A thermo plasma propulsion system is considered feasible now within the present state of development, Plasmadyne scientists point out. In the laboratory, the system can be operated for a matter of perhaps 5 to 10 min. Engineering problems to extend this time to hours or weeks of reliable operation, as for space missions, involves the main consideration of reducing cooling requirements, perhaps by regenerative methods and design refinements. Another big difficulty is extension of electrode life.

In the magneto plasma system, the plasma first is created (by heat or electrical field) then currents are produced in the gas and acted upon by a magnetic field, which has the effect of accelerating the plasma to high velocities. Specific impulses attainable here may be above 3,000 sec., but the upper limit presently is unknown.

Magneto plasma system avoids some of the difficulties of the thermo plasma scheme, such as involved in the conversion from random (heat) energy to directed-particle energy, since the particles are accelerated immediately in the proper direction by the magnetic field, eliminating the nozzle problem. Also, a magnetic field may be used to contain the plasma, thus minimizing the problem of heat transfer to the system's "walls."

With one or two exceptions magneto plasma systems so far conceived are practically all pulsed types, which require, usually, electrical energy storage in condensers and high frequency switching. These factors involve weight penalties and severe engineering problems. Also, magneto plasma systems involve some Joule heating of the gas and this creates random energy which usually is lost. Other problems looming include wall containment factors, and efficient recovery of energy stored in the magnetic fields.

Effort is being pushed to develop continuous magneto plasma propulsors to attain a high ratio of directed-to-random energy in the gas. This refinement also would be especially useful in plasma type wind tunnels, for attainment of higher gas speeds.

Plasmadyne is placing equal emphasis on refinement of the thermo plasma and magneto plasma systems as thrust generators.

Plasmadyne's Magnetohydrodynamics

and High Energy Physics Laboratory is stressing fundamental studies in both these fields.

Magnetohydrodynamics basically involves interaction between electromagnetic fields and moving electrically conductive fluids.

Studies here are expected to improve the fund of knowledge which eventually will contribute to development of equipment for application in space technology for heating, accelerating and channeling of plasmas by electromagnetic means.

Laboratory is interested in detailed atomic processes involving formation of gaseous conductors, to discover means for distributing electrical discharge currents over relatively large areas.

Plasmadyne scientists also are studying the energy exchange process between electric arc and gas flow, attempting to develop means of maximizing energy transfer.

Experimental techniques are being devised to obtain quantitative information on the exchange process to establish fundamentals leading to the design of more efficient plasma jet devices.

Big factor in the investigation of accelerating and channeling of plasma jets is determination of interaction between currents in external circuits and those inside the plasma. Internal currents are created by electrodes or electrodeless induction by varying the magnetic fields.

When gases move through axially symmetric, static and magnetic fields, there are constricting forces which act on the gas. Plasmadyne scientists are performing experiments to use these forces to form magnetic nozzles as a means of confining and channeling the plasma to eliminate the need for a physical (material) nozzle or to reduce the heat transfer to nozzle walls.

Another study is concerned with the creation of extremely high magnetic fields in the range of one million to two million gauss over relatively large volumes for extended periods for use in experimental magnetohydrodynamic investigations.

Also under study are "explosive" single-turn coil geometries for very short pulse durations. Energy densities of megagauss magnetic fields correspond to those of TNT, indicating the physical problem involved in designing stable coils for this service.

Other effort is aimed at development of flux concentrators of special alloys with extremely high magnetic yield points.

Projected are theoretical and experimental studies of charge distribution through a standing shock wave in a plasma jet stream. In these investigations, particular consideration will be given to electron continuum radiation from the shock.

Plasmadyne scientists are pushing research and development on advanced materials to meet requirements in regimes embracing space technology, nuclear field and present-day aerodynamics and propulsion.

Feeling is that solutions to problems in material-gas-temperature interactions at high Mach flow still are substantially obscure. Involved are difficulties associated with melting, vaporization and sublimation of pure and mixed materials and their effect on heat transfer. It has been demonstrated in nose cone and hypersonic tunnel experiments that these processes can affect performance.

Plasmadyne is now proposing a program to make very detailed studies of interaction of materials with gas boundary layers. Graphite generally will be used as the base material for investigation of factors such as sublimation, chemical reaction and erosion. Also, since graphite becomes porous at high temperatures, various organic gases and liquids, and possibly inorganic gases, will be transpirated through the material to determine interaction between the graphite and the boundary layer as a result of the transpiration.

Considerable experimentation is being carried out on performance of materials in plasma jet tunnels—equivalent to studying materials in high-temperature, high-velocity air flows—to gather data applicable both to re-entry bodies and leading edges of manned space vehicles.

Materials laboratory is studying oxides, carbides, cermets, graphite and organic plastics, such as phenolic laminated glass fiber, in temperature ranges of 3,000 to 7,000F at tunnel velocities of 5,000 to 12,000 fps. Gas densities involved are of the order of 0.1 to .001 atmospheres. High-temperature performance factors, such as oxidation resistance, melting point and thermal shock, are being checked. Air and argon are being used predominantly as working fluids.

Results have been reasonably consistent with theory in that the higher melting point materials generally behave best, but thermal shock, and particularly oxidation, prohibit use of these materials in unprotected forms.

High Temperature Coatings

This led to extensive studies of protective high-temperature coatings. Results have indicated that on all materials, these coatings substantially improve performance in high-temperature environment, but that specific coating design is required for each base material. This may involve graded coatings in which the interface is chosen for physical compatibility with the base material, gradually changing the composition of the coating to provide exterior environmental protection.

Coating processes developed with the Plasmatron have given significant advantages over existing coating techniques, Plasmadyne scientists claim. Plasmatron permits temperatures in excess of 20,000F, exceptionally high velocities, and an inert atmosphere.

In the coating procedure, spray material is injected as a powder into the plasma, usually helium or argon. Intense heat of the plasma instantaneously melts, even occasionally vaporizes, the spray for projection onto the base metal.

Advantage of the process is that it allows coating with practically any material in the periodic table without oxidation of the base material or the coating. Example: Tungsten with a melting point of about 7,000F, titanium carbide with a melting point of 5,800F, and molybdenum disilicide, which melts at about 4,500F, have been sprayed without oxidation on materials such as Inconel, chromium, molybdenum and niobium (columbium).

The coatings permit substantially improved performance of refractory metals, graphite and several other materials under consideration for application in re-entry bodies, leading edges and rocket nozzles.

Projected for the immediate future

is development of equipment which will permit complete inert environmental control of the plasma jet spray process.

Long-range research with the plasmatron will be directed to plasma chemistry and the production of completely new high-temperature materials through application of high heat and high pressure. In this way, predicted chemical reactions which were not possible at lower temperatures will be able to be investigated with the extremely high heat available in the plasma jet. This opens the door to possible use of more common materials for high-temperature service, instead of using the generally strategic materials which have been drafted for such service.

Plasmadyne's upper atmosphere instrumentation laboratory is engaged in measurement of scatter and absorption of a number of wave length bands—light (experimental studies), and ultraviolet and millimeter and centimeter band radio frequencies (theoretical studies). This work is tied in with determination of environmental phenomena in high layers in the atmosphere.

One of the results may be the determination of physical phenomena at altitudes likely to be involved in traffic experienced in the near future of space technology developments.

These studies use both natural light and radio waves and artificially produced pulse beams to probe outer atmosphere conditions. One possible application of this pulse beam probe is in a re-entry type spacecraft to furnish instantaneous information on integrated density for a considerable distance ahead of the vehicle, to achieve safe re-entry attitudes at the very high speed involved.

Another possibility seen is to use several probes on the sides of a space vehicle to control vehicle orientation.

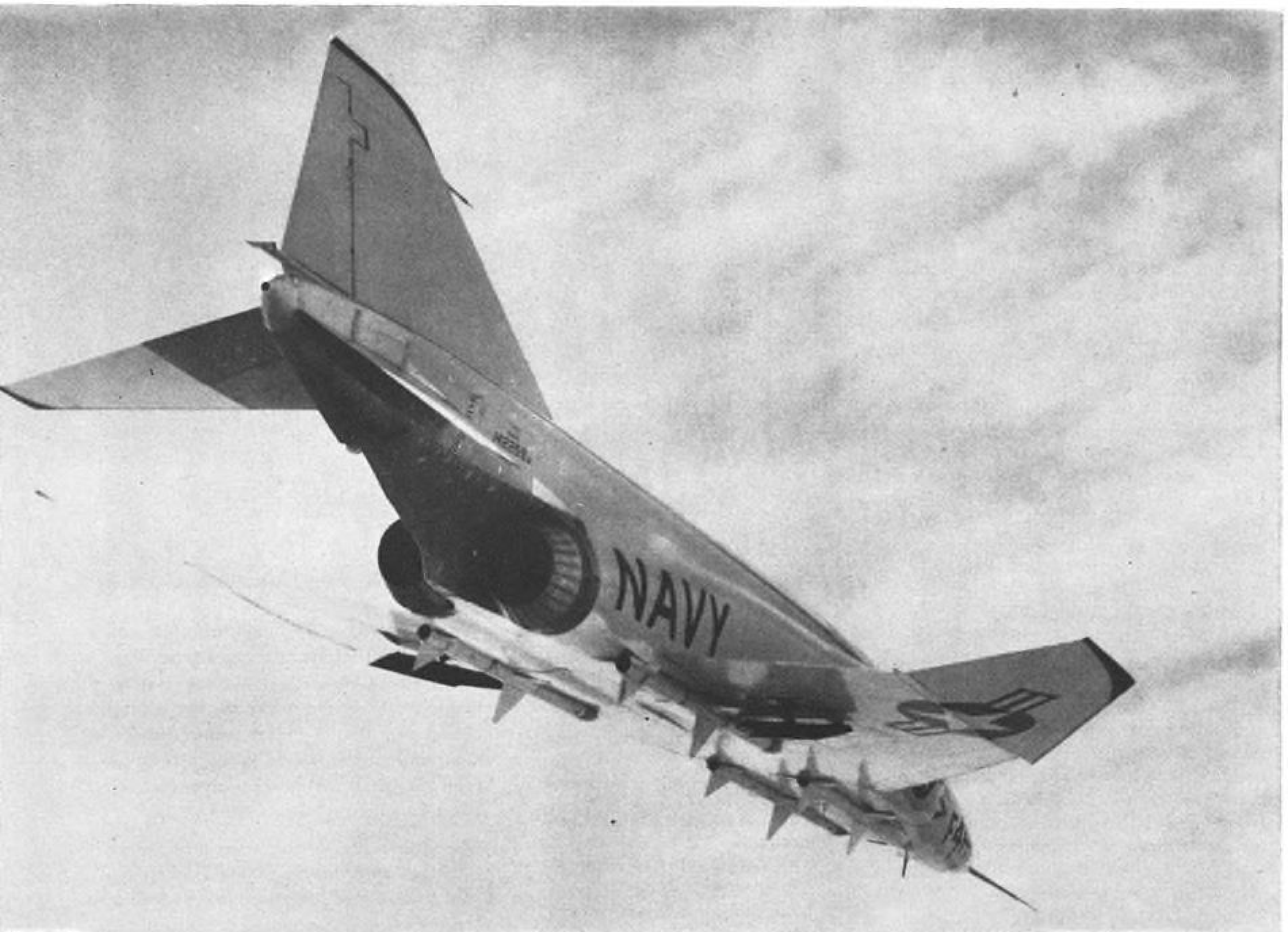
In conjunction with its studies in the upper atmosphere instrumentation laboratory, Plasmadyne is planning the development of a range-finding telescope to locate more accurately the scatter-producing zones.

$5,000 to Be Given For Space Research

New York—The largest cash award for scientific achievement available through any scientific society, the Louis W. Hill Space Transportation Award, will be administered annually beginning January, 1960, through the Institute of the Aeronautical Sciences. The award is intended to encourage space transportation for peaceful purposes.

The award will consist of an honorarium of $5,000 to an individual or up to $10,000 for a team contribution, and a certificate. First presentation will be made at the IAS Honors Night Dinner, January, 1960.

AERONAUTICAL ENGINEERING



SPARROW III missiles are partially recessed in F4H-1 belly. Note cranked-up wing tips and slight area rule.

Two Engine Concept Key to F4H-1 Design

By Craig Lewis

St. Louis, Mo.—McDonnell F4H-1 has been designed around a two-man, twin engine concept to operate as a Mach 2 Navy all-weather fighter which also can be used in an attack role.

The new McDonnell carrier fighter is in the midst of competitive flight testing at Edwards AFB in a program that will determine whether the F4H-1 or the one-man, single engine Chance Vought F8U-3 will provide the Navy with its next fighter generation (AW June 9, p. 43).

With more than 30,000 lb. of thrust available from its two General Electric J79 engines and afterburners, the F4H-1 has a top speed well above Mach 2. McDonnell says the fighter has the greatest range of any Navy turbojet fighter, which means the F4H-1 has a combat radius in the 1,000 mi. class.

The F4H-1 can carry both Sparrow III and Sidewinder missiles, as well as external fuel stores, in its primary defensive fighter mission. The airplane also has a bombing system which permits various delivery techniques for conventional or nuclear weapons on an attack mission, giving it the advantage of flexibility in operational use.

With two crewmen and two engines packed in its 56 ft. fuselage, the F4H-1 is a very dense airplane. McDonnell designed the fighter with the conviction that this dual configuration is both safer and more efficient than the one-man, single engine approach. Company feels that use of a pilot and radio operator crew combination promotes more efficient and effective use of the fighter's armament in foul weather and against the hazards of enemy electronic countermeasures. Since present aircraft are so fast and closing speed on a potential target is so rapid, McDonnell thinks two men are necessary to carry a fighter through the launch, combat and return cycle under all-weather conditions. Chief F4H-1 project engineer Herman D. Barkey told Aviation Week that the dual crew can do a better and more complete job and has a better chance of bringing the aircraft back.

The use of two engines is viewed as another safety factor, and the appeal of the McDonnell airplane relies to a great degree on this dual configuration design concept. Second crewman in the F4H-1 is a radar operator. He has no flight controls, although there is provision in the F4H-1 for controls in the No. 2 position if the Navy wants them. Dual flight controls have been

ENGINE AIR INLET is variable ramp system, in which boundary air is bled off at ramp hinge and through ramp holes. Leading and Trailing edge flaps are extended as the F4H-1 assumes landing configuration (below).

HOW F4H-1, which has an engine mounting layout similar to the USAF F-101, differs from the USAF airplane is indicated below. F4H-1 has enlarged vertical tail for improved high speed control, and horizontal tail has negative dihedral. Cheek inlets also differ. Parabrake for F4H-1 is in tail cone.

THE BIG F°

The Auto-Lite engineers shown here are checking the thermal characteristics of dozens of different kinds of insulation materials. You can be sure that, no matter what the results, they won't be satisfied. They'll go right on looking for other materials that can resist even more heat.

In keeping with the times, Fahrenheit is a mighty important word at Auto-Lite. The Big F° gets top priority in the search for better insulation materials.

Hundreds of different wire insulation materials are being tested here by the finest trained personnel using the most modern research techniques and equipment. Out of these tests comes a wealth of knowledge important to all customers served by Auto-Lite.

No matter what you need—whether it be high temperature aircraft wire or cable, magnet wire or wire for electronic and electrical applications—why not tell us your insulation problem and let us help you in reaching a solution.

AUTO-LITE®

Wire and Cable DIVISION

THE ELECTRIC AUTO-LITE COMPANY • Port Huron, Michigan • Hazleton, Pennsylvania provided in McDonnell's two-man F-101B interceptor.

With two engines, the pilot of an F4H-1 can extend his range or loiter capability by shutting down one engine and conserving fuel. Of course, single engine operation carries with it a considerable penalty in decreased speed and altitude performance.

A key difference between the competing F8U-3 and F4H-1 is the rocket engine which Chance Vought will use along with the J75 engine to give its fighter greater altitude capability. McDonnell's fighter also could be fitted with a rocket engine, either in its tail cone or, more likely, in a pod arrangement. But chances are slight that a rocket engine will be adapted to the F4H-1, and McDonnell will be relying on the considerable power available from the two J79 engines to carry the airplane through its flight test program.

Design Change

Work on the F4H-1 began in September, 1953, when McDonnell got a development contract for a twin engine aircraft then designated the AH-1. Later, new requirements forced a design change to accommodate radar armament control systems which provide advanced air-to-air missile capability. New design specifications were established in July, 1955, and the aircraft was redesignated the F4H-1.

McDonnell put the design through 5,300 hr. of wind tunnel and free flight testing in cooperation with the National Advisory Committee for Aeronautics. Some of this testing resulted in changes in design of the tail and wing.

Construction of the F4H-1 started in August, 1956, and the first prototype was completed last April. After extensive ground testing, chief test pilot Robert C. Little flew the new fighter for the first time last May 27 at Lambert-St. Louis Municipal Airport.

With the first airplane in flight test at Edwards AFB, McDonnell is now working on the rest of the initial Navy order for 23 aircraft. Modifications now anticipated on later models are expected to make the F4H-1 more versatile and effective. They include installation of a larger radar antenna which will increase search range and scan angle and attachment of multi-purpose pylons to the wings so more missiles and more advanced missiles can be carried. Special equipment is planned which will permit effective ground control of all missions.

The prototype F4H-1 was powered by a General Electric J79-3 engine on its first 50 flights, but the airplane now has a J79-2 engine which provides more thrust. Further performance improvements are expected when J79-2A engines are installed.

Air supply for the engines is controlled by two variable devices in the intake system. The variable duct design on the F4H-1 was originally manually controlled, but it is now proving out as an automatic system.

Initial control of the air supply comes at the inlet where McDonnell has used a standard type of variable ramp system. Boundary layer is bled off in front of the inlet, at ramp hinge and through holes in the face of the ramp.

Farther along the intake system the air supply is rationed by a sliding bell mouth inlet duct in front of the engine. By this means, the engine air supply can be optimized for various engine conditions, and all excess air is routed past the engine and dumped at the engine exit nozzle, giving a bypass effect.

This bypassing of excess air not only gives more precise control of engine air supply, but it passes cooling air over the length of the engine. Another byproduct of the bypass sleeve is a titanium inner skin in the engine compartment which provides a firewall in the area.

Wing Configuration

The wings on the F4H-1 have a span of 38 ft., 5 in., and are swept 45 deg. They have leading and trailing edge flaps, and an aileron and spoiler combination has been employed to provide good low and high speed control on lateral surfaces. F4H-1 wing uses a standard NACA airfoil.

After wind tunnel testing, McDonnell decided to sweep the outer wing panels upward as a means of obtaining effective dihedral and improving lateral stability. Outer panels appear to be swept up about 12 deg. from horizontal. Wings fold for storage at the point where the tips are cranked upward.

Wing tips were cranked up because it was easier than cranking the wing spar at the center section, a move that would have meant landing gear changes and other design modifications.

F4H-1 has speed brakes which move downward from the underside of the wing just aft of the main gear. They reportedly cause very little trim change on the airplane.

Starting with the sixth airplane off the line, the F4H-1 will have a boundary layer control system which will improve attitude and control in the approach configuration and cut landing speed about 7 kt. This system is a standard type developed by NACA at Ames Laboratory and reportedly is very similar to that used on the F8U-3.

McDonnell chose an overhanging type of tail section for the F4H-1 because it saves weight and gives the airplane better clearance in the carrier approach configuration. Arresting gear is tied into a forward keel, and there is no need for beefing up the tail to handle it.

Use of this overhanging tail, however, leaves the horizontal slab tail too high for a swept wing. So after some tunnel testing, McDonnell aerodynamicists decided to drop it about 23 deg. to give it a lower vertical location.

Vertical tail was modified by enlarging it to improve high speed directional stability. The low aspect ratio tail gives away some subsonic stability to get the improved supersonic stability that comes with pure area.

Tail cone houses a parabrake as a safety feature for shore operations. The parabrake also has a potential for pulling the fighter out of a spin. Spin technique hasn't been tried on the F4H-1 yet, but it has been done with the McDonnell F-101.

The F4H-1 meets the demands of the area rule, although it has only a small amount of pinching at mid-fuselage. The fighter has a smooth area rule curve over the greatest part of its length. Advantages of the area rule lie chiefly in the transonic range, and the F4H-1 has plenty of power to carry it through that area.

The four Sparrow III missiles carried by the F4H-1 are semi-submerged in the airplane's belly. This has advantages when the missiles are carried, but

1004 Jet Inventions in the Last Two Years

Engineering and research scientists at Westinghouse made 1004 invention disclosures—each representing an improvement in jet engine design—during 1956 and 1957. The number of inventions this year is keeping pace with previous years, proving that creative engineering at Westinghouse is striving constantly toward better, more efficient jet propulsion.

Westinghouse, designer and builder of the first American turbojet, now holds more than 175 U. S. patents—many of them basic patents—on the jet engine. A few of the Westinghouse "firsts" in the field include the axial flow compressor, iris exhaust nozzle, annular combustion chamber and step wall combustion liner.

The Aviation Gas Turbine Division is a completely integrated facility for design, development, testing and production of propulsion systems. For further information, write: Westinghouse Electric Corporation, Aviation Gas Turbine Division, P.O. Box 288, Kansas City, Missouri. J-54047

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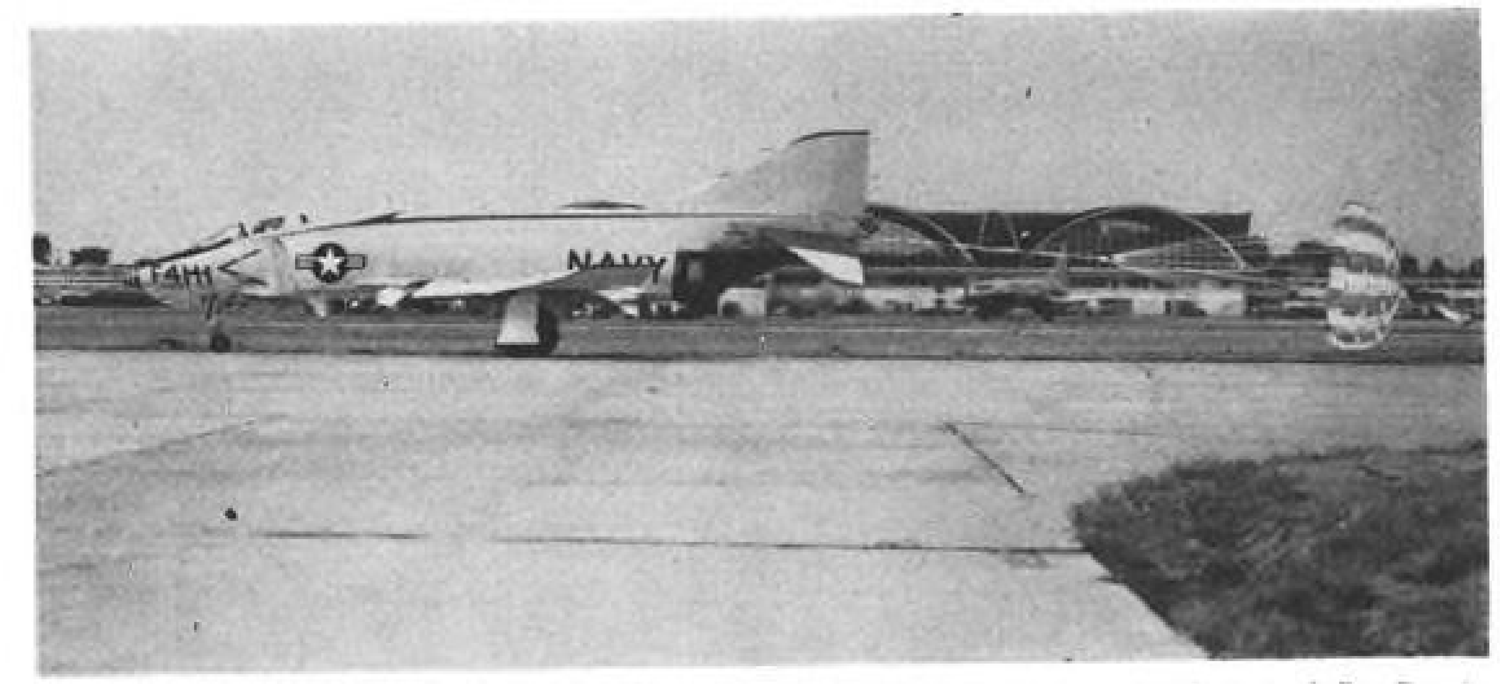


PARACHUTE BRAKE extended, McDonnell F4H-1 rolls to a stop in front of St. Louis Municipal Airport terminal. Brake has potential for pulling the aircraft out of a spin.

the wells offer some penalty when flying without the Sparrows.

F4H-1 fuel system uses bladder cells in the fuselage similar in location to the F-101, but the new fighter has an improved transfer system and also carries fuel in integral tanks in the wings.

Standard air-to-air armament is the four Sparrow IIIs nestled under the fuselage, but the F4H-1 can carry Sidewinders on wing pylons at the same time, and more Sparrows probably could be slung under the wings. Conventional and nuclear weapons can be provided in order to give the F4H-1 the flexibility of an attack capability.

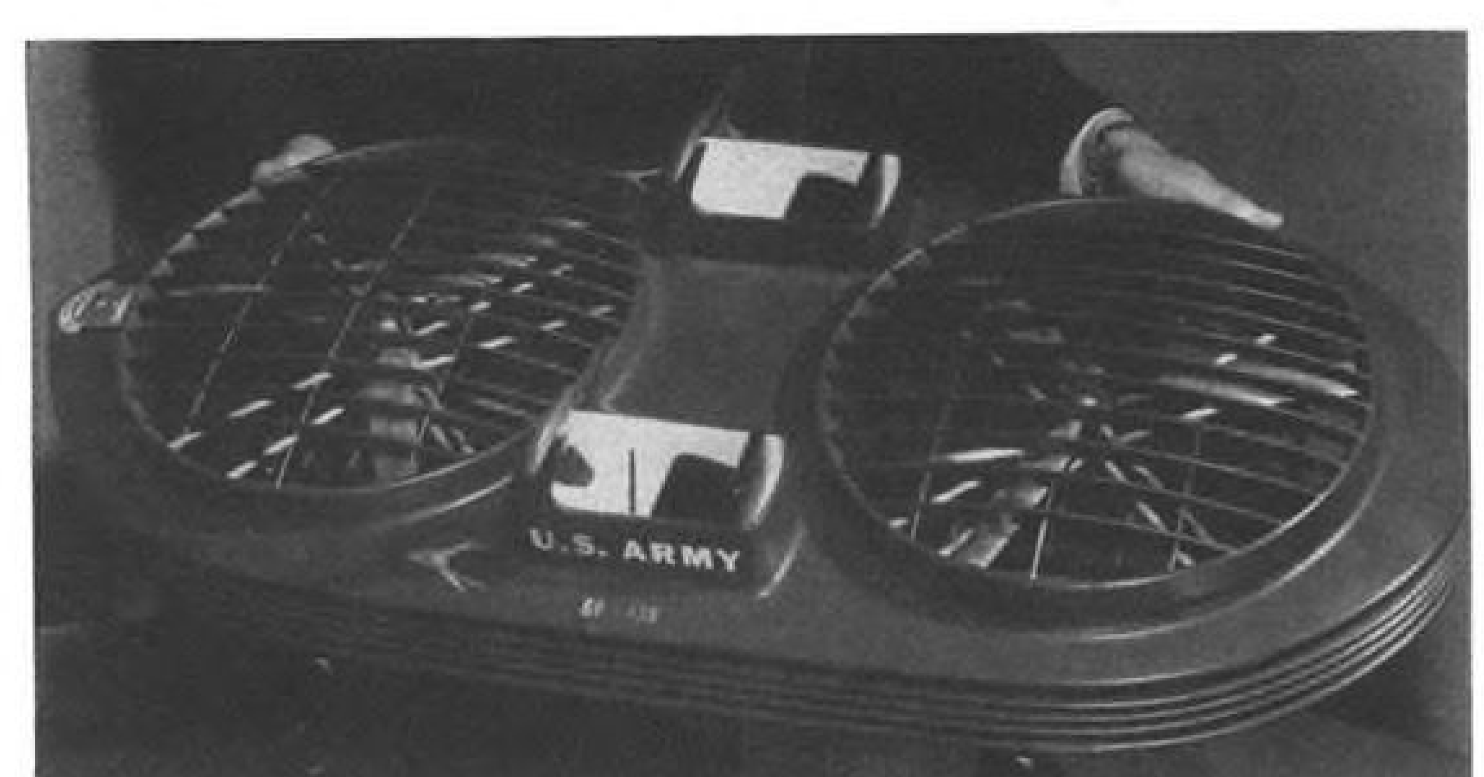
External fuel stores also can be carried, slung in a centerline rack or under each wing. The fighter can be refueled in flight.

The F4H-1 has a flight control system which uses a General Electric autopilot with the same basic features as the Minneapolis-Honeywell system in the F4H-1. It has push-button capability for automatically holding the airplane at chosen speeds and flight configurations.

To the greatest extent possible, McDonnell has used systems in the F4H-1 which are already proven in service in previous McDonnell aircraft. The power control system, for instance, can be traced back to the XF-88, and it is essentially the same, with some improvements, as the systems in the F-101 and F3H, including the longitudinal feel system.

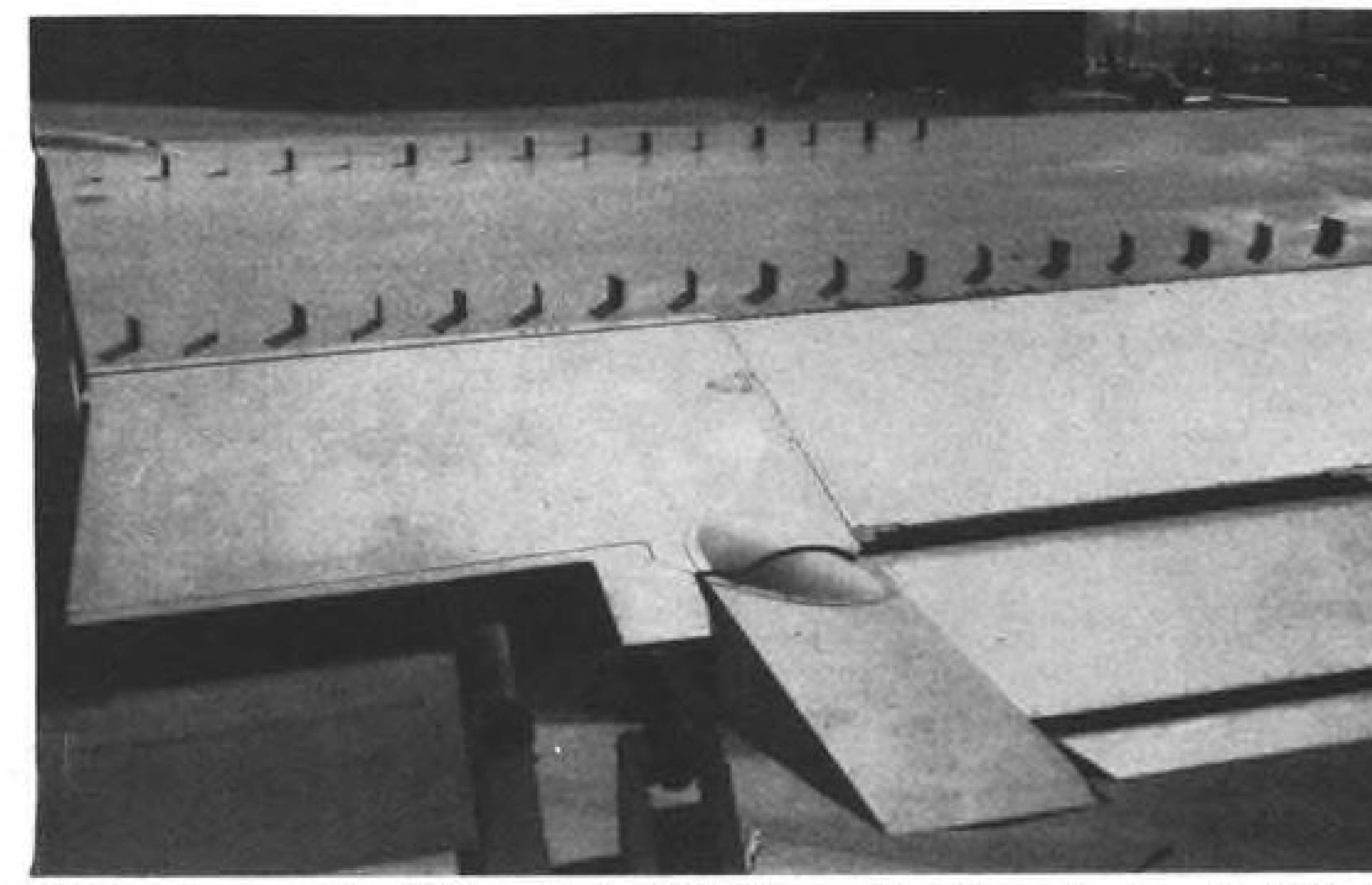
Other features can be traced back to previous McDonnell models, including the twin engine concept which was used in the Phantom and Banshee, and which has also been proven in the high performance F-101.

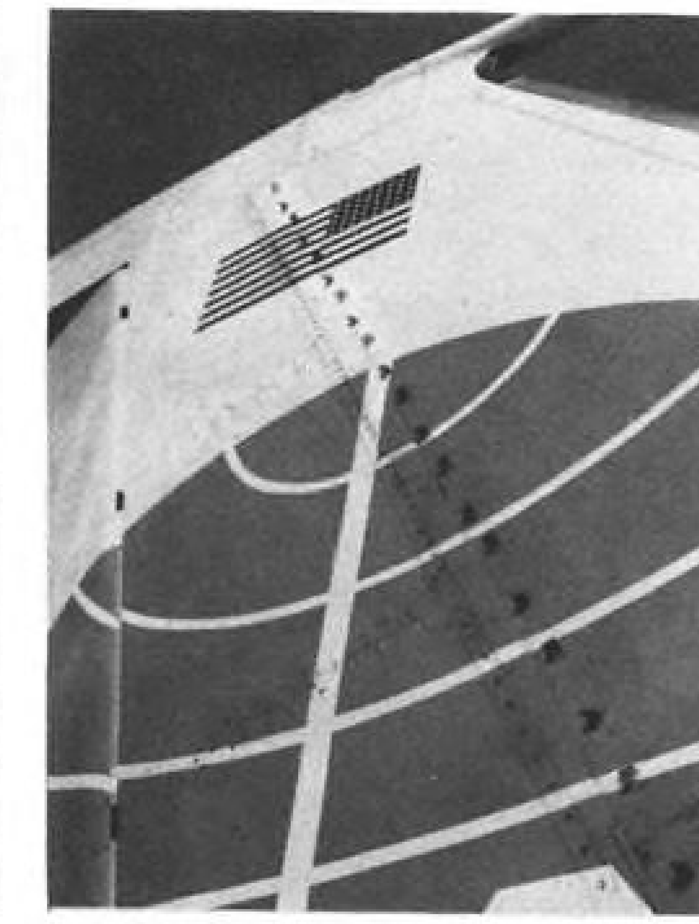
McDonnell also feels it has learned from some of its past troubles. For example, the F-101 had brake and tire trouble. The company says these problems have been cleared up with the F4H-1 gear. F4H had some early troubles, but McDonnell says these have been cured. The Navy fighter has a triple brake system. In addition to the regular power brakes, it has an independent emergency system which parallels the regular braking system, and there is also a manually operated hydraulic brake in case of failure.



Chrysler Tests Ducted Fan Vehicle

Ducted fan research vehicle is under development by Chrysler Corp.'s Defense Operations Division for Army transportation Corps. Unit is 20 ft. by 10 ft.; double rotor is powered by 350 hp. aircraft engine. Vanes deflect air to desired position for VTOL capability.





WING vortex generators (left) on Boeing 707-120 smooth airflow and raise critical Mach number .01. Fin vortex generators (right) have been incorporated to obtain full rudder effectiveness instead of the hydraulic boost system, primarily for engine-out-at-takeoff condition.

Aviation Week Pilot Report (Part II):

707 Imposes No Undue Stress on Pilot

By Richard Sweeney

Seattle—Highest speed attained in Aviation Week's flight evaluation of the Boeing 707 jet transport (see AW Oct. 6, p. 70 for Part I) was Mach .92. This was accomplished without the aid of Mach trim or yaw damper.

Force reversal starting at approximately Mach .84 and extending through approximately Mach .91 proved much less a problem than expected.

Forces were light enough so that the airplane was flown to the maximum speed without automatic control aids.

Minimum trim was used and manual yoke pressure was used alone from Mach .85 onward to sample control forces from the expected reversal point to maximum speed.

At all points in this speed spectrum, manual control was effective and forces built up considerably without pitch trim being used.

Zero trim point was approximately Mach .85 in level flight.

Repetition of the high speed run, accomplished starting at about 33,000 ft. altitude, with Mach trim engaged, was extremely smooth, with considerably less control force.

Speed warning devices are horn and melodic gong sound; both units were activated at approximately Mach .9 to warn the pilot of onset of limit speed.

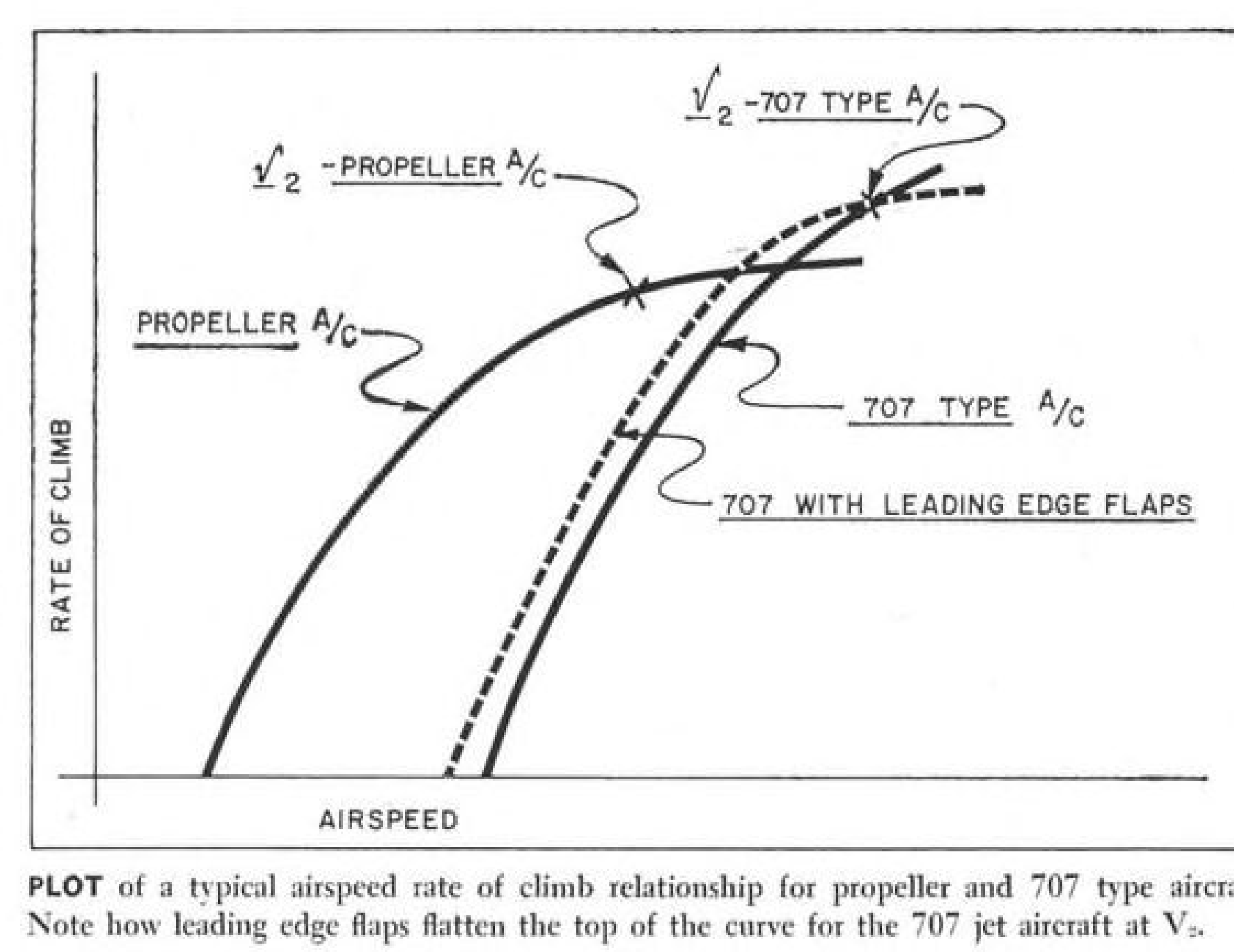
For dynamic loading (q) limits, the airspeed gage incorporates a "barber pole" hand which rides constantly at that indicated airspeed which produces limit loads, adjusted for ambient atmospheric conditions.

During F&R flight, all four engines were shut down and restarted, one at a time, at 37,000 ft., with the lowest speed specified at 210 kt. IAS. During an engine shutdown and restart, Dutch roll can occur if rudder work is not prompt and proper; however, this proved no significant problem, and all engine shutdowns and restarts were done without aid of the yaw damper. No. 3 engine was restarted at 205 kt. IAS, right at the low edge of the speed spectrum for this altitude.

Shutdown of the turbojets produces a definite yaw, but much less than would occur with propeller driven aircraft. Rudder deflection forces are not high, and control effort is directed toward preventing Dutch roll more than anything else.

Inducing accelerated stalls with the aircraft resulted in an airframe "rattle" with ample significant warning of the condition prior to heavy effects. Severe effects are not produced if the aircraft is kept within the acceleration limits placarded.

Stalls were performed in a variety of configurations, at approximately 13,000 ft. altitude, at gross weight of 190,000 lb. and various power conditions. However, use of power above flight idle produces little major feel change in char-



PLOT of a typical airspeed rate of climb relationship for propeller and 707 type aircraft. Note how leading edge flaps flatten the top of the curve for the 707 jet aircraft at V_2.

707 Leading Edge Flaps

Renton, Wash.—To delay airflow separation, extend high lift coefficients at high angles of attack and get better climb rates at takeoff, Boeing Airplane Co. has developed leading edge flaps which are being incorporated on production 707-120 jet transports.

Developed in a Boeing continuing product improvement program, the leading edge flaps are used to obtain the largest single performance increase in this flight regime at the least cost in time, tooling and production effort, and weight. They are not intended to increase economic takeoff gross weights or takeoff and landing distances primarily, although gains are made here.

Since the angle of attack, related to airspeed and attitude, is critical in large, swept wing airplanes at takeoff and initial climb, Boeing sought to increase the spread between airspeed at which the airplane becomes airborne and that at which the pilots could get into trouble by too high an angle of attack, lower airspeed or steep attitude.

Leading edge flaps are tailored to this model, have a 10 ft. span which extends inboard from No. 1 and 4 engine pylons. Chord is 14 in. and a large radius is incorporated on nose of flaps in the extended position. Travel to a single fixed position results in a 110 deg. arc with respect to wing reference plane, or an angle of 70 deg. with wing reference plane extended forward of wing leading edge.

Leading edge flaps are hydraulically actuated automatically whenever the main flap travel exceeds 9 deg., and a check valve precludes accidental retraction in case of hydraulic failure. Construction is aluminum alloy. A continuous hinge along the span is faired in open and closed position to ensure clean air flow.

In development, Boeing experimented with full span leading edge flaps but stability became marginal at the stall. Particular segment was chosen to get improvement in desired areas of wing and provide optimized spanwise aerodynamic characteristics.

Original work on low speed devices was accomplished in the Boeing transonic wind tunnel with flight test on the —80 prototype correlating wind tunnel findings, providing a means for final optimization of devices.

acteristics, merely sends the aircraft an extra distance upward prior to buffet and break.

Stalls attempted from normal flight proved impossible—one runs out of elevator prior to buffet, let alone reaching the break point.

The aircraft must be trimmed down to about 160 kt. IAS in order to retain enough elevator to accomplish a full stall.

First stall was done with spoilers shut off, 30 deg. (approach) flap, which brought the outboard ailerons into use. Gear was up.

Initial buffet occurred at about 130 kt. IAS, and the airplane had to be worked on down to 120 kt. before the break. The shuddering, shaking, hammering, buffeting and general hard work required of the pilot to bring the airplane to the break should definitely preclude any pilot's inadvertent stall. After initial buffet, the pilot has to use considerable exertion to bring the airplane through the buffet region to the stall point.

Lateral control remained excellent through the stall. Rudder work was minimal, with yaw damper off.

This stall was held through initial into secondary stall, to check lateral control retention and yaw action.

Rudder work through the last half of the maneuver, i.e., after initial, through the noseup and dropoff into secondary, remained minimal with the ailerons being the predominant control throughout.

After the break from secondary, the right wing dropped, and it was necessary to drop the nose and initiate recovery to regain lateral control.

Stalls through additional configurations, with spoilers operating, yielded approximately the same flight characteristics, i.e., lateral control remains excellent through the buffet and to the break, and is retained if recovery is initiated immediately after the break.

Additional stalls were performed at a 50 deg. flap setting without spoilers, and with spoilers, also at 30 deg. flap, 20 deg. flap and in the clean configuration. Gear down configuration decreases stall speeds, but otherwise leaves characteristics unchanged.

Clean confiuration stall produced a tendency to drop the right wing after the break without going through to a secondary stall.

Watching the aircraft's wing during a stall from the passenger compartment yields a fascinating display of wing flexibility, the bending and torsional loads occurring during the stall, as the wing works heavily during the maneuver.

Another stall was performed with 30 deg. flap in a half rate left turn. Charac-

AVIATION WEEK PILOT Richard Sweeney makes a panel check prior to beginning a stall in the 707. Airspeed gage reads 210 kt. and the "barber pole" q limit speed is about 350 kt. Gages, in relation to pilot's hand, are: airspeed (two gages left); RMI-ADF gage (behind hand); Sperry horizon-zero reader and clock (right). Lateral control remained excellent throughout the stall. Rudder work was minimal, with yaw damper off.

teristics remain the same as the forward maneuver, if wings are leveled prior to the break. No snapping tendency was observed and the maneuver was done without yaw damper.

With spoilers inoperative at high speeds, control pressures stay about the same for turns, but roll rate is naturally decreased. With spoilers inoperative at pattern speeds, about 170 kt., in approach and configuration, roll rate is better than at high speeds due to outboard aileron use, and control pressures are relatively lighter than at high speeds.

Low Altitude Capability

Low altitude maneuvering with the 707 is excellent. Good samples of this capability were obtained after a descent from altitude to perform ILS approaches on Paine Field, north of Seattle. A Northrop F-89-equipped interceptor unit is based at Paine, and descent was made while Paine was initiating a fighter dispatch, with varying departure routes used by the military aircraft.

Several sharp dives and turns were made to put extra margins of distances between N709PA and the departing interceptors, and still arrive with the transport at the proper spot for the initial approach to the Paine ILS.

Steeply banked turns were made with placarded accelerations reached in level and descending flight path, and while control forces were higher than normal, they were not excessive, and roll rate with the spoilers was very high.

First approach was made with coupler of the PB-20 autopilot, a very

From Honeywell, a quantitative report on reliability

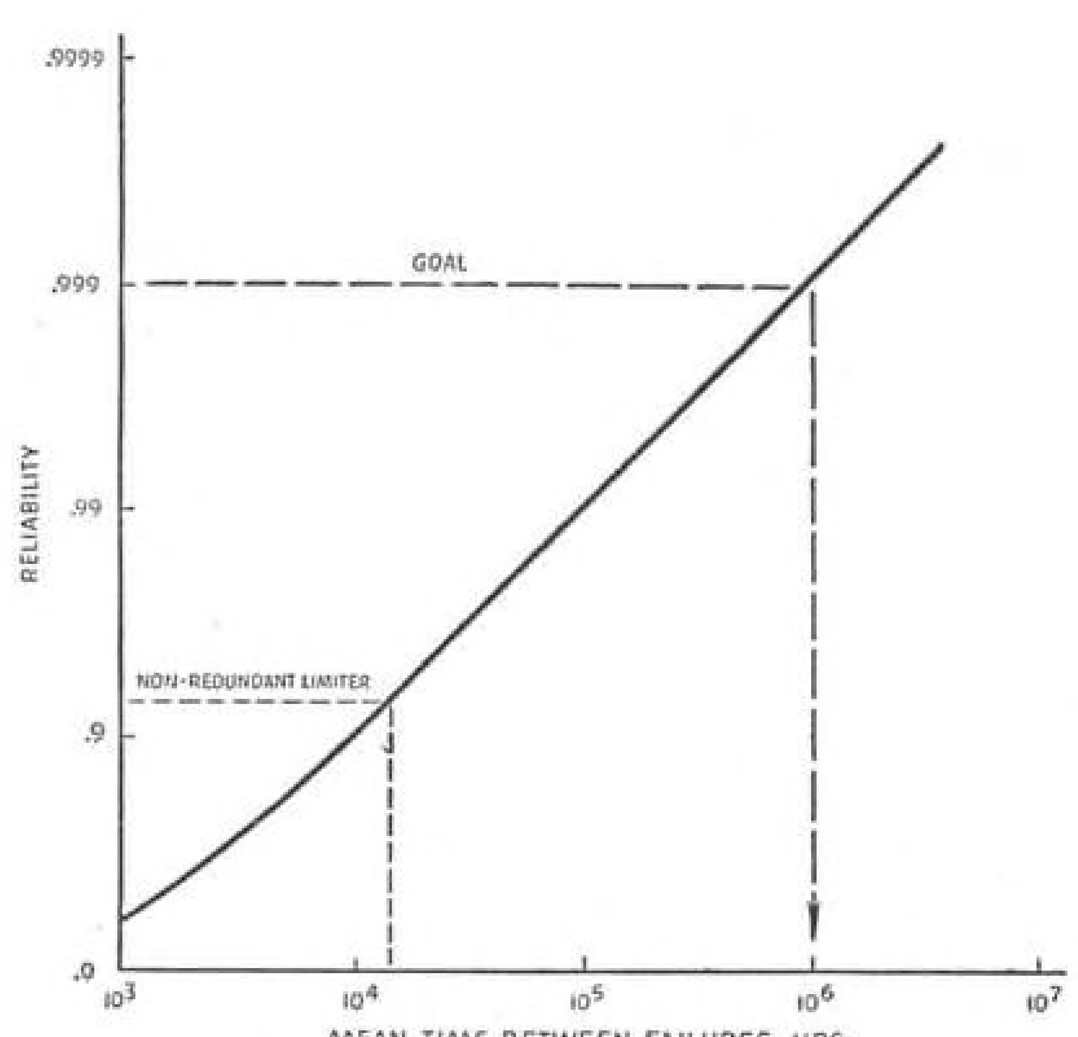
A device may be called "reliable"—but only when reliability is expressed *numerically* can we control and improve it.

The Military doesn't ask for a "reliable" aeronautical device—it asks, for example, for a device with a .999 *Reliability for 1000 hours of operation*. This gives us an expression of Reliability in a quantitative term that is not only meaningful in specifying performance, but also allows us to control and improve Reliability during design and production.

To that end, Honeywell believes that every phase of its operations—planning, design, production, testing, storage, shipment, maintenance and operation in the field—must be included as factors in determining Reliability. It is Honeywell's goal to establish numerical values for as many of these factors as possible.

The following is one example of how far Honeywell has already come in establishing quantitative Reliability practices.

THE PROBLEM: A .999 Reliability for 1000 hours—or 1 failure per million hours



1. Reliability over a 1000-hour operating period as a function of mean time to failure.

Last year Honeywell was called upon to design and manufacture an integrated limiter whose function was to disengage the automatic flight control system of an advanced high-performance aircraft immediately prior to overstress of the airframe. The requirement is a .999 probability that no failures will occur in 1000 hours of flight.

Experience shows that given the mean time between failures the random failure law may be used to predict Reliability. Substitution into the graph at left shows that a limiter which fails on the average of once every 1,000,000 hours will meet the .999 Reliability requirement.

THE DESIGN—To make limiter specifications compatible with the requirement, the following techniques are practiced:

Simplicity—The simpler the design, the less chance for built-in failure mechanisms. As a first approximation, Honeywell uses the chain law of Reliability, which states that the Reliability of an assembly is the product of the Reliabilities of the parts. This allows us to evaluate the effect complexity has on Reliability.

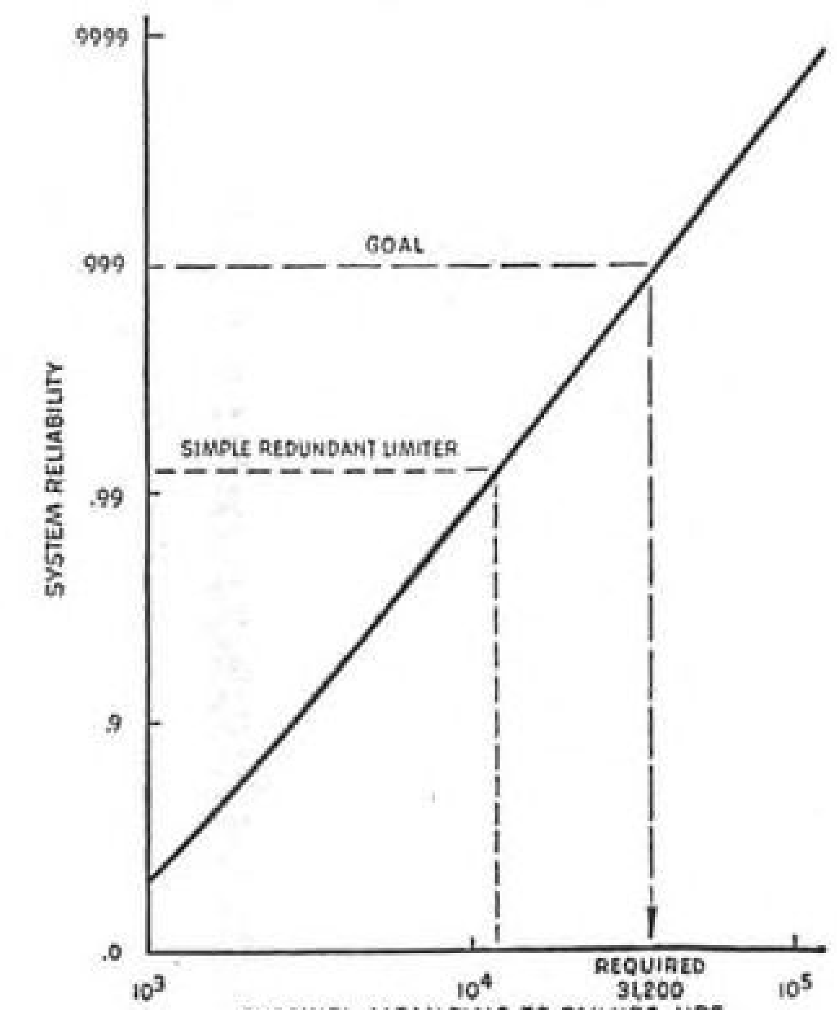
Derating—Used because we know a part's Reliability goes down as stress is raised from zero to the part's rating.

Design Review—Prior to final testing, the device is subjected to a design review by senior designers, a parts application review in which each part is examined by an expert, and a qualification test by an independent expert.

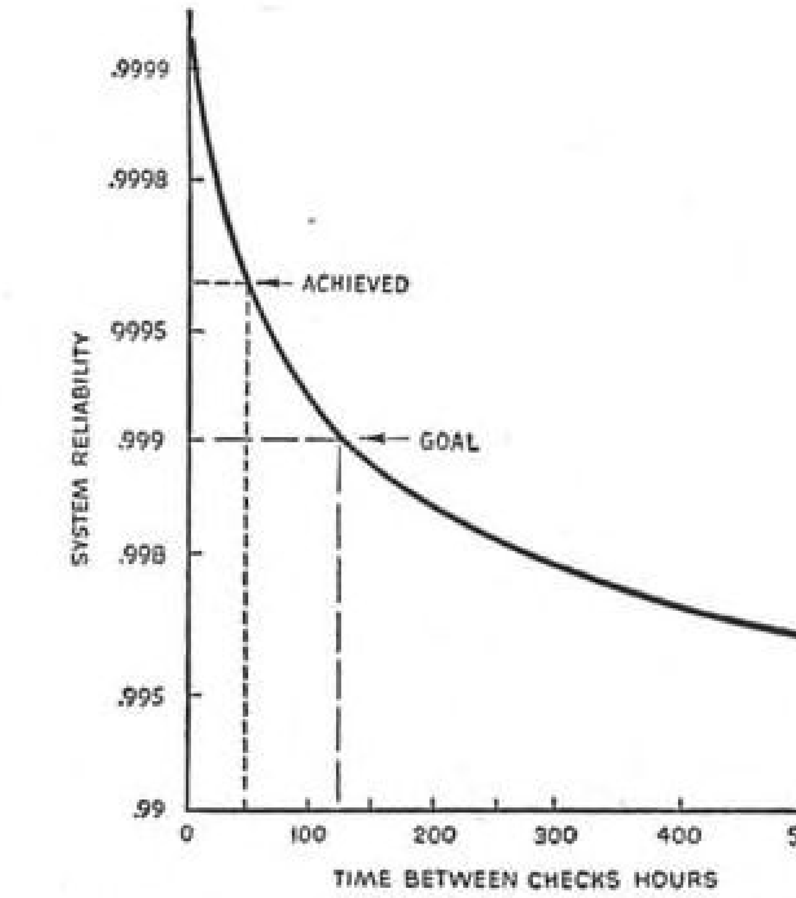
After initial design of the limiter, the mean time between failures for the circuit is computed from the mean time between failures of the parts. At this point, mean time between failures for the limiter is predicted to be 11,000 hours.

Redundancy is introduced

To raise an 11,000-hour mean time between failures to the required 1,000,000 hours, *two* parallel basic channels, each able to fulfill the complete function alone, are mated. This raises mean time between failures to 131,000 hours, still a long way from the required 1,000,000 hours. The graph (below) shows the relationships and solution.



2. Two channel redundant system reliability over a 1000-hour operating period as a function of channel mean time to failure.



3. Reliability of a redundant system of two 11,000-hour MTBF channels over 1000-hour operating period as a function of the operating time between checks.

Periodic Checks, the Solution

It is found that a periodic check every 50 hours to make sure both channels are operating will result in a mean time between failures of 2,000,000 hours. This meets and even surpasses the requirement. Above is the graphical solution of the computations.

Testing Bears Out the Results

The limiter is tested for 16,000 channel hours with zero failures. Computations show there is only a 10% chance that the Reliability is less than .999 for 1000 hours of limiter operation. This test is conducted under environmental conditions in Honeywell's evaluation laboratories in which any standard environmental requirements can be simulated. Honeywell also utilizes government sled tracks for qualifications involving supersonic environments.

Some Further Results of Honeywell Reliability Methods

The above account is only part of the Honeywell Reliability story. Equally impressive are these examples:

- MG7001 Servo: 10,800 hours mean time between failures based on 500,000 hours experience.
- HG2 Integrator: 35,600 hours mean time between failures.
- Safety and Arming Mechanism: no failures in 50,000 units built.
- Fuze Mechanism: no failures in 1,500,000 units, tested twice each unit.

Results such as these make Honeywell the logical choice for work in the design, development or production of systems and components to meet military specifications. Call or write Honeywell, Military Products Group, 2753 Fourth Avenue, South, Minneapolis 8, Minnesota.

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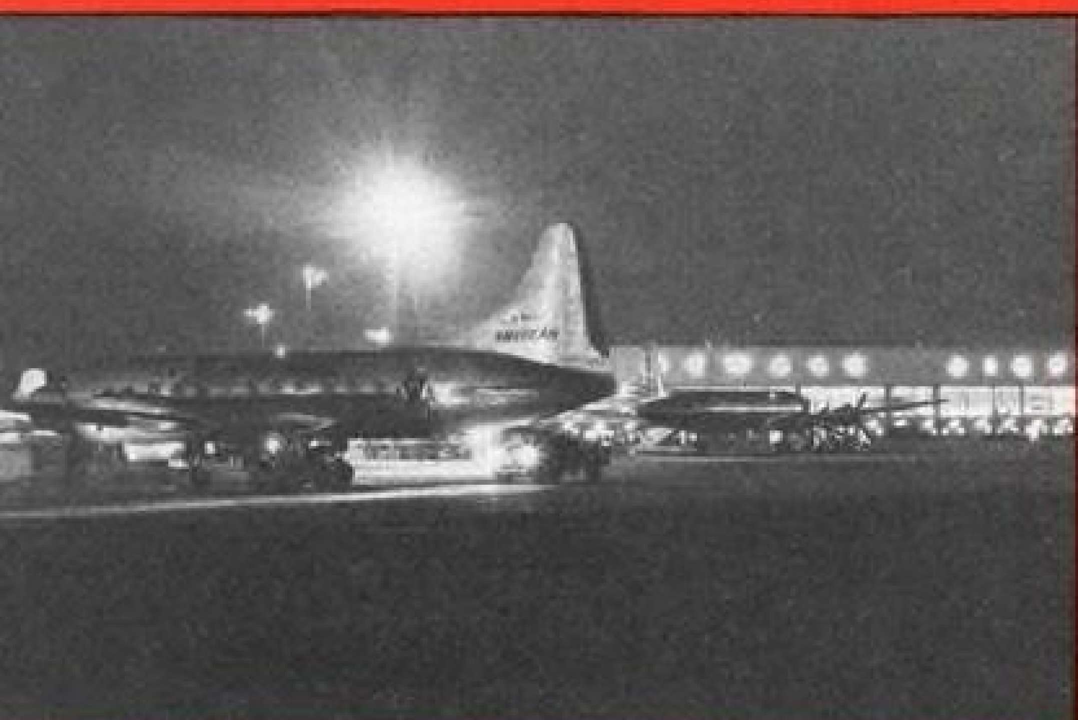

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smooth procedure. Breakoff at 300 ft. above field level was made, and aircraft brought around for another ILS.

Use of throttles on the 707 does not call for light and easy movement. Pilot can move levers back and forth fast, and acceleration of the engines, which incorporate fairly recent hydromechanical fuel controls, was fast. Anticipation of power requirements was required, but not extreme anticipations which have been talked of in some quarters.

Power is applied with the thrust levers sooner than would be required on a piston engine; thrust buildup is fast and acceleration is not slow when power comes in.

Landing checklist for N709PA was again an F&R type, covering more than would be required for normal landing. However, one item which is important here is checking for brakes off, with the anti-skid unit tested and a check of indicator on overhead panel above the pilot accomplished.

Setting up for landing in the 707 is no more difficult than in piston aircraft; if anything, it is easier in that there is less to do.

Since 707 speeds at low altitudes are not greatly above those of today's transports, initial entry is made at about 180 kt. Landing at Boeing Field has the initial approach made across Seattle-Tacoma International Airport, with a left turn onto final for Boeing.

On the approach across Seattle-Tacoma, airspeed is reduced to V_2 plus 30 kt., with V_2 here referring to minimum safe flying speed or what would be "unstick speed" in takeoff. Gear is down, landing checklist starts before turn onto final, completed on final.

As with landing any aircraft, setting up properly on the final approach contributes greatly to landing the 707. Establishing rate of descent desired according to terrain, holding steady, bleeding off airspeed from initial value to arrive over the fence with about V_2 plus 10 kt. is the best procedure.

On final, made without yaw damper, lateral oscillations can be a problem if allowed to start, and if started, not damped out. First approach in N709PA wound up with some oscillation, due to a slight correction, which was not allowed to occur again, although the first landing was satisfactory despite the approach.

Descent Rate

Descent rate approximated 500 fpm. for first landing. Should a pilot find himself high on the final approach, use of spoilers will drop the aircraft to the desired position with precise application indicated, although with the extra speed margin and power application, an incipient undershot is not hard to correct for in the 707.

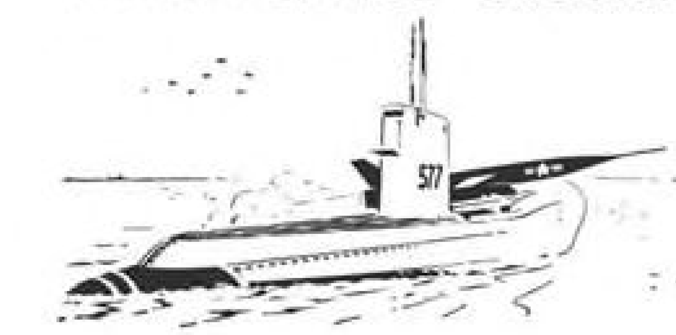
Spoilers usually are not used on final. Airspeed is controlled by attitude and rate by power, and establishing desired conditions as soon as possible on the final precludes the necessity for use of spoilers.

As the 707 comes over the fence, flareout is initiated at approximately V_2 plus 5 or 7 kt. Flare is smooth and

H-43A Equipped with Bear-Paw Landing Gear

Kaman H-43A crash-rescue helicopter for USAF is equipped with bear-paw landing gear designed for mud, sand and snow operations. Note inboard fins, characteristic of H-43s. H-43A, powered by a Pratt & Whitney R1340 rated at 600 hp. max., is equipped with Kaman in-flight rotor tracking device, rescue hoist, cargo hook and litters for injured.

Crusader I on duty with the Fleet.



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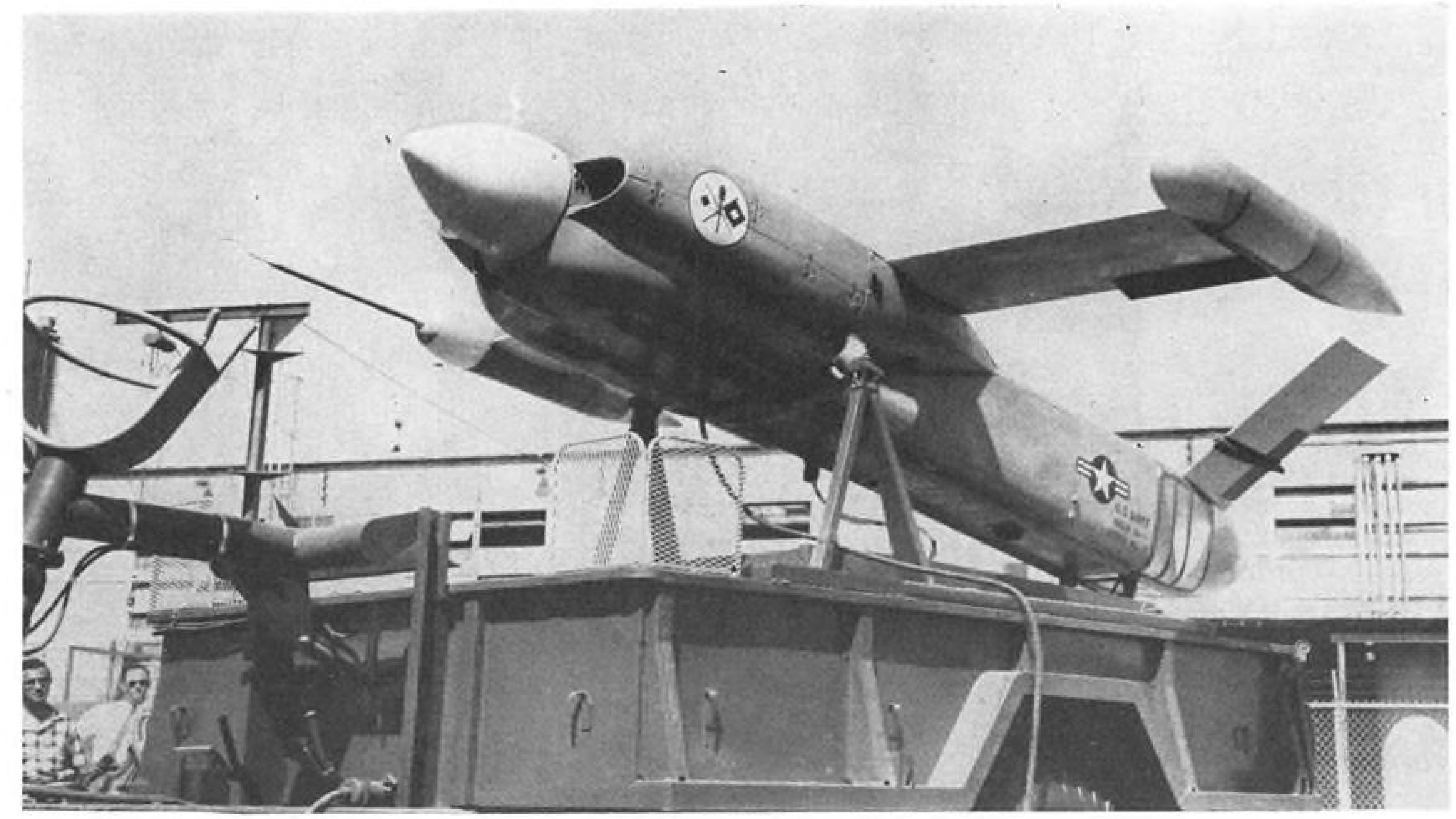


Rheem SD-2 Surveillance Drone Tests Complete

Rheem Mfg. Co.'s SD-2 surveillance drone has completed successful test flights at Army Flight Test Station, Yuma, Ariz. Drone is launched from metal framework on standard Army truck, assisted by two rockets. Engines take over after launching; drone continues to area, reports information to control center. Recovery is by parachute. Fuselage, tail and wing assemblies are removable. Unit is truck transportable.

nose is not required to be extremely high, and technique is to complete flare, cut the power, hold the speed and the airplane flies on smoothly. It can be made to float, or can be dropped in as well, and in either case, recovery is as with a propeller driven aircraft. Since speed is adequate, aerodynamic control recovery is effective, and power can also be used.

After the main wheels contact the ground, the nosewheel is lowered and spoilers are raised quickly to dump lift. As spoilers are raised, a noseup pull is felt, probably the result of high forces applied on a long moment arm from the main landing gear trucks.

Thrust reversers are activated as soon as spoilers are up. Moving thrust reverse levers to their first mechanical stops activates the clamshell doors, and as doors close, stops disappear and levers are moved further aft to increase power.

A definite tug is felt with application of the thrust reversers, and the airplane decelerates fairly sharply. Reversers can be operated up to 90% rpm. on N_2 down to 60 kt., after which power is reduced to 1.5 EPR. The airplane can be controlled using differential reverser power as an adjunct to rudder during initial roll and can be used alone afterwards. High buffet associated with reverse propellers is not present with Boeing thrust reversers.

In up-and-down flights at Boeing, no brakes at all or slight applications at turnarounds for takeoff, were the order; thrust reversers and differential power in conjunction with nose-wheel steering were used for taxi and ground control.

In one landing at 172,000 lb., by Tom Layne, Boeing test pilot who checked out Aviation Week pilot, the aircraft was touched down approximately 1,000 ft. down the runway, was completely stopped at 8,000 ft. marker and allowed to back up several feet, all with reversers alone, operated at prescribed levels. No brakes were touched and steering was by nosewheel.

Characteristics Assessed

Landing by Aviation Week pilot at various weights up to and including 189,000 lb. emphasized the 707-120's controllability, stability and good landing characteristics. Speeds varied from approximately 125 kt. after flare up to about 135 kt., according to gross weight. In all landings, an effort was made to achieve precise speed control according to weight data, without margins, both to assess airplane characteristics and those of pilot not accustomed to the aircraft.

In all operations, adherence to calculated airspeed values paid dividends in case of pilot effort as well as in airplane performance.

Landing data from test flights has shown, according to Boeing, that the average sink rate of pilots at 707 landings is on the order of 2 to 3 fps., which yields the same loads at takeoff gross weight as a 10 fps. sink rate at maximum landing weight of 175,000 lb. This ensures that should a takeoff have to turn into a once-around-the-pattern flight, emergency landings can be safely made at takeoff weight.

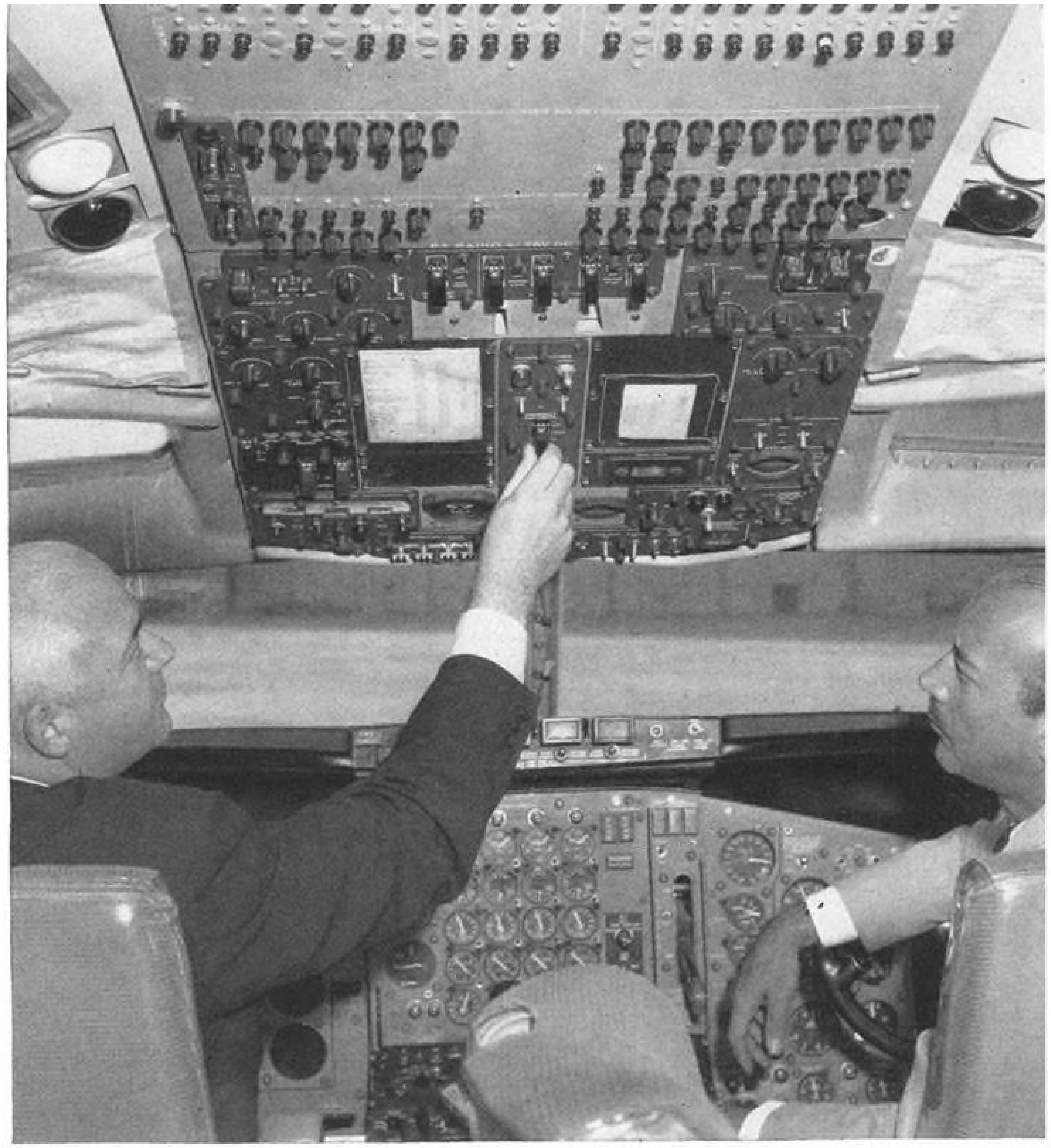
On a number of flights in N709PA, additional pilots were aboard from Civil Aeronautics Administration, as well as Boeing pilots achieving familiarity with the airplane.

Watching various pilots during landing and takeoff, in-flight maneuvers, indicated ease of mechanical flight transition to the 707-120. In all cases, pilots were observing stated values for airspeeds and maneuver limits, although the degree of familiarity with jet flight, large swept wing airplanes and other aspects, varied. In no case, did effort and concentration required appear to impose undue pilot stress.

Aviation Week pilot's left seat night flying in N709PA, with Boeing test pilot James R. Gannett, included landing, takeoffs, manual ILS approach on Paine Field.

Usual changes from day to night flying prevailed, i.e., depth perception impressions, etc., but general flight and handling techniques remain the same. No great mental adjustments were required by the impressions yielded by operations in the dark.

Night takeoff remains essentially the



Veteran test pilot Fisher gets 707 flight test checkout from long-time friend Tex Johnston, Boeing Chief of Flight Test.

Noted test pilot gives a behind-scenes operational report on America's first jet airliner . . . another in Champion Spark Plug Company's series on aviation history in the making

FLIGHT TEST, 707!

by HERB FISHER

International aviation authority, veteran test pilot, author

The 707 seats 112 to 180 passengers. New York to London, 6½ hours! Pan American starts first jet service to Europe this Fall.

That "greatest-yet" moment in American aviation history—dawn of the commercial jet age—stands at zero hour. Pan American has just taken delivery on the first of 23 Boeing 707 turbojets. Other airlines will put Douglas, Convair and Boeing turbojets in service in the months to come. It's been a long count-down . . .

The 707, designed to cut existing passenger schedules in half, was first flight tested on July 15, 1954. A transcontinental speed record was almost automatic—Seattle to Baltimore, 3 hours, 48 minutes; cruising speed, 612 mph.

As a test pilot who's flown about every type of transport including the 707, I'll say right now it's impossible to describe the performance difference between the 707 and conventional aircraft. The 707 is a pilot's dream as well as a passenger's. It's easy to fly. Its performance is superb . . .

You flick a switch. Champion jet igniters fire three- to four-inch bursts into the combustion chambers every second for 30 seconds. The 112- to 180-passenger aircraft comes alive instantly. No warm-up necessary. Flight test is on.

Releasing brakes for takeoff, you realize in an odd moment of pride-spiked humility that your finger tips command $5 million of precision-built aircraft—and 60,000 pounds of thrust that's going to ram skyward *a mass nearly twice the weight of today's big propeller airliners.* The 125-ton ship breaks ground at 150 knots. You feel a surge as retracting landing gear and flaps reduce drag. Soon you're at 300 knots indicated. Your rate-of-climb is more than double that of present-day aircraft.

I climbed to 35,000 feet in 13 minutes.

Cruising at 600 mph between 30,000 and 40,000 feet—well above weather and where jets perform best—you sit back, smile, look around. Absence of piston-engine throb delights you. There's practically no vibration. You hear turbines whine but faintly. Aft, passengers will hear only a faint whistling, will not be buffeted by ordinary turbulence.

You check your 20 engine instruments again. It's quick and easy: All needles are parallel during normal operation. All the pilot need do is watch for a needle off parallel!

Pilots, the simplicity and honesty of jet control is like a prayer answered. Gone are prop synchronizer, supercharger, cowl-flap, mixture, carburetor-heat and prop-pitch controls and mag switches. Primary flight controls are 100 per cent manually operated. No power-boost. Spring tabs cable-connected to wheel and rudder pedals actuate controls. Internal pressure balances provide low control forces for low-speed maneuverability and higher forces for high speeds where abrupt maneuvers aren't desired. End result—"natural" feel. No sluggishness, no over-sensitivity.

Mid-span, high-speed ailerons supplemented by hydraulic spoilers and (when flaps are down) use of outboard, low-speed ailerons simplify lateral control. This permits safe operation from airports with a 90° crosswind of 30 mph, and the spoilers provide speed brakes for a wider choice of approach angles.

Power control is simple as a broom handle. A single lever mechanically connected to a hydro-mechanical regulator on the engine slows and speeds the plane. Fuel-air ratios take care of themselves.

For dual reliability, each engine has normal tank fuel flow plus two independent electric boosters. Engine-driven pumps feed fuel if the electric pumps are lost. In emergency, a manifold line may draw fuel from any tank. Likewise, the 707 has two independent hydraulic systems for actuation of spoilers, flaps, landing gear, nose-gear steering and brakes.

Even over air-turbulent Mt. Rainier, 707 passengers will experience but slight, springy motion.

You put the 707 through her paces. Then—the crucial moment: *You simulate flameout,* though chances of it happening are slim. Engine is dead. And the life-trigger—the jet igniter—has been in this jet furnace *enduring temperatures of thousands of degrees for hundreds of accumulative flight-test hours . . .*

Flameout. You take comfort in the knowledge that Champion's long history of spark plug development includes *unique* know-how with jet igniters dating back to the birth of experimental jet engines—those built by General Electric in wartime 1943! And that Champion was first with jet igniters in military aircraft—and has held that lead since . . .

You flick the switch. Two jet igniters spit lightning into the dead turbine. The big Pratt & Whitney engine flashes to life.

Flight test secure, you descend comfortably at 10,000 feet a minute. With speed brakes, single-motion power control and provision for lowering wheels at cruising speed, slow-down distance is but *two miles.* Go-around safety is assured. The big ship maneuvers easily in the traffic pattern.

The 707 goes into service as the most thoroughly tested airliner in history, Tex Johnston, one of the great test pilots, tells me. It's backed by 24,000 hours of wind tunnel testing, 1,500 hours of flight testing—plus the performance record of its military counterparts.

Likewise has the reliability of the vital Champion jet igniter been established—15 years of testing and performance in military aircraft operating under grueling conditions, four years in exhaustive 707 flight testing. Champion's depth of experience and demonstrated ability to make metal and ceramic parts capable of perfect functioning in fantastic temperature ranges led Pratt & Whitney to Champion when the J-57 engine was being developed. A jet igniter must not only be capable of re-igniting the turbine at critical altitudes and speeds, it must deliver instant starts on takeoff day after day.

Today Champion is teamed with engine manufacturers in advanced jet engine development and remains the greatest volume producer of jet igniters in the industry—hence the superior igniters at much lower competitive costs.

Tomorrow . . . well, this is *it* for Pan Am, American Airlines—and the 707!

Champion Spark Plug Co. • Toledo 1, Ohio

. . . salutes the Boeing Airplane Company

Airframes in assembly at Renton, Washington. Boeing takes extra pains with 707 airframe structural safety and endurance.

Fisher and Rudolph Blazek, Experimental Pre-flight Foreman, inspect Champion jet igniter in 707 turbine.

same as for daylight, with greater concentration on gages since horizon reference is lacking.

Landing was at 189,000 lb., requiring airspeeds above those used in day flights, initial approach, with average 1.5 EPR power setting, was made from over the water, a reversal of day operations direction.

Holding standardized speed values throughout, the airplane flies down nicely, and with night height impression adjusted for, landing was normal. Since additional takeoffs and landings were to be run, thrust reverser, nosewheel steering and differential power were used for ground control.

Night ILS Approach

Night ILS approach was made under completely simulated IFR conditions, with the command needles of the Sperry attitude gage as prime reference, cross checked against the other gages as required for good techniques.

Since small lateral movements which were too small to note in the airplane-horizon relationship of small Sperry attitude gage produced proportionately great deflections on the localizer steering needle, care had to be exercised to avoid inducing Dutch roll since the yaw damper was not in use. Making small corrections and using steady control pressures rather than movements resulted in a smooth approach path being achieved prior to reaching middle marker. Power level was 1.4 EPR after the glide slope interception.

Breakoff at prescribed IFR minimums presented no great power anticipation problem. Throttles were advanced at the minimum altitude and airplane sink was stopped immediately. Since the initial approach was started at V_2 plus 30 kt., and speed bleedoff was slow and steady, sufficient airspeed remained to check descent and initiate climbout as power was applied, without getting into any tight corners, illustrating soundness of values which had been established for these procedures. The quick engine response combined with proper airspeed should give pilots a normal ILS approach and go-around.

Trim being very important in 707 flight, protection has been incorporated for a variety of contingencies which might arise. Differential spoiler use can offset a stuck stabilizer as noted earlier.

Runway Trim

Should runaway trim occur, it can be manually stopped and recovery effected without spoilers. A runaway condition is highly unlikely, since the actuation motor has a.c. electrical power while the clutch operates off d.c. power. Failure in either one would normally stop the other.

However, if both circuits are jammed

open, the pilot can hold the manual trim wheel in the cockpit firmly and stop the mechanism.

Layne went through the demonstration by applying runaway nosedown trim while Aviation Week pilot was flying manually. Stopping the wheels with a firm grip, the trim circuit cutoff switch can be operated to stop entire operation.

Recovery to level flight is effected by pulling the nose up as far as possible against forces, neutralizing controls and cranking in as much trim as possible by manual wheel before forces build up too much. Additional sequences were required of noseup control force, neutralize and crank, since initial runaway trim was allowed for demonstration purposes to produce a decided nosedown attitude.

However, throughout the entire operation, with two pilots working manual trim wheel, the airplane remains controllable and recovery can be effected without entering danger areas of flight envelope, although considerable pilot muscle is used in recovery cycle.

General Features

A number of general features were observed by Aviation Week pilot in various phases of N709PA flight work and riding in passenger compartment.

One is the aerodynamic noise, which is predominant one in cockpit area.

A pronounced hiss is heard throughout the flight spectrum. It is not unpleasant, and does not impede conversation, which can be conducted at normal voice levels.

Aerodynamic noise results from use of spoilers, according to the degree of extension. Spoilers also produce a definite shake of the aircraft, which should not be disquieting to passengers who have been told in advance what to expect.

Gear Extension Noise

Landing gear extension also produces a definite noise as air roars into wheel well cavities until main gear doors close after extension.

Watching the landing gear extension by the emergency system, showed that the sequence was not difficult and could be accomplished quickly.

Small face of 3-in. attitude indicator in Sperry pilot display substantially reduced usefulness of that element of the instrument for Aviation Week pilot. Width of the horizon bar and airplane symbols was great enough that small movements of the airplane went almost unrecorded as far as being precisely and easily visible and noticeable to pilot. The larger 4-in. gage which is being used in other installations should help overcome this feature.

Aviation Week pilot made one left seat flight in Boeing KC-135 tanker aircraft which was part of a USAF acceptance flight. USAF pilot in command was Capt. Hollis R. Downing of Larson AFB.

Tanker was at light gross weight, with comparatively low speed points. Departure from Boeing Field was by a controlled route according to regulations now in effect, until 20,000 ft. altitude was reached.

Flight work included a stall, in which characteristics remained much the same as those of the commercial transport, and turns, accelerations and decelerations and general flight characteristics.

As assessed by the Aviation Week pilot, flying the tanker is very similar to flying the 707-120 transport, although it could be expected to be different at high gross weights, since the tanker can be loaded to upwards of 300,000 lb. while maximum value for 707-120 as of now is just under 250,000 lb.

One maneuver performed in the tanker which was not done in the transport was high speed descent, made from 20,000 ft. to 2,000 ft. in jet penetration, and above that in sample of flight handling.

Air Braking

Use of spoilers, flaps, landing gear as air brakes combined with minimum power sends aircraft down at fairly steep angle although the airspeed does not build up. Speed was kept in the region of 250 kt. IAS during the descent, which averaged out over-all at about 12,000 fpm. Airplane is noisy during descent, there is some shake from spoilers. Descent can be initiated instantly when desired, since spoilers can be raised at any velocity up to V_{ne} on either tanker or transport. Gear drop is placarded higher in the tanker than in the transport, as is maximum speed with gear extended. However, in no case did it seem that airspeed wanted to build up to maximum or near maximum values, while an adequate descent rate was retained.

The tanker panel layout is different than that of the transport, with the fuel management panel on the center pedestal between pilots. Also, main instruments differ on flight sections, with a large 5-in. Lear attitude indicator proving extremely useful in adjusting pitch angle as desired in stall, other maneuvers.

Another difference is in the speed gage and altimeter, with the altimeter using differential hands in the military airplane as contrasted with the one hand and drum-in-window of commercial aircraft. Also, the military speed gage has one main hand reading in hundreds, while a drum-window reads in single knot increments.

The military panel was much easier to fly with than commercial, although airline operations and CAA regulations specify more gear for a civil transport; the design of the gages themselves was much better in the tanker.

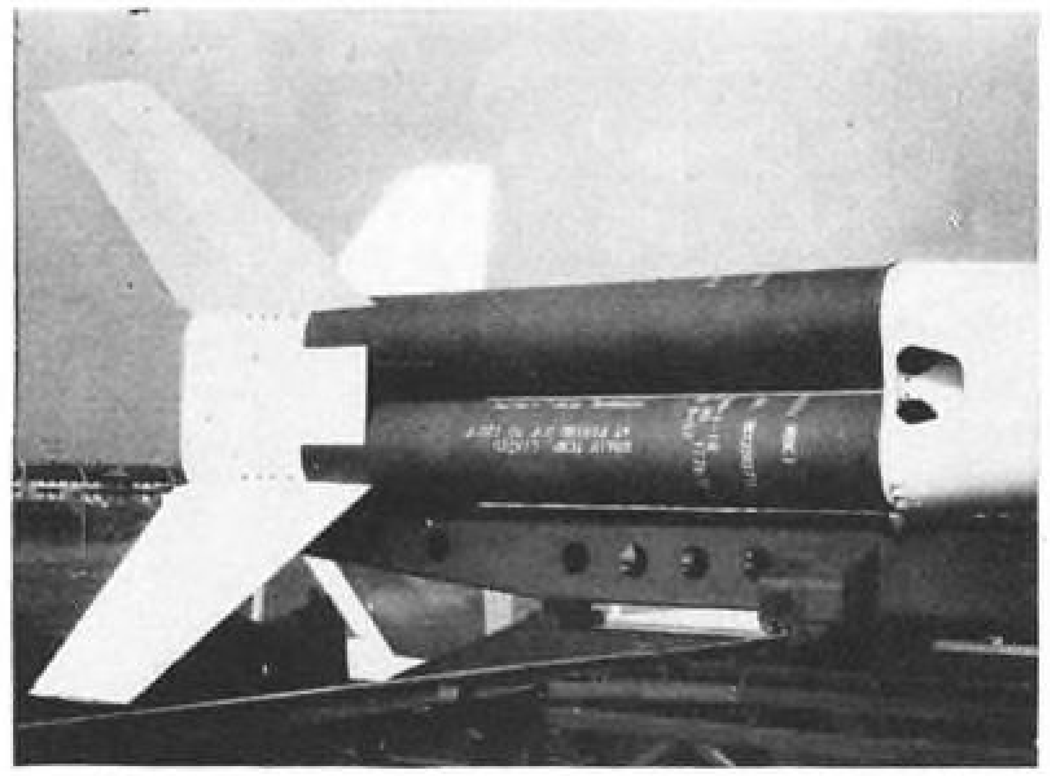
Conway Testbed Loss May Retard Program

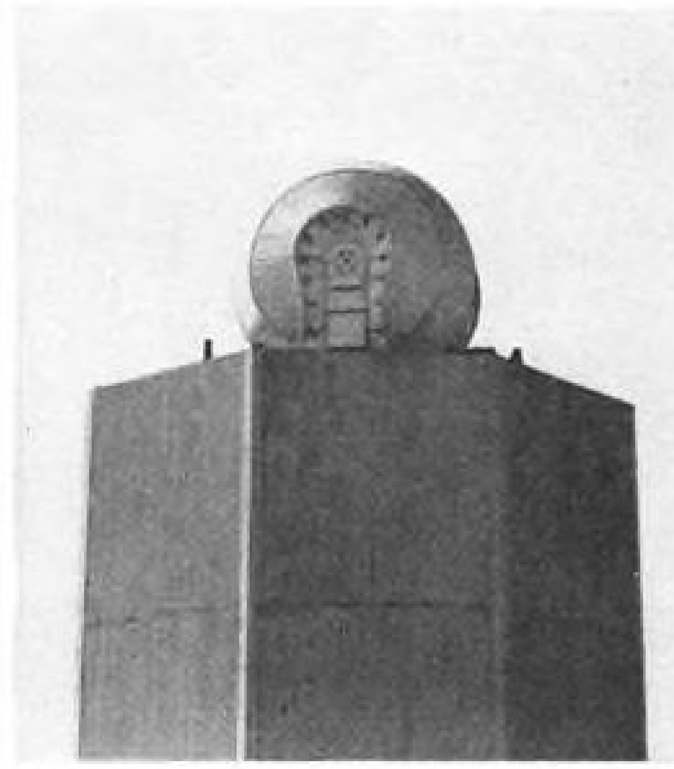
London—Development of the Rolls-Royce Conway bypass turbojet engine will be delayed by the crash of the Avro Vulcan being used as a test bed in the program.

The aircraft disintegrated and burned at an altitude of about 250 ft. during a flyby before a crowd of 20,000 persons at a Battle of Britain display. Seven persons were killed: crew of three civilians and a Royal Air Force navigator, and two ground staff sergeants in a runway control caravan and a senior aircraftsman in a fire rescue Land Rover.

Rolls-Royce said there was no evidence the four Conway engines were a contributing cause. The aircraft was the first prototype of the Vulcan, bailed from the Ministry of Supply to Rolls-Royce. It first was equipped with Rolls-Royce Avon engines, later had the Armstrong Siddeley Sapphire and Bristol Olympus.

No piece of the aircraft larger than 10 ft. struck the ground.



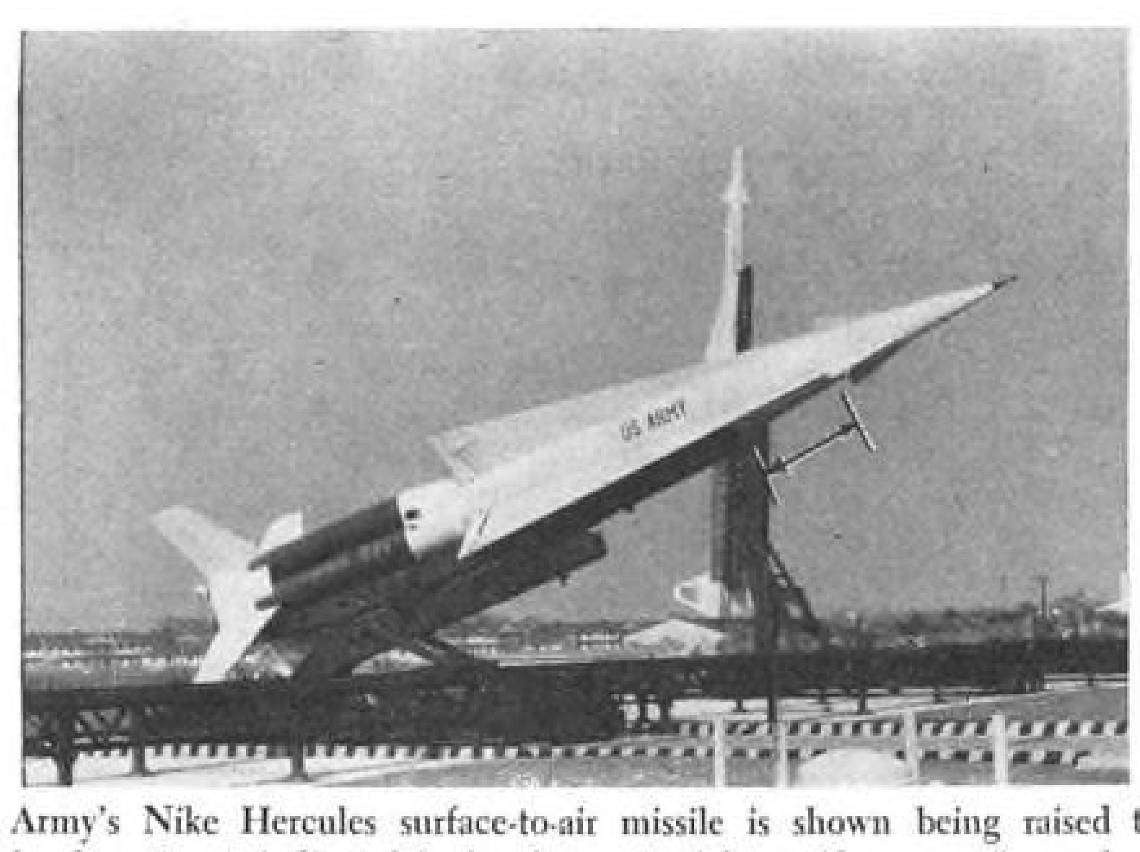


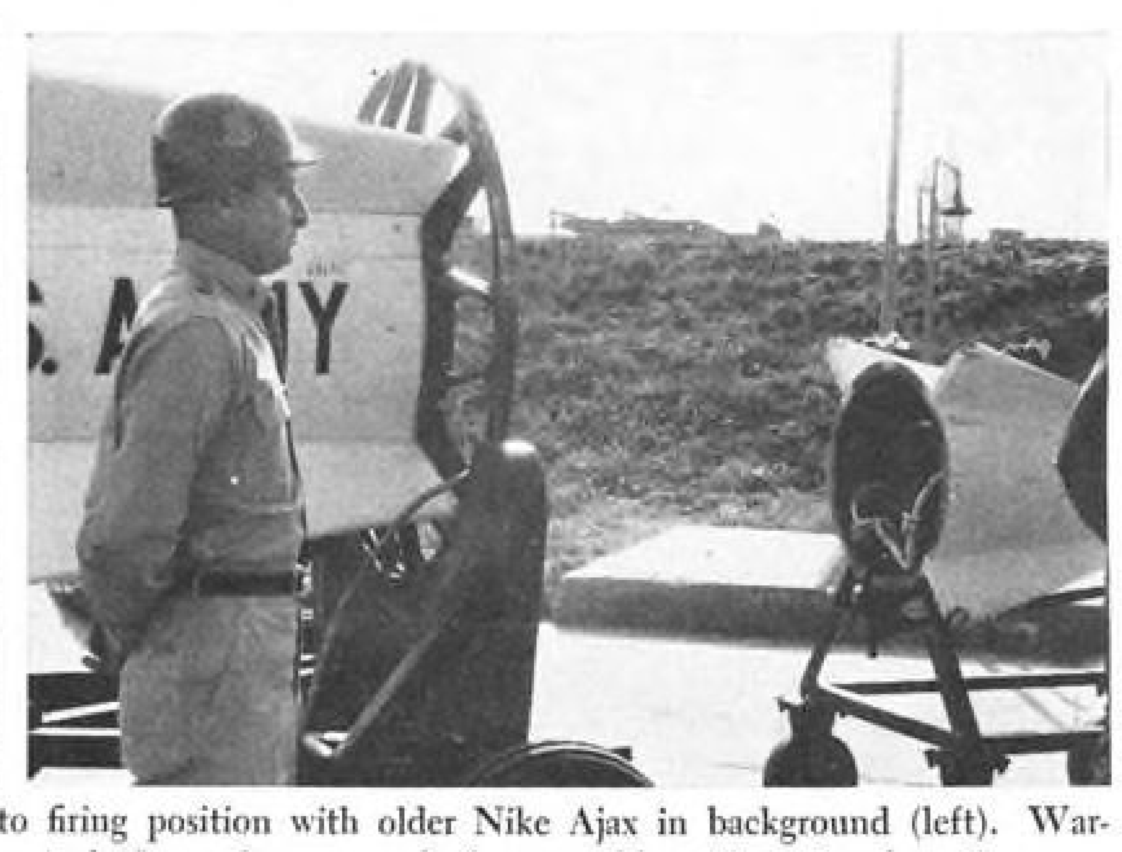
Four Nike Ajax boosters join to make Hercules booster (left). New tracking antenna (center) of system is double reflector monopulse type covered by rubberized canvas radome. Acquisition antenna (right) is solid dielectric housed reflector with cosecant squared pattern.

Guidance section (left) houses missile receiver and beacon with antennas at missile fin tips which also mount pitot tubes (shown with cover snaps). At right, Nike Ajax guidance is checked out in assembly building. RF test set connects to missile through saddle coupler.

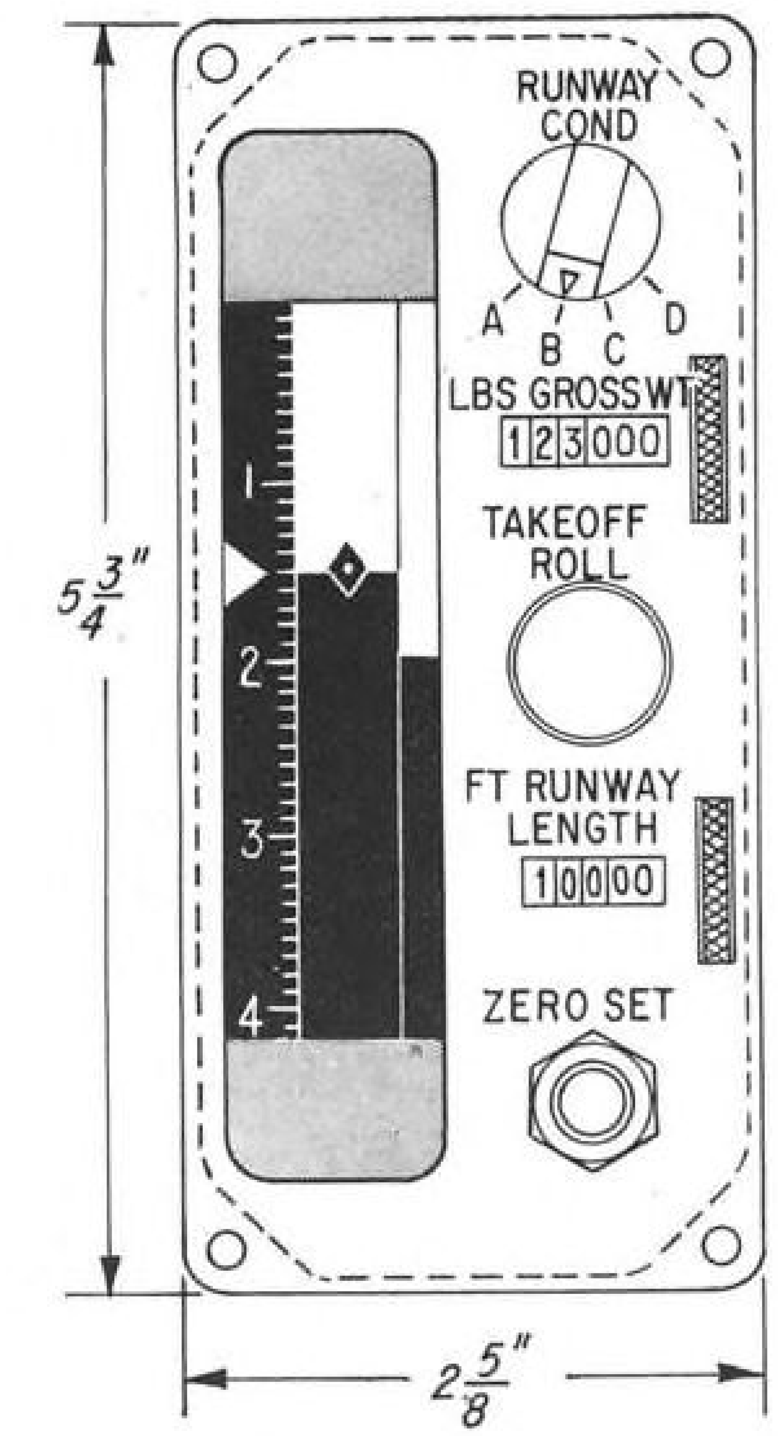
Army's Nike Hercules Shown Disassembled

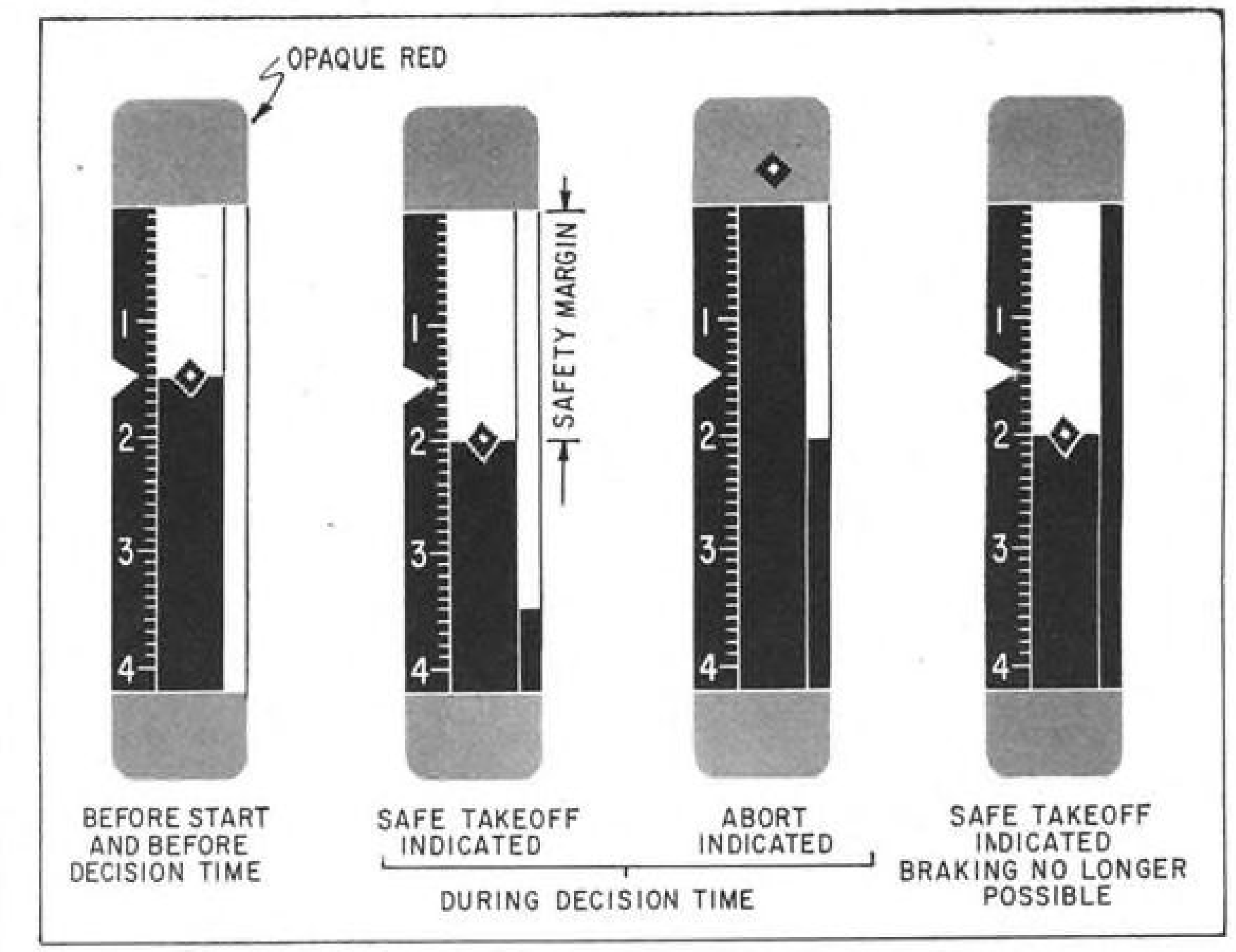
Army's Nike Hercules surface-to-air missile system is located at Ft. Tilden, N. Y. The missile system employs acquisition, target tracking and missile tracking radars and computer to provide command guidance bringing missile to target interception point. Both Nike Hercules, with conventional and nuclear warhead capability, and Nike Ajax use modified Ajax launchers. Stated range of Hercules exceeds 75 mi., altitude capability 80,000 ft. New tracking radars are said to have 75% improvement in range and accuracy. To date, however, no tests of either missile have been announced against supersonic targets.





Army's Nike Hercules surface-to-air missile is shown being raised to firing position with older Nike Ajax in background (left). Warhead section is indicated by brackets. At right, guidance section and main body section are ready for assembly with warhead section.





TAKEOFF MONITOR proposed by Servomechanisms, Inc., presents takeoff data to pilot by servo-driven tapes. Continuously calculated point of takeoff is indicated by center diamond, is compared by pilot with textbook calculated takeoff point shown as triangle at left. Right-hand tape shows pilot point along the runway where his aircraft would stop under full deceleration. Movement of computer calculated takeoff point from predicted point may be pilot's first sign of trouble.

Takeoff Monitor Computes Runway Roll

By James A. Fusca

Hawthorne, Calif.—Takeoff monitor, designed to provide highly accurate information to a pilot as to where his aircraft will leave the ground on takeoff and whether he should abort, has been proposed by Servomechanisms, Inc.

Monitor displays the takeoff situation in the form of a graphic vertical scale that presents a picture of the end of the runway with markers showing the point at which the wheels will leave the ground and the point at which the aircraft would stop if full brakes were applied.

Need for such a device has been demonstrated by the increasing number of takeoff accidents with the advent of jet aircraft. The reasons are: ambient temperature and pressure-altitude dependence of jet engine thrust, increased takeoff speeds, and fewer "cues" to the pilot from slower acceleration, decreased noise and vibration.

As a result, use of this type of device has been recommended for commercial jet aircraft by the recent International Air Transport Assn. technical conference in Miami. At least six other avionic manufacturers have already entered the competition with takeoff monitors of their own: five are airborne systems; one is a ground-based system.

Proponents of the airborne approach include: Avien, Doman Helicopters, Kollsman Instrument, Minneapolis-Honeywell and Sperry Gyroscope. Northrop Aircraft's Nortronics Division has proposed a ground-based system that requires no equipment in the aircraft (AW June 23, p. 65, AW July 28, p. 77).

Servomechanisms' System

The monitor designed by Servomechanisms has been proposed to major airframe manufacturers and to Wright Air Development Center. Although this monitor would weigh about 9 lb. as compared with the 3-7 lb. of competing systems and would possibly cost more to produce, the company believes its approach provides much more accurate data to the pilot in the form that he can most easily assimilate at the critical point of the takeoff roll where he must decide, "Will I, or won't I?"

Philosophy of the Servomechanisms approach separate three problems in the design of an optimum performance takeoff monitor. These problems are considered to be presentation, prediction and computation. The resolution of these problems is based on the fact that the monitor becomes most important to the pilot at a time of maximum stress—when an emergency is imminent—therefore, the form of the presentation dictates the system.

Regardless of the input data to the computer or the equations of the computation, the company believes the final presentation must be in a form that tells the pilot whether his wheels will be off the ground when the end of the runway is reached. Human engineering serves the purpose of matching this information to the pilot in the most effective manner, eliminating the need for him to perform mental data processing.

Servomechanisms considers any instrument that directs a pilot to act without presenting the information for judgment is useless. A light that indicates "takeoff" or "abort" makes the pilot part of a servo loop rather than freeing him from mechanical jobs for command decision.

In certain types of military missions, for example, a pilot might decide to risk whatever safety factor has been allowed in the computation because of the importance of the mission.

In designing the face of the instru-

ment, the company employs a vertical scale display that indicates the end of the runway, a marker to show the text-book-predicted point of takeoff, and servo-driven tapes with markers to show the continuously-computed actual point of takeoff and the point where the aircraft would stop under full deceleration. The company has employed moving tape type presentations on other projects such as a vertical scale altimeter instrument program for Wright Air Development Center.

Rather than using the usual method of mathematical extrapolation to predict the takeoff point which it considers subject to considerable inaccuracy, Servomechanisms bases its prediction on the published takeoff curves of the aircraft. The reasons for this can be seen by considering the variables of these curves.

Takeoff occurs when the lift exceeds the weight of the aircraft. The lift is determined by the dynamic pressure and the angle of attack. The pilot can adjust the angle of attack, but there is some minimum dynamic pressure at which takeoff can occur.

Since dynamic pressure is measured by indicated air speed (that is, for every dynamic pressure there is just one indicated air speed—or, more properly, calibrated air speed), there is some one indicated airspeed where takeoff will occur. This means that predicting indicated airspeed will serve to predict takeoff without reference to such considerations as temperature and altitude.

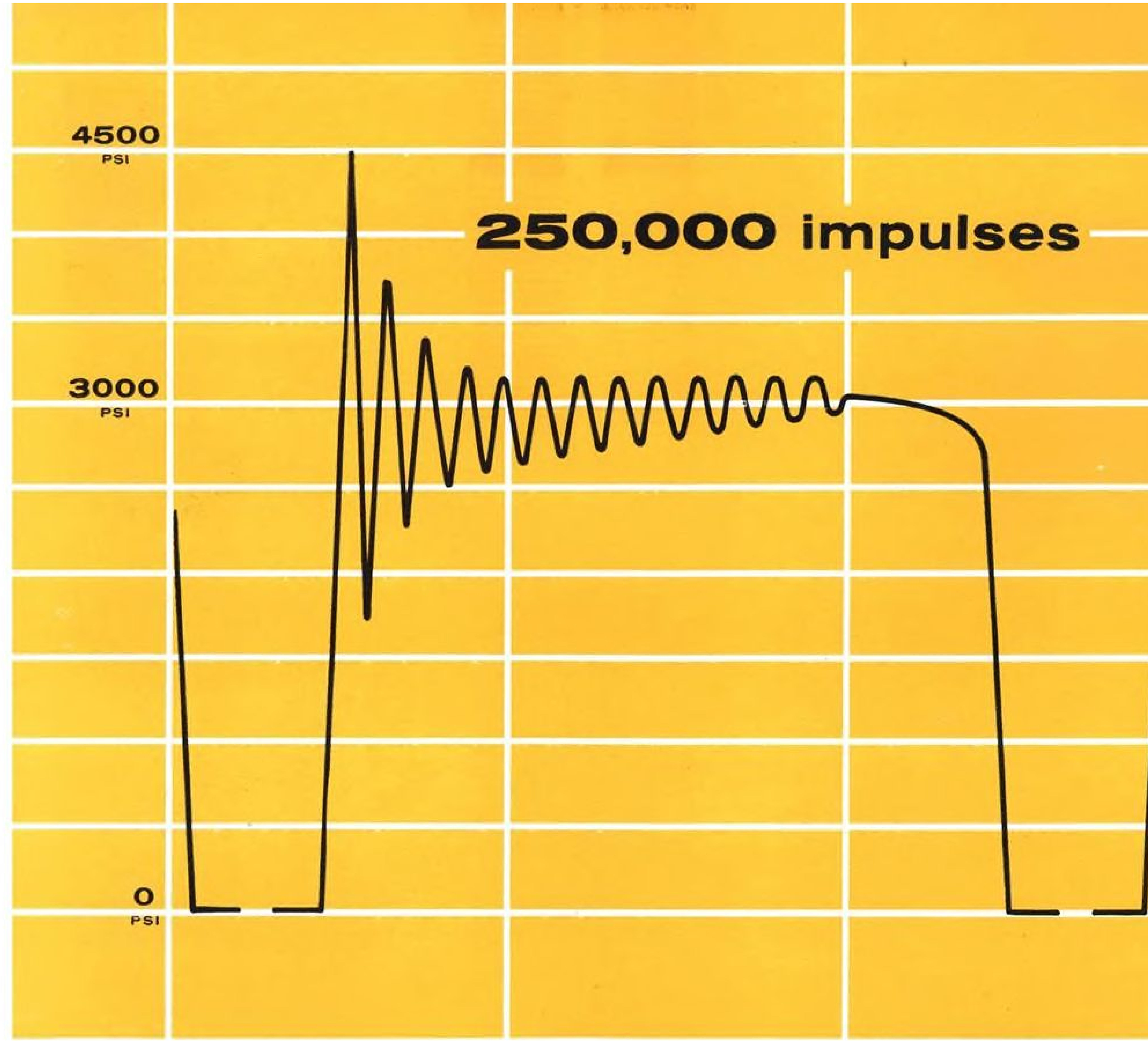
Indicated airspeed for takeoff is then determined by weight alone, but the time or distance in which that indicated airspeed will be reached is a function of many variables. While the computation could be performed either way, the desired input to the display is distance.

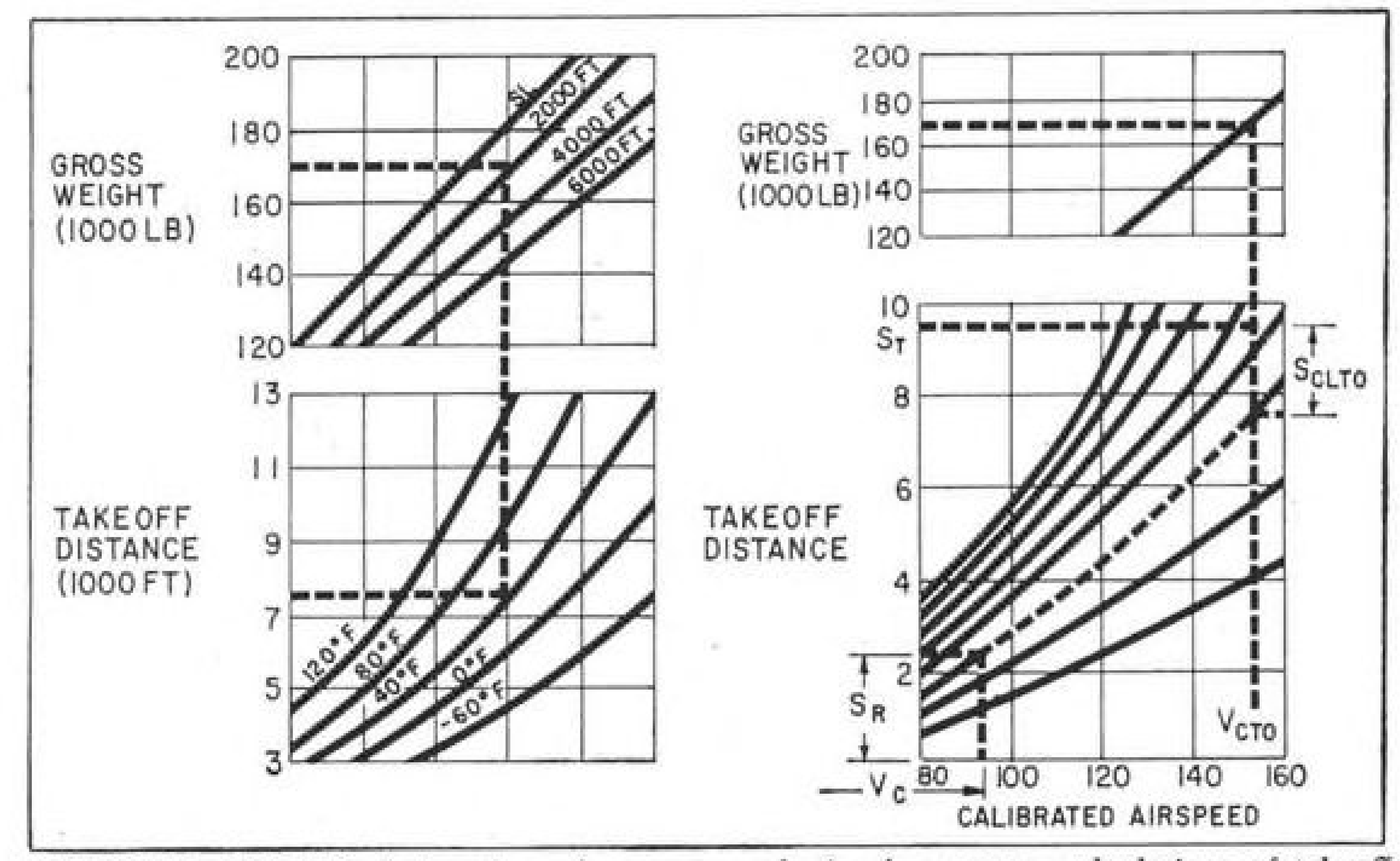
Using the plot of a family of curves of indicated airspeed vs. distance down the runway, where the takeoff speed has been computed from gross weight, the problem is to predict which curve will be followed by the aircraft. This is the point where the other variables affecting the takeoff enter. A series of curves can be drawn for differing values of:

- Altitude.
- Barometric pressure.
- Temperature.
- Engine condition.
- Tire condition.
- External stores drag.
- Door and flap configuration.

The outstanding characteristic of these curves is that they seldom cross, and where they do it is at a very acute angle. Assuming that they do not cross, the problem of prediction involves simply selecting the correct curve and finding the intersection of the takeoff velocity line.

Choosing the correct curve is a function of the listed variables and, per-





PUBLISHED CURVES of aircraft performance are basis of computer calculations of takeoff point in Servomechanisms system. Textbook type curves at left are employed by computer as shown on right. Takeoff speed (V_{cto}) has been computed from gross weight. Also set by pilot are runway length (S_t), takeoff roll, runway condition. Sensors provide distanced rolled (S_r), calibrated airspeed (V_c) from which computer extrapolates takeoff clearance (S_{clto}).

haps, others. Even where the exact functions are known, the variables are not known. For example, temperature can vary by more than 30 deg. from one end of the runway to the other, there can be a loss of engine thrust caused by intake clogging, or there could be changes in the wind.

By drawing a family of curves, each representing a typical takeoff under some conditions of thrust, one curve will represent or approximate any given takeoff, but calculating all these curves would be a major problem. Servomechanism's solution is to measure the selected variables.

By measuring distance and indicated airspeed, one point on the plot can be located which will have a curve passing through it. The computer, then, follows the chosen curve up to the takeoff velocity and thereby reads the distance to takeoff.

If conditions change in the middle of the takeoff roll, if temperature or flap configuration change or engine thrust is lost, the indicated airspeed will drop below the corrected value and the computer will follow a new curve to determine a new takeoff point. As the aircraft progresses down the runway, the degree of prediction grows less and the output grows increasingly accurate.

Changes in conditions during the takeoff roll will cause the marker showing the point of takeoff to move to a new position. Since the marker is set by direct measurement rather than by measurement of engine parameters, acceleration or similar variables, it is possible that the first indication of trouble would be a shift in the marker.

The computer is probably the least of the problems. Over the last 10 years an increasing number of airborne computers of this general type have been manufactured. These units, now transistorized, are flying in almost all jet aircraft today.

Similarly, the sensor required for measuring indicated airspeed is well known and has been refined over many years. Only during the early stages of the takeoff roll when speed is low, does the accuracy suffer. But in these stages the accuracy of the prediction is inherently bad because insufficient data has been gathered to establish the takeoff point accurately. For this reason, the computer has been designed to use the textbook prediction until the aircraft has rolled far enough down the runway to allow measured data to be inserted, at which point the computer automatically switches to measured data.

A sensor to measure distance is a more difficult problem. The company says that methods involving integration do not meet the accuracy requirements. An accelerometer tilted one degree measures a false horizontal acceleration of more than half a foot per second each second (giving a reading of almost 1,000 ft. after a one minute wait) although this signal can be balanced out while standing at the end of the runway. Integration of velocity has the same effect but to a lesser degree, but would require many of the precise techniques of inertial navigation systems.

The measurement of distance selected is the counting of wheel revolutions on the landing gear. This is done by a pulse magnetic method. A potential source of inaccuracy is the fact that tire circumference does not remain constant. Tests, however, by the Boeing Airplane Co. have shown that the equivalent circumference varies linearly with distance down the runway, and the slope of the straight line is a constant. Therefore, the plot of distance vs. wheel revolutions is a parabola, and can be inserted in this form into the computer.

The sequence of events would be:

- **Paper work.** In the same manner as at present, either the pilot or the controller would use the published takeoff curves for the aircraft to predict the takeoff distance.
- **Data insertion.** The pilot would manually insert on the face of the indicator the gross weight of the aircraft, the runway length, the predicted takeoff roll and the runway conditions (which selects a value for calculating braking deceleration).
- **Zero set.** At the beginning of the runway, the pilot would check the computer by pressing the zero set button. If working normally, the computer will position the predicted takeoff marker opposite the marker showing the takeoff distance obtained from the takeoff curves.
- **Beginning roll.** During the first few seconds of roll, the takeoff position marker will remain opposite the prediction marker, after which the computer will switch to measured data and the takeoff marker will adjust to increasingly accurate data as roll continues.
- **Braking point.** The predicted braking point then moves into view. Until the braking point tape goes off the end of the scale, the pilot can still abort by maximum braking if the takeoff situation appears unsatisfactory.
- **Commital point.** When the tape indicating the braking point goes to the top of the scale, the decision has been made to take off. Braking to a stop on the runway is no longer possible, although the tape will indicate how far off the end of the runway the aircraft will travel in an emergency abort.

An additional safety feature is an annunciator to attract the pilot's attention under either of two conditions:

- **When the takeoff point** is within a certain predetermined safety margin from the end of the runway.
- **When the braking clearance** is within a certain predetermined safety margin from the end of the runway. This means that if the pilot has not responded to the visual warning from the predicted takeoff position indication and he is approaching the point where he cannot brake in time, the annunciator will operate.

Because the display system uses a remote servo drive for the instrument indicators, the display would not have to be permanently mounted on the cockpit panel. Used only during takeoff, it could be mounted in a manner so that it could be removed and stored during the remainder of the flight.

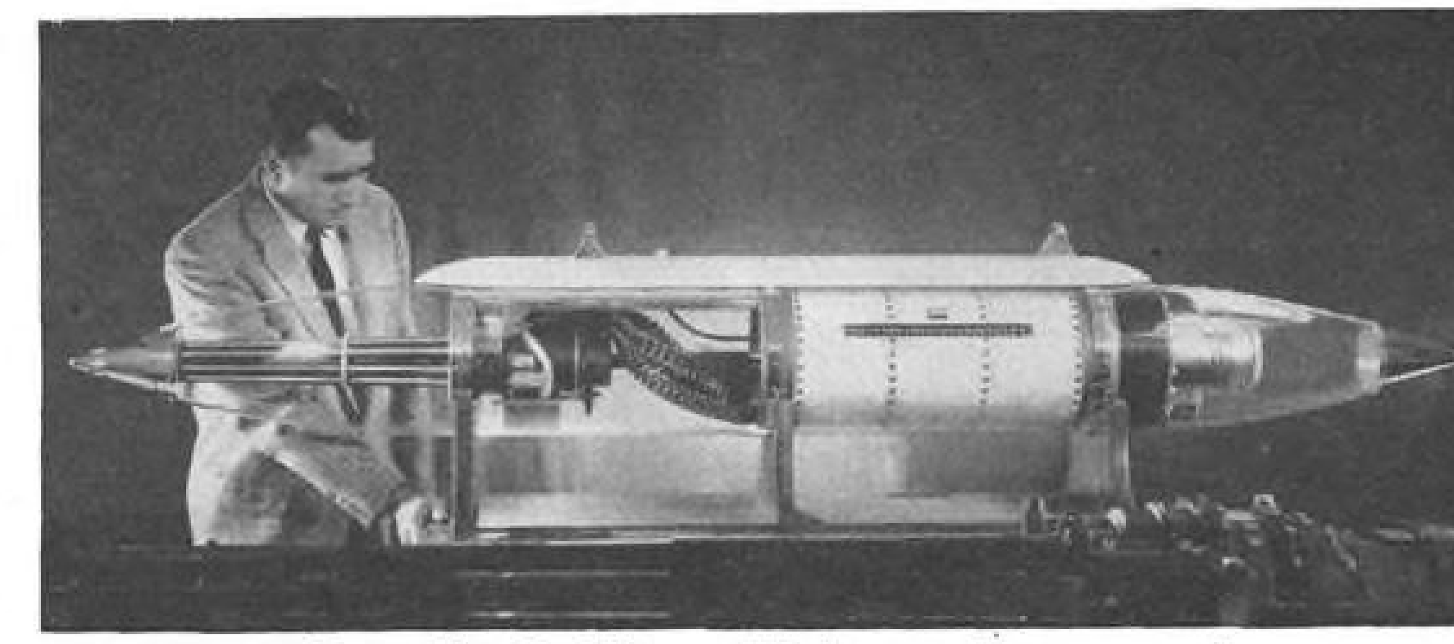
NEW AVIATION PRODUCTS

Jet Starting System

Jet engine cold air starting system is designed for installation at commercial airline terminals and jet overhaul bases. System will be used by the Navy, the company reports.

JAS-100 system, based on "hydrant" system of refueling, delivers relatively cold compressed air at pressures up to 110 psig. at flows to 200 lb. per min. to strategically placed hydrants. Diesel-driven compressor unit will start five engines simultaneously. More powerful systems are available, as are units suitable for use with gasoline, steam turbine or electric drives. System is said to be either automatic or semi-automatic or can be furnished with manual controls.

Wells Industries Corp., North Hollywood, Calif.

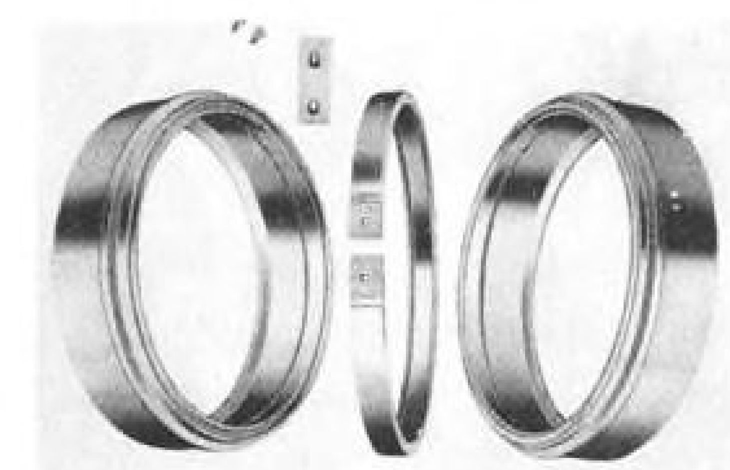


Small Caliber Vulcan Proposed

Mockup of small caliber 7.62 mm. Vulcan self-powered gun pod is compared with 20 mm. Vulcan (foreground). Proposed by General Electric, the eight-barreled 7.62 mm. Vulcan is designed to fire standard NATO cartridges at 6,000 to 10,000 rounds per minute. Pod has linkless ammunition feed system and weighs 188 lb. Wing mounted, weapon would provide anti-personnel capability for NATO fighters.

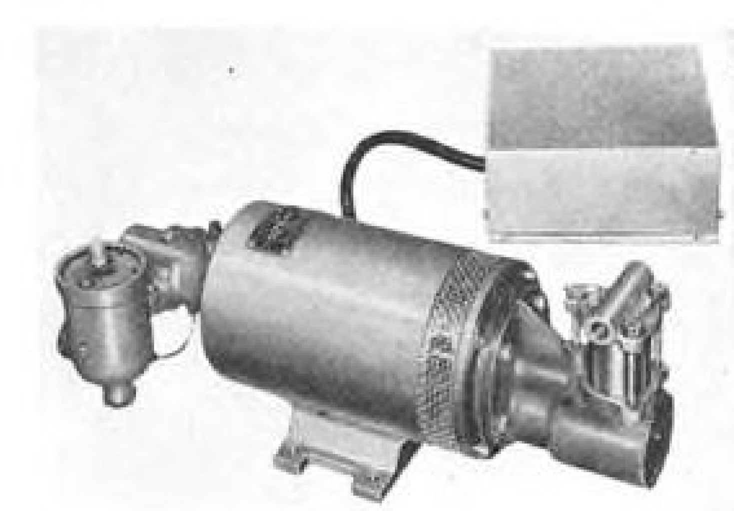
Flush Latch Coupling

Flush latch coupling is said to be adaptable to any cylindrical structure such as missile bodies, ramjet engines, antenna housings, radome mountings, rocket pods or external tanks.



Coupling is installed or removed with two screws and is said to be adaptable to the use of seals where pressure requirements are critical.

Marman Division, Aeroquip Corp., 11214 Exposition Blvd., Los Angeles 64, Calif.



Preflight Instrument Tester

Double ended a.c. motor driving an oil-free reciprocating air compressor and an oil-wetted rotary vacuum pump is designed to preflight missile and aircraft instruments. Designation is Model RG-18130.

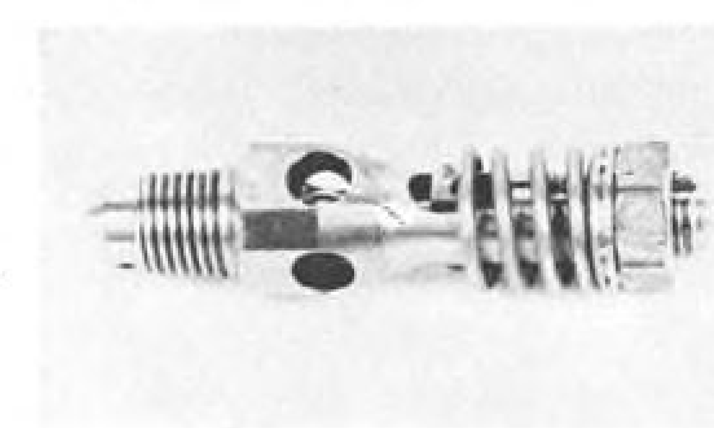
Air compressor delivers 450 cipm. of free air at 30 psi. gage discharge pressure and operates with pressures up to 65 psi. gage. Vacuum pump has an ultimate vacuum of 0.20 in. Hg. or 600 cipm. flow with 10 in. Hg. absolute inlet pressure, and will operate in ambients from −65 to +140F. Motor is rated for continuous duty.

Lear-Romec Division, Lear, Inc., Elyria, Ohio.

Missile Relief Valve

Hot gas pressure relief valve is designed to control maximum pressure of high temperature solid propellant exhaust gases.

Valve has replaceable working parts for developmental firings, adjustable relief pressure, and elimination of spring



"fade" problems, the maker states. Valve specifications include: gas temperature 2,300F, relief pressure 1,000+ or −50 psi. (std.), maximum flow rate .024 lb./sec.(std.), weight .86 oz., envelope 2 in. X.5 in. diameter, ambient temperature −65 to +170F.

Sundstrand Turbo, 2480 W. 70th Ave., Denver 21, Colo.

Missile Recorder

Miniature 25-channel inkless recorder is primarily designed for directly recording shaft position data of missile flight

control movements. Model ER 125 recorder is armored to withstand missile impact shock and can withstand 100G vibration.

Recording tape can be either metalized Mylar 0.0015 in. thick or chemically treated Alfax paper. Standard time base of the unit is 10 cps. but 100 cps. time base can be provided for greater time resolution. Drive system is a governor-controlled 27v. d.c. motor coupled to a reduction train driving the tape transport system at a nominal 5 in. per sec. speed. Maker states that field stripdown can be completed in less than one minute by unskilled personnel. Weight is 4 lb.

Santa Barbara Instrumentation Corp., 5481 Santa Monica Blvd., Los Angeles.

High Temperature Hydraulic Fluid

Synthetic fluid, an alkyl silane, is said to hold promise as a hydraulic fluid for high performance aircraft and missiles.

Designated QF-6-7009 Fluid, material is thermally stable in closed systems over the range of −25 to 550F for long periods; up to 700F for short times. Additionally, the fluid is said to show promise as a base oil in high temperature turbine lubricants.

Dow Corning Corp., Midland, Mich.

Advanced missile and space projects require **Engineers** *and* **Scientists** *to work on*

THE FRONTIERS OF SPACE TECHNOLOGY

Lockheed Missile Systems Division, recently honored at the first National Missile Industry Conference as "the organization that contributed most in the past year to the development of the art of missiles and astronautics," holds such important, long-term projects as: the Navy Polaris IRBM, Earth Satellite, Army Kingfisher target missile, and the Air Force X-7 ramjet test vehicle.

To carry out such complex projects, the frontiers of technology in all areas must be expanded. Responsible positions in our research and development laboratories and in our project organizations are available now for high-level engineers and scientists.

If you are experienced in physics, mathematics, chemistry or one of the engineering sciences, your inquiry is invited. Please write Research and Development Staff, Sunnyvale 2, California. (For the convenience of those living in the East and Midwest, offices are maintained at Suite 745, 405 Lexington Ave., New York 17, and at Suite 300, 840 N. Michigan Ave., Chicago 11.)

FLIGHT IN THREE MEDIUMS

Several things set the Polaris apart from other outer space weapons in the ballistic missile category, for the Polaris program involves a wholly new concept of weaponry:

1. It will be dispatched from beneath the surface of the sea.
2. It will be radically smaller than currently developed land-launched missiles, yet its payload will be as effective and its range the same as other IRBMs.
3. It will be the first operational outer space missile to employ solid fuel as a propellant.
4. It will travel through three mediums in a single flight: water, air, outer space.
5. Its launching base—a submarine—is not fixed but a mobile vehicle.

OUTER SPACE PROGRAM

Very little can be said about the Earth Satellite program at this time except that its success will necessitate advancing the state of the art in all sciences.

The Earth Satellite Project is perhaps the most sophisticated outer space program to reach the "hardware" stage in the U.S. today.

ENEMY SIMULATOR

The Kingfisher is the nation's fastest target missile, developed for the Air Force and currently being manufactured for the Army to test the accuracy of our newest supersonic weapons.

It is a ramjet target vehicle with Mach 2-plus capabilities. The Kingfisher not only has the speed to match the defensive missiles, but can also simulate a vast array of supersonic enemy missiles and airplanes attacking from great height. It is instrumented to score near misses and even theoretical hits without itself being destroyed.

It is recoverable from flight by parachute to be flown again, permitting weapon system evaluation to be conducted at greatly reduced cost.

Lockheed

MISSILE SYSTEMS DIVISION

SUNNYVALE • PALO ALTO • VAN NUYS • SANTA CRUZ
VANDENBERG AIR FORCE BASE, CALIFORNIA
CAPE CANAVERAL, FLORIDA • ALAMAGORDO, NEW MEXICO

WHO'S WHERE

(*Continued from page 23*)

Changes

Ennis B. Warren, head of the newly established West Coast regional office (Monrovia, Calif.) Engineering and Optical Division, Perkin-Elmer Corp., Norwalk, Conn.

James A. Trapp, manager, Data Processing and Controls Department, Engineering Division, The Thompson-Ramo-Wooldridge Products Co., Los Angeles, Calif. Also: **Henry L. Bechard,** customer relations manager-special control and data reduction systems; **Dan L. McGurk,** proposals and contracts manager.

Roy Segerdahl, manager, Quality Control Division, Ford Instrument Co., a division of Sperry Rand Corp., Long Island City, N. Y.

John E. Smircina, assistant to the vice president-general manager, Chicago Aerial Industries, Melrose Park, Ill. Also: **Richard A. Schram,** director of public relations.

Robert Lent, director of marketing, Statham Instruments, Inc., Los Angeles.

Conrad H. Hoeppner, chief scientist, Radiation, Inc., Melbourne, Fla.

John F. S. Abbott, director of research and development, Rockbestos Products Corp., New Haven, Conn. Also: **James F. McClelland, Jr.,** manager, and **David Chaffin,** assistant, of the newly formed Production Engineering Department.

Roy Healy, program director for development of a space-mission propulsion cluster for the Army Ballistic Missile Agency, Rocketdyne, a division to North American Aviation, Inc., Canoga Park, Calif. Mr. Healy continues as program manager of the Jupiter engine systems.

Ralph B. Reade, manager of the newly formed communications division, Airborne Systems Group, Hughes Aircraft Co., Culver City, Calif.

C. W. Cowing, Air Force Advanced Development Sales Manager, General Electric Co.'s Heavy Military Electronics Department, Syracuse, N. Y.

Charles F. McCabe, manager of support base activation for the Atlas ICBM, Convair Astronautics Division of General Dynamics Corp., San Diego, Calif.

Charles E. Bartley, coordinator-rocket propellant field, Food Machinery and Chemical Corp., San Jose, Calif.

Max D. Liston, director of engineering, Beckman Instruments, Inc., Fullerton, Calif. Also: **Thomas V. Parke,** director of product standards, and **Earl C. Janson,** director of manufacturing.

Harry H. Goode, technical director, Systems Division, Bendix Aviation Corp., Ann Arbor, Mich.

G. W. Taylor, director of The Boeing Airplane Co.'s overseas regional office at Sydney, Australia.

Milton Rosenberg, director-advanced development, Telemeter Magnetics, Inc., Los Angeles, Calif.

Theodore W. Benedict, manager-military contracts, Bridgeport Division, the Singer Manufacturing Co., New York, N. Y., and **George F. Mayforth,** military contracts administrator.

SAFETY

USAF Accident Investigation Report:

Complications of Aircraft Handling Linked to KC-135A's Fatal Crash

At approximately 0030 hr., Eastern Daylight Time (EDT), on June 27, 1958, a U. S. Air Force KC-135A Strato-Tanker, SN 56-3599A, crashed shortly after takeoff and was totally destroyed approximately one mile off the end of the departure runway at Westover Air Force Base, Chicopee Falls, Mass. Seven crew members and eight passengers were injured fatally.

HISTORY OF FLIGHT

a. In compliance with competent orders, USAF KC-135A, SN 56-3599A, was scheduled for an early morning departure from Westover AFB, Mass., on a transatlantic flight on June 27, 1958. The aircraft, the third of four KC-135s for departure on the mission, was scheduled to fly nonstop from Westover AFB to London, England, thence to New York City, N. Y., and on to a mission termination destination at Friendship International Airport, Baltimore, Md. A fully qualified flight crew of seven was assigned and eight passengers were authorized to be aboard the aircraft.

b. All required flight crew and maintenance preflight inspections were completed satisfactorily during the evening of June 26, 1958. Thorough and comprehensive briefings on pertinent aspects of the mission were given to the flight crew and the eight passengers. This aircraft, as number three, and the one scheduled to follow were configurated for higher departure gross weights than were the first two aircraft.

c. Since mission requirements called for the maximum permissible fuel load, surface air temperature and its effect upon aircraft takeoff performance provided a limiting factor. The aircraft had been serviced with fuel to provide an initial gross weight of approximately 289,000 lb. Additional fuel was to be added if air temperature at takeoff time would permit. At 2200 hr. EDT, on June 26, 1958, takeoff prediction calculations were made. Using a forecast 67F air temperature, a 30 deg. flap setting, and a gross weight of 290,000 lb., the expected takeoff ground roll distance was computed as 10,000 ft. By 2300 hr. EDT, June 26, 1958, it became apparent from air temperature readings taken on the departure runway that temperature at takeoff time might be as high as 70 to 72F. The airborne mission commander and the aircraft commander of the KC-135, taking into consideration the higher than originally expected air temperature, reevaluated the takeoff performance calculations and determined that use of an increasd flap setting (40 deg.) would provide a desired decrease in the distance required to enable the aircraft to become airborne. (The pilots of the first two aircraft had determined, and used successfully, a 30 deg. flap setting for their lower gross weight takeoffs. The takeoff of the fourth aircraft, at approximately the same gross weight as 3599, was canceled as the result of the accident.)

d. After engines were started at midnight on June 26, 1958, the aircraft was taxied to the takeoff runway, the crew completed satisfactorily all pretakeoff engine and equipment checks and the pilot received an Instrument Flight Rules air traffic clearance. In consideration of the higher air temperature, additional fuel had not been added and the gross aircraft weight at takeoff approximated 289,396 lb. Takeoff power was applied and the aircraft started rolling on runway 23 at 0030 hr., EDT, June 27, 1958. The precomputed takeoff ground roll for the aircraft, with a 40 deg. flap setting, was 9,600 ft. Observers noted actual aircraft lift-off after about 10,000 ft. of ground roll. Weather conditions at the time of takeoff were reported as a broken layer of clouds at 700 ft., a 10,000 ft. overcast, a visibility on the takoff runway of 1¼ mi. in fog, a temperature of 71F., and wind of 9 kt. from 220 deg. There was no precipitation. From the distinct noise level of the engines during takeoff, it was obvious to competent witnesses that the aircraft engines were being supplied with water augmentation for maximum takeoff power and all four engines were apparently performing without difficulty. The takeoff appeared satisfactory to ground witnesses although with a noticeably flatter climbout angle than would be normal for this type of aircraft at a lesser gross weight. At a distance of 2,100 ft. from the end of the departure runway, the aircraft passed well clear of tree tops extending 26 ft. above the runway elevation. At a point 4,050 ft. from the end of the runway, the aircraft fuselage, left wing and engines struck tree tops that were approximately 16 ft. above the runway elevation. After an additional 700 ft., the aircraft, which up to this time had been in a wings level attitude, assumed a left bank of approximately 30 deg. and again struck tree tops. The aircraft continued on, cutting through six commercial power cables, and struck the ground in a near vertical left bank. The aircraft was completely destroyed by ground fire and disintegration and fatal injuries were incurred by the crew of seven and the eight passengers. Between the time the aircraft started its takeoff roll and the time of ground impact, no communication was received from the aircraft and the first indication that something was amiss was when observers noted the ground fire resulting from burning fuel.

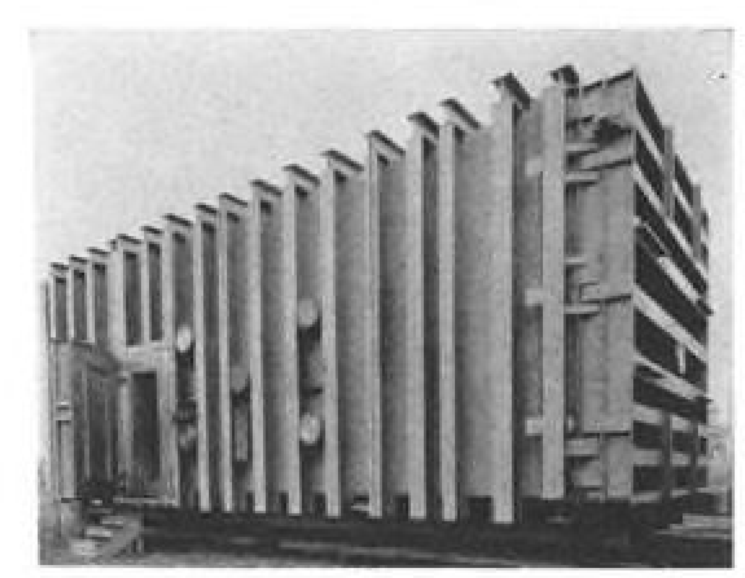
INVESTIGATIVE DETERMINATIONS

a. The flight crew on this aircraft was fully qualified in the positions as assigned.

b. In consideration of the relatively high gross weight of the aircraft (as required by the mission), marginal weather conditions and darkness, this particular takeoff could not be considered as "routine." The use of a 40 deg. flap setting which would and did act to decrease the takeoff ground roll distance required maximum performance from crew and aircraft. The penalty to be paid for a decreased ground roll would be a shallower climbout flight path. This penalty was known to the flight crew through their takeoff prediction calculations and was to be negated, as soon after takeoff as performance would permit, by retracting flaps to a reduced extension setting.

c. It was determined conclusively that there was no structural failure, inflight fire, engine malfunction or any failures within the fuel, hydraulic, or electrical systems prior to ground impact. Further, the loading of the aircraft and the resulting center of gravity was well within recommended limits.

d. The aircraft descent during the period that a climbout flight path should have been established is considered the result of complications in aircraft handling technique compounded by flight instrument limitations. In order to clear successfully all obstacles, the aircraft, with all its systems, and crew performance were required to be near optimum. Since air speed is a primary consideration immediately after takeoff and with cognizance of the inherent normal errors in other flight instruments, it is considered likely that pilot concentration on the air speed instrument may well have lasted a sufficient length of time for the aircraft to assume an undetected and relatively slight (4 deg.) descent angle. The magnitude of descent sufficient to cause contact with the trees was only approximately 60 ft. as the aircraft traveled forward nearly 2,000 ft. from the point of highest altitude. The very short period of time from the point of becoming airborne until the first obstacle was struck by the aircraft precluded any flap retraction and final ground impact occurred with the flaps at their original 40 deg. extension setting.



Bomarc Load Test

Hydraulic test machine is shown applying 100,000 lb. compressive loads on the aft section of a Bomarc missile. Built for Boeing by the Baldwin-Lima-Hamilton Corp., the 90-ton machine is rated at a maximum capacity of 1,200,000 lb. Machine can apply tension, compression, flexure and combined loads, and a 5,750 kva. power source provides heat for structure tests at elevated temperatures.

CESSNA 150 is seventh airplane to join the company's business fleet. Aircraft can be entered from either side.

Aviation Week Pilot Report

Cessna Returns to Two-Place Market

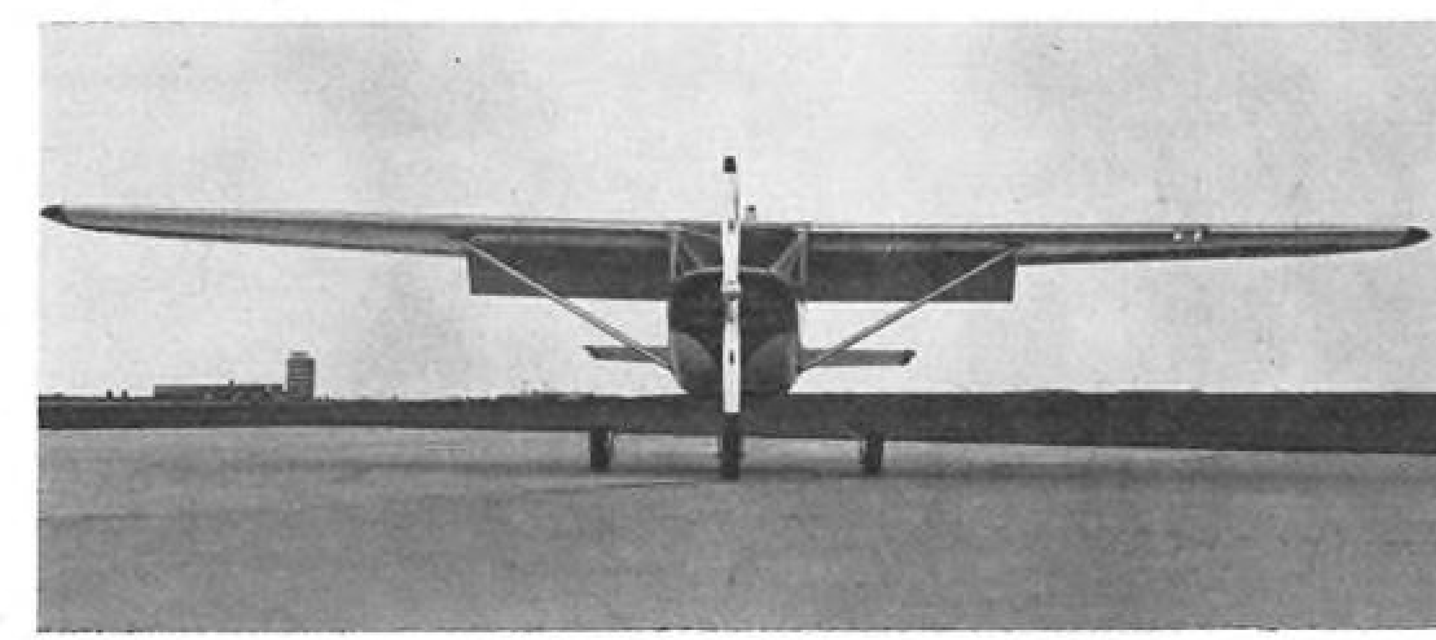
By Robert I. Stanfield

Wichita, Kans.—Cessna is back in the two-place market after an eight-year absence, and its new, light all-metal Model 150 has the potential of a good student trainer and an easy-to-handle business airplane.

Power for the side-by-side airplane is supplied by a four-cylinder Continental 0200-A engine rated at 100 hp. at 2,750 rpm. Engine dry weight is 189.7 lb. (220 lb. with accessories). Displacement is 200.9 cu. in. Compression ratio is 7:1. Propeller is metal Sensenich M69CK-52 with ground clearance of 10 in. Engine overhaul time has been initially set at 600 hr. (AW Aug. 25, p. 72).

Performance features evidenced during flight evaluation by this Aviation Week pilot included:

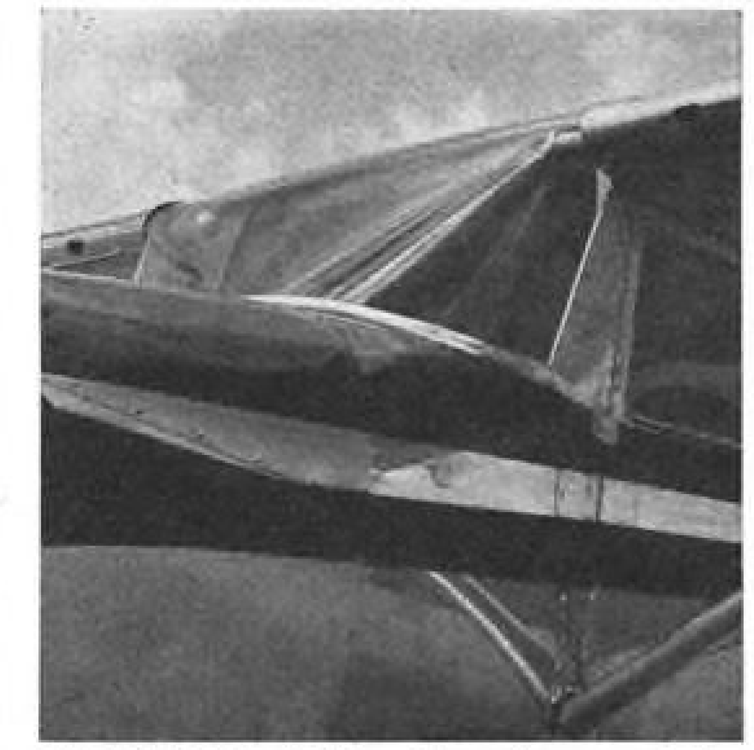
- **Climb-cruise power.** At takeoff, pulling 2,750 rpm., an 800 fpm. rate of climb was initiated at 70 mph. and held through 4,000 ft. At 9,000 ft., indicating 63 mph., rate of climb was 400 fpm. At 10,000 ft., pulling 2,740 rpm.—68% power—the airplane indicated 108 mph. for true air speed of 128 mph.
- **Stall and slow flight.** Model 150 was stalled in landing configuration—power off, full flaps—with wheel pulled back to the stop and feet off the rudders. The airplane porpoised along in series of pitches, losing altitude at a rate of 600 fpm., with no tendency to fall off on wing or break away sharp. With flaps up, at 1,500 rpm., the airplane was slow-flown through varying degrees of bank at 45 mph.
- **Short-field capability.** With 20 deg. flaps lowered before takeoff, the air-



FLAPS are in full down position in this view. Wing span is 33 ft., 4 in.

Model 150 Specifications

Engine:	Continental O200-A (4-cylinder)	100 bhp.
Speed:	Maximum—sea level at 2,750 rpm.	124 mph.
	Maximum recommended cruise—70% power @ 9,000 ft.	121 mph.
Range:	At maximum recommended cruise, no allowance	520 mi.
	Endurance	4.3 hr.
	True airspeed	121 mph.
	Maximum range: 43% power at 10,000 ft.	630 mi.
	Endurance	6.6 hr.
	True airspeed	95 mph.
	(All performance figures are for gross weight)	
Rate of climb: sea level		740 ft./min.
Service ceiling		15,300 ft.
Gross weight		1,500 lb.
Empty weight		962 lb.
Luggage compartment capacity		80 lb.
Fuel capacity (range based on 22.5 gallons usable)		26 gal.
Wing span		33 ft. 4 in.
Length		21 ft.
Height		6 ft. 11 in.
Wing area		160 sq. ft.
Wing loading		9.4 lb./sq. ft.
Power loading		15 lb./hp.



WINDSHIELD is "free blown" type and has no center strip, an aid to visibility.

plane broke ground at 50 mph. after a run of a few hundred feet into a 5 kt. wind. At a gross weight of 1,500 lb., zero wind and no flaps, the 150 will fly off in slightly over 600 ft. Landing roll at this weight is less than 400 ft.

Evaluation flight was made in Cessna's second production airplane, N5502E. Accompanying AVIATION WEEK pilot was William Stinson, regional sales manager for the company.

Airplane flown was the 150 "Commuter," which has all the instrumentation and accessories of the trainer—Narco Superhomer VHT-3 with nine crystals, microphone and cabin speaker, turn and bank, rate of climb, outside air temperature gage, dual controls, landing lights, sensitive altimeter, clock, sun visors, control lock—plus addition of direction and horizon gyros and fin-mounted rotating beacon.

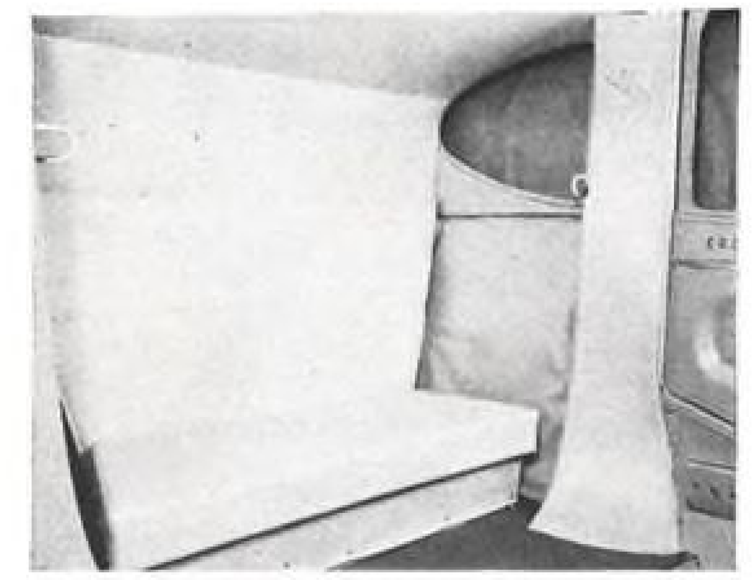
Speed fairing and prop spinner add to the 150's sleek appearance. The chrome vanadium steel gear is the same design used on the 172, 175 and 182 models. Tread width between main gears is 77 in. Nylon tubeless tires measure 5:00 by 5 for all three wheels.

To reduce vibration, the engine is bolted to engine mounts through rubber cushions, providing separation between engine and airframe. The windshield is "free blown" and designed with no center strip as an aid to visibility.

Fuel is gravity fed to the engine from two 13-gal. wing tanks, running through fuel shutoff valve and fuel strainer to the carburetor. Total usable fuel is 22.5 gal. Oil capacity is 6 qt., of which 2 qt. are considered unusable. Access door on the right side of the engine cowl allows for quick check of oil quantity.

The 150 can be entered from either side of the airplane. Windows in each door may be used for ventilation during warm-up and taxiing. Two cushioned seats with a common adjustable back seat are provided.

The seat back is adjustable to four



SPECIAL seat kit is available for installation in Model 150 baggage compartment.

positions at the bottom and three positions at the top, and pivots forward and down for access to the 80-lb. baggage compartment. A utility shelf for small articles is above the baggage area.

A small children's seat may be installed just aft of front seats in place of the baggage compartment and utility shelf. The back of the seat is hinged at the top and may be lifted up for access to airplane's battery in fuselage tailcone.

Cabin heat is provided by a manifold-type heater. Ventilation is also provided by two manually adjusted ventilators in the upper corners of the windshield.

Once settled comfortably in the cockpit (there was plenty of head and leg room), the aileron-elevator control lock was removed. Safety feature of this lock is its metal flag which covers the starter "T" handle; prevents engine starts and the possibility of takeoff with the controls locked.

Fuel valve is located on cabin floor, centered just forward of seats, and is safetied in "on" position, providing flow from both tanks simultaneously. Adjacent to the valve are the elevator trim wheel and flap handle. Safetied valve also is a deterrent against a student reaching for the flap lever and mistakenly cutting off the fuel supply.

The engine fired quickly after two prime shots and the airplane was taxied out for takeoff. Turns are no problem in the 150; the nose gear is steerable, via rudder pedals, and incorporates an air and oil shock strut and a shimmy dampener. The nose wheel steers through an arc of about 10 deg. each side of neutral, after which it becomes free-swiveling up to 30 deg. right or left of center. It is automatically centered while airplane is in flight.

For a tight turn we used a little braking action, and swiveled around in about the radius of a wing span. Brakes are manufactured by Goodyear and are hydraulically operated. Matched gears and teeth around the perimeter of the disks and the inside of the wheel castings replace keys and clips previously used to hold the disks in place.

Empty weight of the 150 is 962 lb. Useful load is 538 lb. With the two of us, plus 26 gal. of fuel (80/87 octane is specified), airplane's gross weight was about 1,470 lb. Outside air temperature at takeoff was 59F. Sea level pressure was 30.20. Wind was from the north at 5 kt. Field elevation was 1,380 ft.

No flaps were used for takeoff, and with full throttle—which was held throughout the climb—the airplane flew itself off at about 60 mph. A slight rudder pressure compensated for torque, and we used about 600 ft. of runway.

Holding 70 mph., airplane climbed out at 800 fpm. The climb angle was good at this speed, and with a bit of elevator trim—tab limit is 10 deg. up, 20 deg. down—the airplane climbed out hands-off. Once past 5,000 ft. the mixture was leaned out.

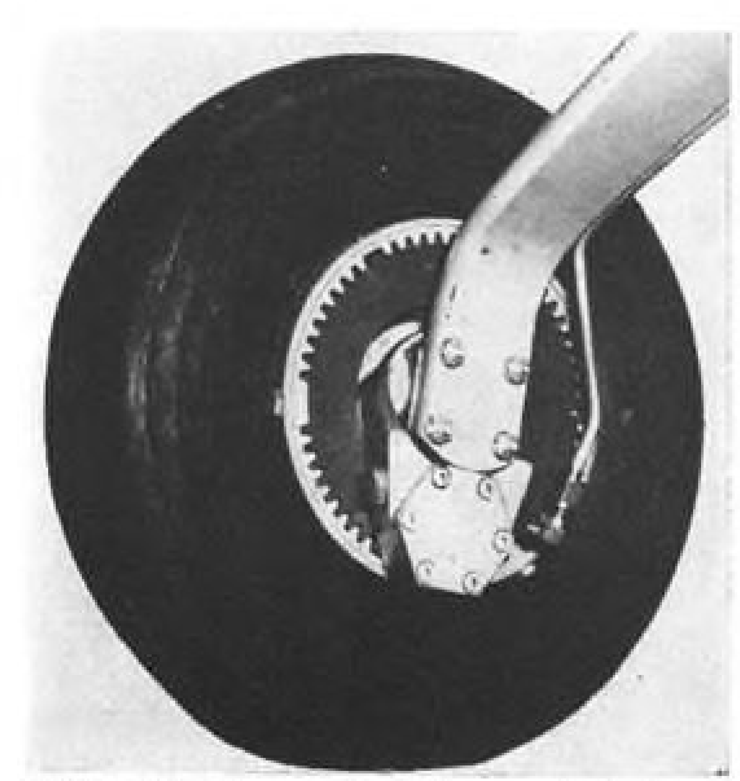
Going through 6,000 ft. the 150 indicated 66 mph. and rate of climb was 500 fpm. At 9,000 ft. the airplane was ascending at 400 fpm. Airplane was leveled off at 10,000 ft. Here, with outside air temperature 41F, pulling 2,740 rpm. (68% power), indicated air speed (IAS) was 108 mph. for true air speed (TAS) of 128 mph. Reducing power to 43%—2,200 rpm.—airplane indicated 78 mph. for TAS of 93 mph.

Descending to 7,500 ft., airplane was cruised at 2,200 rpm. (44% power), 2,500 rpm. (57% power) and 2,700 rpm. (69% power). True air speeds, at these settings, were 95 mph., 113 mph. and 127 mph., respectively.

At 5,000 ft. the same power settings again were used. True air speeds—for 2,200, 2,500 and 2,700 rpm.—were 95 mph., 115 mph. and 127 mph.

The 150 is redlined at 157 mph. and yellow-arced from 120 mph., true indicated airspeeds. Normal range begins at 54 mph. Normal operating range begins at 2,000 rpm. and runs to 2,500 rpm. at sea level, 2,650 rpm. at 5,000 ft., and 2,750 rpm. at 10,000 ft. Recommended entry speed for chandelles, lazy eights and steep turns is 106 mph.

Noise level during flight was at a minimum and there was no difficulty in



CAST aluminum wheel has newly-designed Goodyear tooth-type brake disks.

holding a normal conversation. Airplane's stability was excellent; trimmed up, it does a good job of flying itself. Large ailerons—2,575 sq. in.—are also quite effective throughout stalls. Travel is 20 deg. up, 14 deg. down.

We ran through some stalls at 5,000 ft. With power off, and 30 deg. flaps, the stall warning horn sounded about 42 mph. IAS. Buffeting occurred below 40 mph. and the rate of descent slowly dropped to 500 fpm. At 40 mph. the 150 was easily flown through varied degrees of bank.

With no flaps and power off, the warning horn sounded at 48 mph. and a docile "break" came about 45 mph. IAS. Increasing power to 1,800 rpm., the stall warning sounded at 45 mph. Airspeed dropped below the 40 mph. level (there are no indicator readings for lesser speeds) and the airplane flew along, nose high, horn blowing, with no altitude loss.

Normal landings are made power off, no flaps, or with any of the four flap settings (10, 20, 30 or 40 deg.) at pilot's option. Approach speeds run from 65-75 mph. flaps up, to 60-70 mph. flaps down, depending on weight, turbulence, wind and other conditions.

Our approaches were made at 60 mph. and we used full flaps. Forty degrees of flaps sets up a good rate of descent and the airplane will touch down for a minimum ground roll—less than 400 ft.—in the neighborhood of 40 mph. With some brake application the 150 can be dropped in and turned off in half this distance.

Electrical energy is supplied by a 12-v. direct current system powered by an engine-driven 20-amp. generator. The 12-v. storage battery serves as a standby power source, supplying current when the generator is inoperative.

The 150 is the seventh addition to Cessna's business fleet. Firm orders for the airplane total 600 from the company's distributor organization, plus another 115 being allocated for export. There were about nine aircraft off the line at the end of September; beginning in October, production is scheduled at the rate of three a day.

Inter-city Commuter, flown by Aviation Week pilot, cost $8,545; the trainer is priced at $7,940. Most economical model, the Standard, runs $6,995 and is equipped with a starter, generator, tachometer, altimeter, navigation lights, gages for oil pressure-temperature and fuel, carburetor heat, stall warning and airspeed indicators, parking brake, hydraulic toe-operated brakes on pilot's side and steerable nose wheel.

Exterior of the 150 is available in green, red and blue. Fluorescent paint is an optional item. Interiors are either red or blue; headliners and side panels are of ivory.

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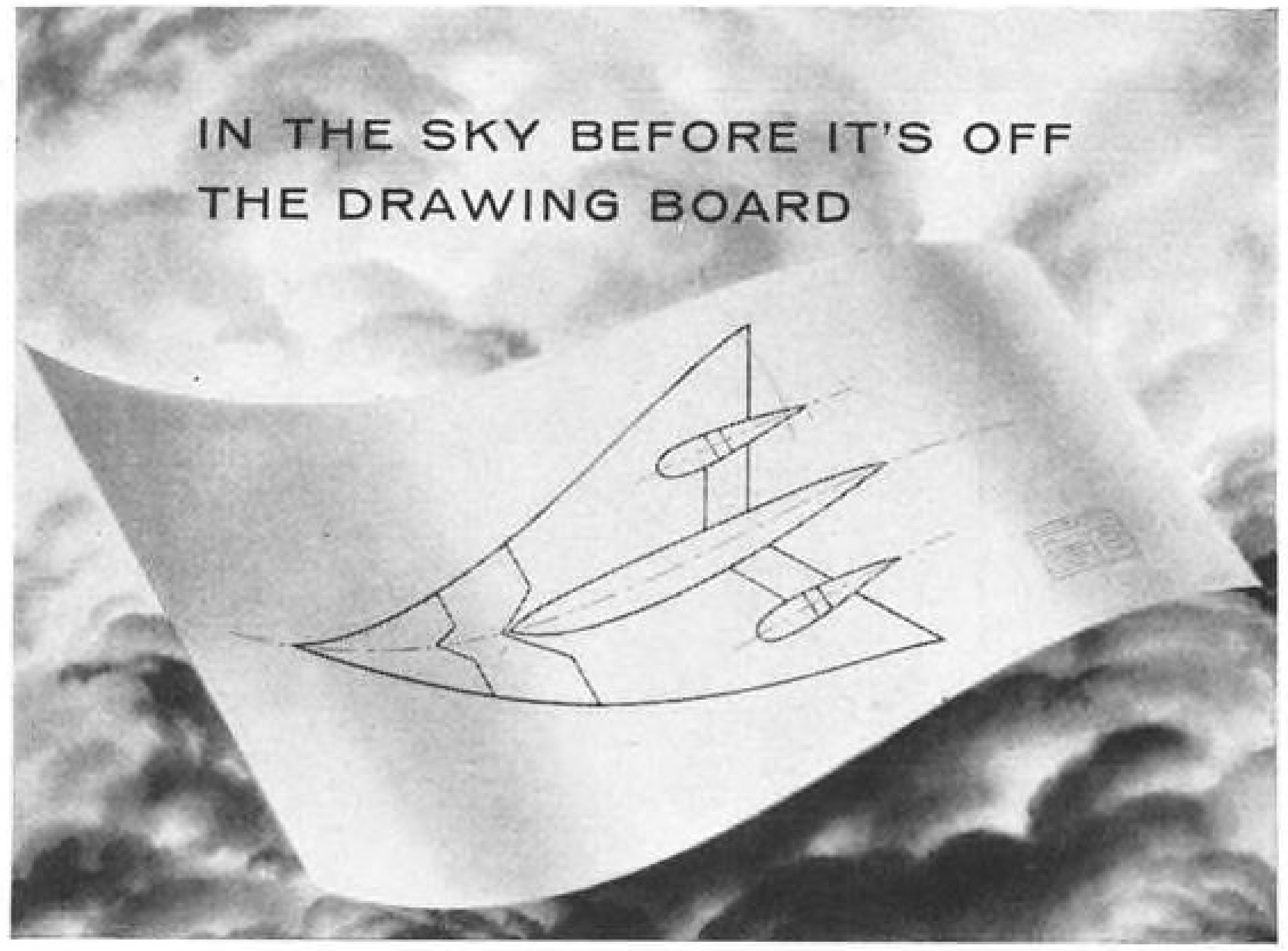

VARIABLE STABILITY AIRCRAFT

AT CORNELL AERONAUTICAL LABORATORY

The flight research hangar at C.A.L. houses a most unusual airplane. Outwardly it appears to be a standard T-33 jet. Closer examination reveals a mass of electronic gear packed solidly into an enlarged nose section and controlled by a unique console mounted at the side of the aft cockpit.

This airplane is the latest in a family of variable stability aircraft developed by C.A.L. Its handling characteristics can be changed — in flight — to simulate those of an infinite number of different aircraft. It can be dial-set to handle like a lumbering cargo carrier, or with the sharp snap of a century series fighter. It can even be set to simulate the flight characteristics of a space ship entering a planetary atmosphere. The T-33, by providing experimental evaluation of vehicles not yet built, yields significant savings in lives, time and money.

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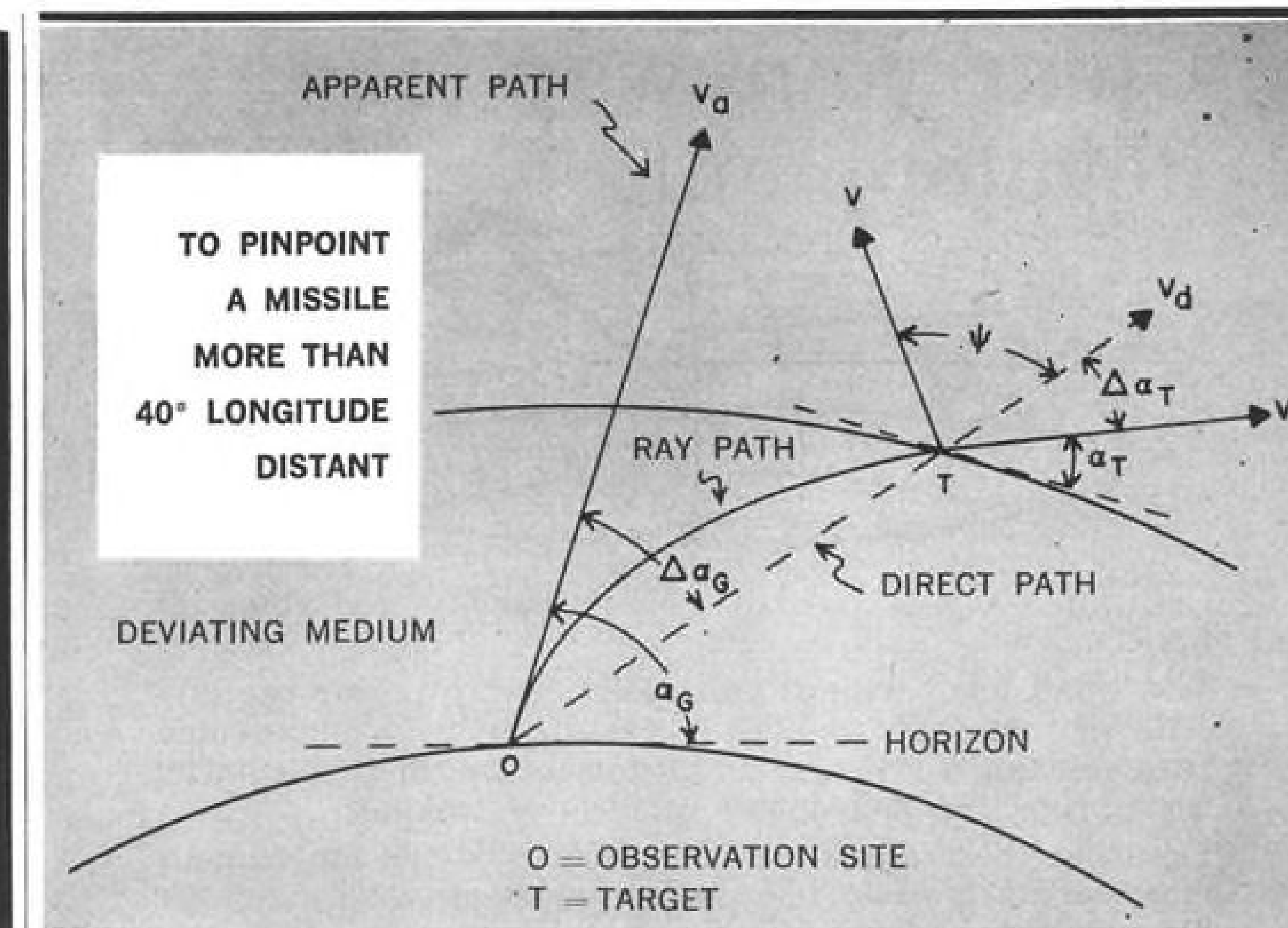

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Staff Engineer William Howard (center) reviews gearing accuracy requirements of test equipment with electronic circuit designers.

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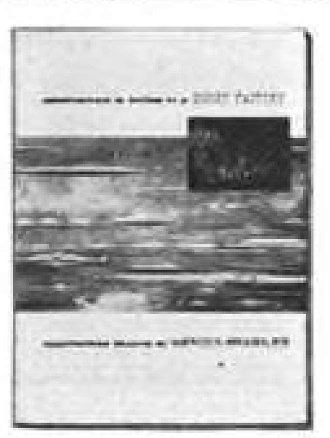

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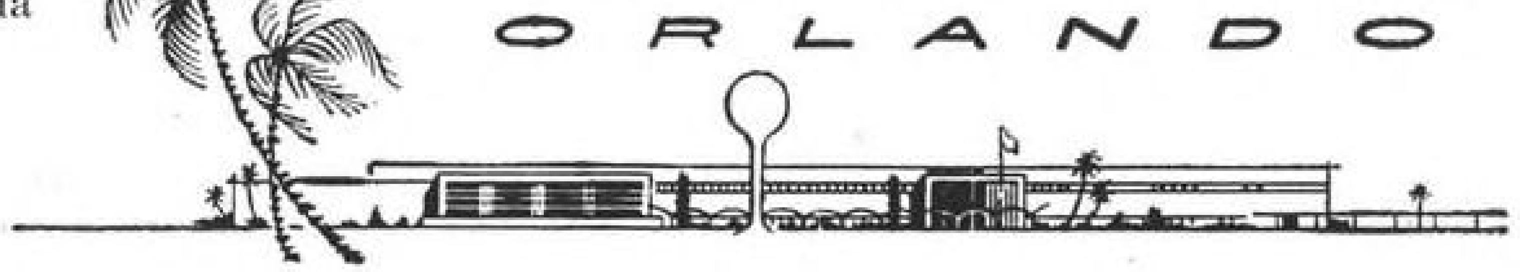

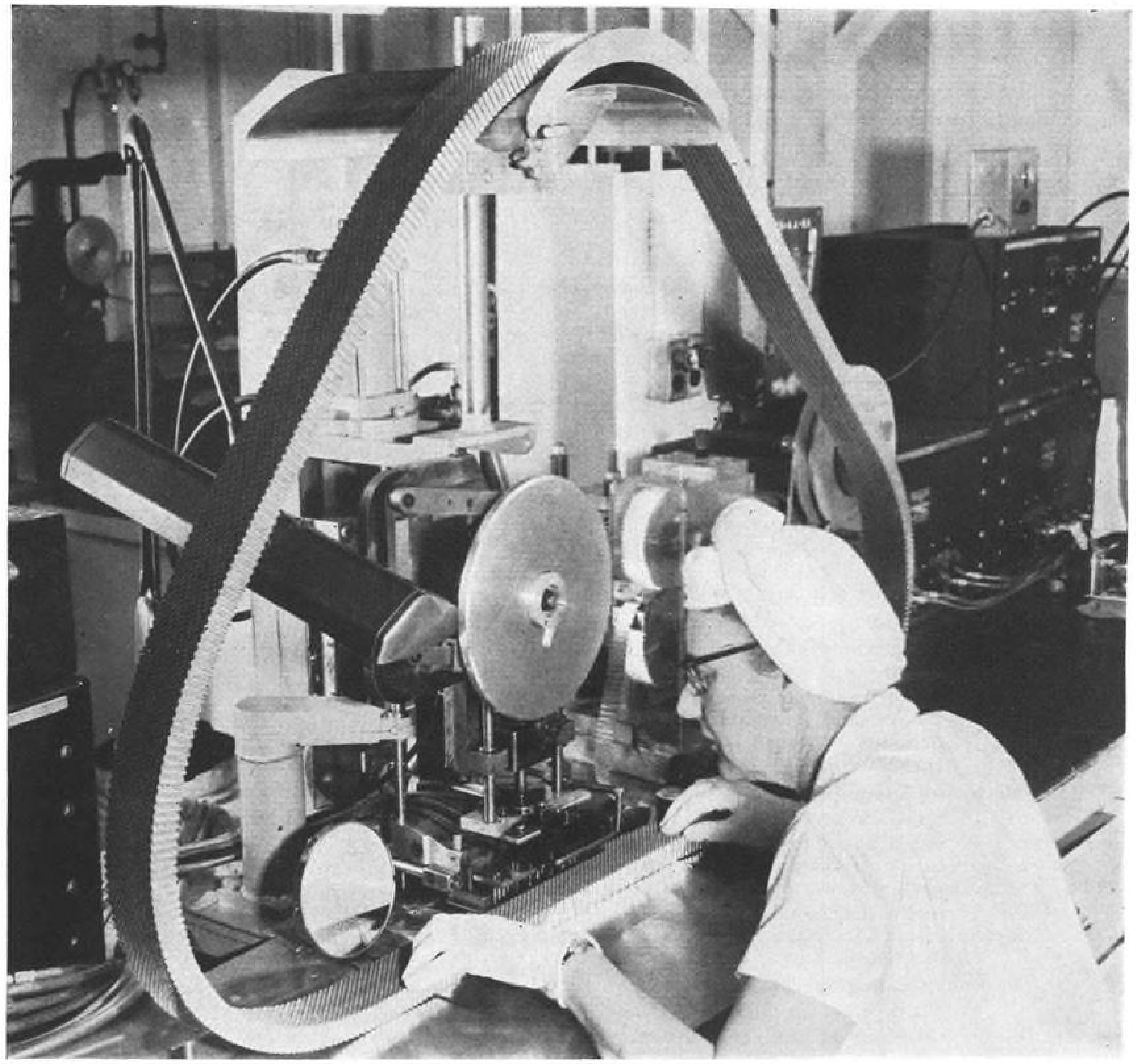

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AVIATION WEEK, OCTOBER 13, 1958

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F. J. Eberle, Business Mgr.

ADVERTISERS INDEX

LETTERS

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

VFR Flying

Only the Lieutenant, who referred to airline pilots reading "funny books" (AW Aug. 18, p. 118), knows if he meant that remark to be as sassy as the rest of his letter.

However, Clarence Hudson seems unaware in his well justified rebuttal (AW Sept. 15, p. 134) that the terms "funny books" and "funny papers" have long been used in some circles to denote the paper paraphernalia used in flight. For example, one may bear a remark in a cockpit, "Do we have all our funny books aboard?" or when a long winded traffic control clearance has just been copied a pilot might say, "Please pass the funny book, I've got to figure this one out."

Such colloquialisms double for a bad situation. Over the last 20 years the airway system has just "growed" like Topsy. Only it has become so complex that it seems that just one chart of a given area cannot begin to display the overlapping facilities. It would be so convenient for pilots to have just a single chart.

Consider how this can affect a pilot of a single seat jet on a very ordinary flight of just going from one place to another. He prepares for possible ARTC clearances by arming himself with a flight plan, a high altitude airway chart, several charts of Victor airways, several charts of low frequency airways, a departure route chart, penetration letdown charts, some ordinary aeronautical maps, paper and pencils. The cockpit is tiny. There are the usual restrictions to movement, like the parachute pack, the mask, the helmet, oxygen hose, wires, cords, belts, harness, clamps, levers, handles, switches and hot buttons.

One hand is always occupied with flying. At least 50% of the eye work must be devoted to aircraft attitude, either by looking at the instruments or, more preferably, by looking outside when possible. In a sensitive ship the eyes cannot forget this task much more than five seconds at a time.

Our boy has heard that a good pilot stays ahead of the airplane in thinking and planning. So he must consider which of the charts (each 3 ft. x 1½ ft.) he should have handy to anticipate and interpret ARTC instructions. He decides to open the high altitude chart on one knee and low frequency chart on the other. He places a pertinent Victor chart and an aeronautical map nearby on the floor for quick use.

He has made a good guess and he is cleared for a low frequency departure just as he had requested. This fits in well with the chart open on his knees and his flight plan. It's smooth climbing in this pitch dark, starless night. All is peaceful.

But now, the Center is calling and asks, "Do you have Omni?"

Regardless of what suspicions our pilot may have of what the Center may be up to, he answers, "Affirmative, Omni aboard."

Then it comes! The controller says, "You are now cleared to climb out the 313 radial of the Cow's Neck Omni, cross Pidgeon Cove Intersection at 27,000, cross Stillbrook Omni at 33,000. Report leaving 27,000 and 33,000."

Our boy repeats back the clearance in a confident voice without letting on that he doesn't know where these fine places are. However, he can correct that shortly.

All he has to do is get the flashlight and unfold the Victor airways chart with his free hand. He holds the flashlight and/or the control stick with one hand and the chart with the other. Cow's Neck is 116.3. So he tunes it in.

While he is doing this he wonders what two charts are doing up in the canopy ceiling. That's odd. So it dawns that he is upside down. He glances at the instrument panel only to find that another chart has covered it.

About this time there is a terrific shudder of the ship. Our boy has his clue on how to possibly recover without instruments and with no outside vision. But he needs both hands and he hasn't time to fish that funny paper off the instrument panel. He is making knots, he is exceeding the ship's Mach limitations, and he is probably headed straight down. He has to do something. So off comes the power and out go the dive brakes.

The dive brakes force the ship out of the drive. The G forces squash our boy into his seat. His eyesight is going, he can't hear and he can just barely feel. Trying to think with that faraway feeling he pushes on the control stick. He believes he is being forced into a loop. He passes out as he is still pushing forward.

He comes to when the seat of his pants leaves the seat and only the belt keeps him from a weightless float around the cockpit. That unconscious pushing has recovered him from the start of an inside loop, but now he is starting an outside one. So he levels off. The papers drop to the floor and there is the instrument panel right where it should be.

Our pilot gets back on course, continues his climb.

He also has a deep despect for kind Providence and its control.

Robert E. Trimble
Washington, D. C.

Cockpit Visibility

We have just finished reading "Painful Reality" (AW Sept. 15, p. 134). Mr. Hudson seems quite concerned with the restricted visibility of today's modern airliners.

Why then, do the airline companies purchase aircraft that have such restricted visibility? If the airline companies would insist on improved cockpit visibility, wouldn't the aircraft industry have to comply?

The pilot who is described in Mr. Hudson's letter as "sitting . . . with his manual and abstruse navigational charts on his lap, . . ." is an accurate description of a military jet pilot on an instrument flight plan. The description does, however, fail to mention the comfort of this pilot who must wear a crash helmet, oxygen mask, life preserver parachute, seat belt, and shoulder harness, seated in the most cramped quarters imaginable. The jet pilot's navigational facilities usually consist of one receiver (low frequency bird dog, VOR, or Tacan) and one transceiver.

Let us contrast this to the equipment that is available to the airline captain. First to be considered should be the spacious cockpit (as compared with the jet fighter) equipped with armchair type seats to which is attached only a seat belt. Next is the clothing to which no bulky objects are fastened.

Now that we have the airline captain comfortably seated in reasonably comfortable surroundings, let's see what equipment is available to him. The navigational aids will consist of at least two VOR receivers, two bird dogs, and an autopilot, not to mention marker beacon receivers, DMS, ILS, etc. To this impressive array of equipment we add a copilot who is always at hand to pour coffee, maintain flight logs, handle radio communications, set power settings (if there is no flight engineer), and even fly if need be. Add to this fact that the captain is flying a route thoroughly familiar to him and we now have Mr. Hudson's "Painful Reality."

We readily agree that the airline pilot is a highly skilled individual flying a complex machine. We think that this applies also to the military pilot. If the military pilot is capable of "Swivel Necking", the airline pilot with all his advantages must be capable of the same.

Mr. Hudson went on to say, "Transparently, the Lieutenant offers—exactly nothing!"

What the Lieutenant offers, Mr. Hudson, is the only reliable method of avoiding midair collisions. Until a more reliable system is available, let us all use "Swivel Necking."

Lt. Alvin F. Ribbeck, Jr. USMCR
Lt. Robert A. Poncin, USMCR
Marine Attack Squadron 217
Marine Air Reserve Training Detachment
U. S. Naval Air Station
South Weymouth, Mass.

Specified Altitudes

Being a faithful follower of your magazine and a careful fan of your "Letters" each week, I would like to add this little word on IFR/VFR. I believe that a great deal more emphasis should be placed on the new Civil Air Regulations 60.32 and 60.44, which were placed into effect on Aug. 15, 1958.

If all VFR traffic will adhere to the altitudes as specified in these regulations (and incidentally it would be a good idea to make everyone, by every means available, fully aware of these regulations), a great step towards just a little safer flight will have been made.

Louis F. Leon
Chenango Bridge, N. Y.