Aviation Week & Space Technology

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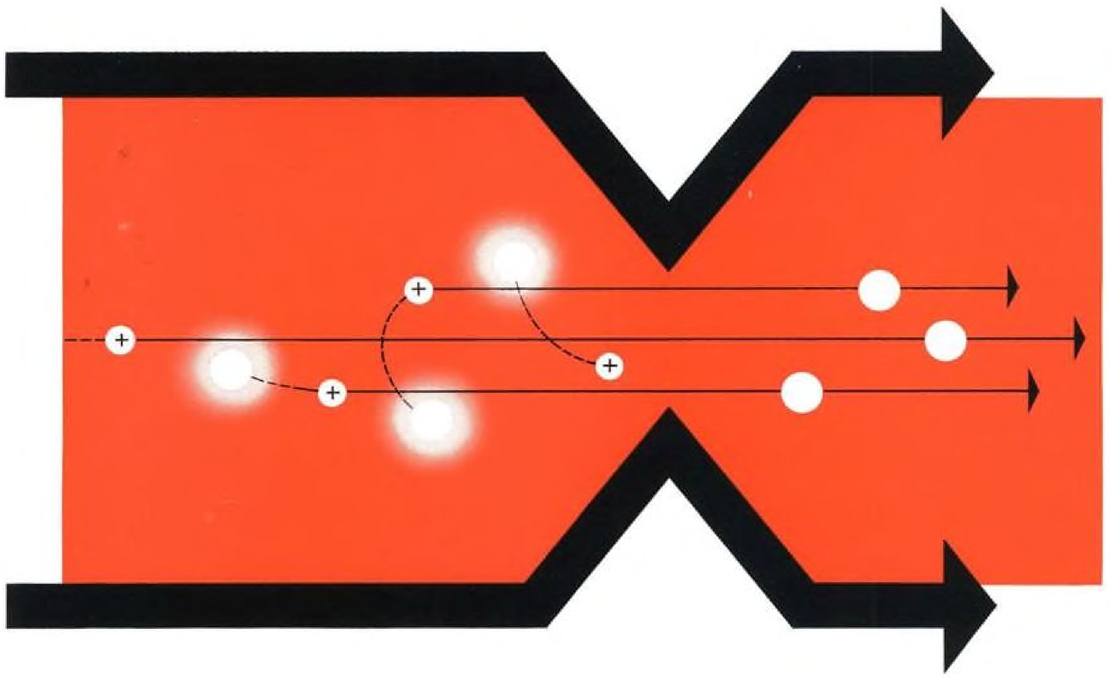
A McGraw-Hill Publication

December 23, 1963

SPECIAL REPORT:

Douglas S-4B Upper Stage For Saturn

USAF/Northrop F-5A Fighter



PHYSICS: ADVANCING THE STATE OF THE ART

AGN'S Research Division is conducting experimental and theoretical investigations in the fields of plasma physics and electric propulsion; explosive-electric energy conversion; and nuclear and solid state physics.

Objectives: reduction by charge exchange of energy used for ionization in accelerators ▪ verification, through advanced research, of approaches to controlled thermonuclear reactions ▪ achievement of high mass utilization and current densities by means of an energetic arc for plasma propulsion ▪ efficient production of electric power by converting the energy of high explosives ▪ creation of multi-million gauss magnetic fields ▪ improvement of satellite reliability by determining effects of extraterrestrial nuclear radiation.

For information on AGN'S research in plasma physics, write for AGN Active File No. 5.

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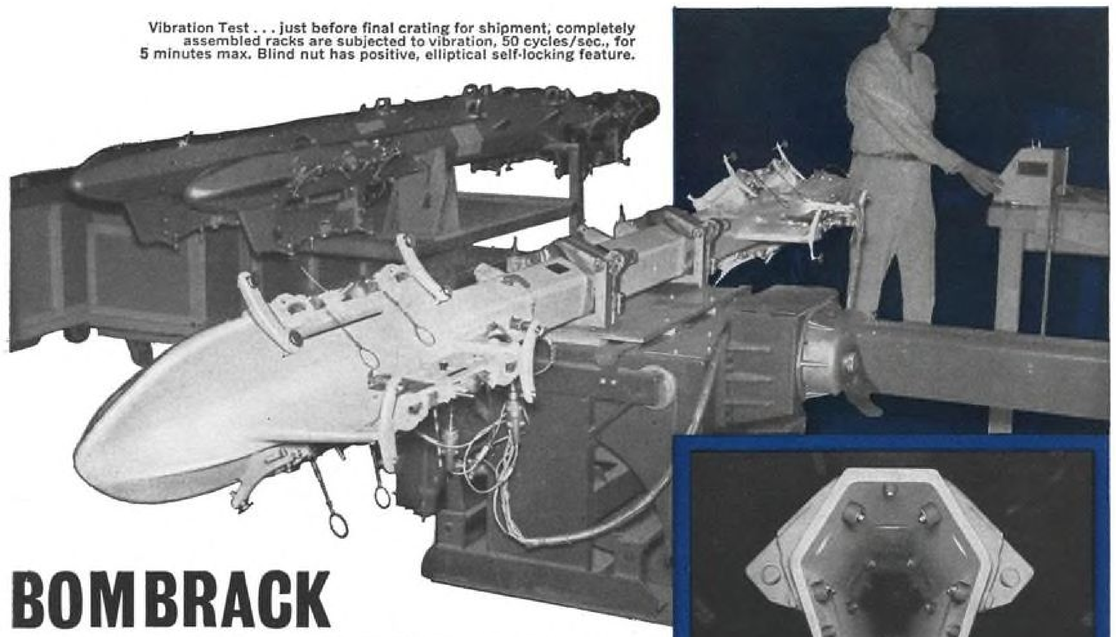
GENERAL TIRE T.M.

Vibration Test . . . just before final crating for shipment, completely assembled racks are subjected to vibration, 50 cycles/sec., for 5 minutes max. Blind nut has positive, elliptical self-locking feature.



BOMBRACK ASSEMBLY *SIMPLIFIED* WITH Blind Nuts™

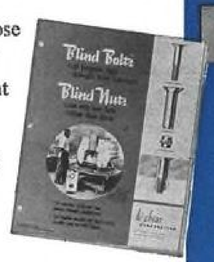
To provide for carriage and release of a wide variety of bombs and other external stores on its U. S. Navy A-4E Skyhawk, armament engineers at Douglas Aircraft Company, Inc., Aircraft Division, came up with an unusual cartridge-ejection, multiple bombrack system. Structurally it is comprised of a long carriage-beam which is suspended from a standard bombrack pylon under the aircraft wing and six individual bombracks that attach directly to the carriage-beam. The success of this rack system on the A-4E is recognized by its adoption by other Navy and Air Force fighter aircraft.

Several unusual blind fastening conditions were created by the hexagonal shaped carriage-beam . . . one was the lack of accessibility to install gang channels and nutplates into the interior of its 10-ft. length. Another was the need for a simple fastening method suitable to volume production.

Because of their simplicity of hole preparation and their ease of installation and replaceability, Blind Nuts were selected to provide the thread engagement in the beam for the bolting on of a variety of rack hardware.

Blind Nuts and Blind Bolts have proven their all-purpose usefulness numerous times in factory production jobs, military or airline repair, and modification work . . . wherever restricted structure or congested areas present fastener assembly problems. Installation time is measured in minutes rather than hours.

For complete information on Blind Nuts and Blind Bolts, test data and installation tooling, write for our 24-page brochure.



End view of Carriage-Beam . . . made from an 7075-T6 aluminum alloy extrusion. Some 54 stainless steel Blind Nuts in 5/16 and 3/8-24 UNF-3B sizes are used in each beam assembly. Other Blind Nuts are used in rack attach fittings.

Installing Blind Nuts in beam . . . hand-held, hydraulically actuated Gun is used. Standard drills are used to prepare the hole. Close tolerance holes are not required since the sleeve portion of the Blind Nut automatically expands during installation to tightly fill the hole.

BLIND NUT BLIND BOLT

Blind Nuts and Blind Bolts match NAS nutplates and bolts for practical comparison of strength purposes and are capable of repeated usage. Blind Nuts and Blind Bolts are less grip sensitive than similar fasteners . . . especially important in blind applications.

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AEROSPACE CALENDAR

Dec. 30—Annual Meeting, American Assn. for the Advancement of Science, Cleveland, Ohio.

Jan. 7-9—Tenth National Symposium on Reliability and Quality Control, Statler Hilton Hotel, Washington, D. C.

Jan. 9-10—Workshop Conference on "Long Range Goals of Biology in Space," University of Rochester, Rochester, N. Y.

Jan. 13-17—Society of Automotive Engineers Automotive Engineering Congress & Exposition, Cobo Hall, Detroit, Mich.

Jan. 19-23—16th Annual Convention, Helicopter Assn. of America, San Marcos Inn, Chandler, Ariz.

Jan. 20-22—Aerospace Sciences Meeting, American Institute of Aeronautics and Astronautics, Hotel Astor, New York.

Jan. 21-24—Second International Arms Control and Disarmament Symposium, Ann Arbor, Mich. Sponsors: University of Michigan; The Bendix Corp.

Jan. 25—Seventh Annual Inland Empire Quality Control Conference, American Society for Quality Control, California State Polytechnic College, Pomona, Calif.

Jan. 27-28—Second Annual Symposium on Fundamental Phenomena in the Material Sciences, Sheraton Plaza Hotel, Boston, Mass. Sponsor: Ilikon Corp.

Jan. 27-29—Conference on Control and System Optimization, Monterey, Calif. Sponsors: Society for Industry & Applied Mathematics; American Institute of Aeronautics and Astronautics; Institute for

(Continued on page 7)

AVIATION WEEK & Space Technology

December 23, 1963

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AEROSPACE CALENDAR

(*Continued from page 5*)

Mathematical Statistics; U. S. Naval Post Graduate School.

Jan. 27-30—20th Annual Technical Conference, Society of Plastics Engineers, Chalfonte-Haddon Hall Hotels, Atlantic City.

Jan. 27-30—Applications Forum on Antenna Research, University of Illinois' Midwest Electronics Research Center, Urbana, Ill.

Jan. 29-31—44th Annual Meeting, American Meteorological Society, University of California, Los Angeles, Calif.

Jan. 29-31—Solid Propellant Rocket Conference, American Institute of Aeronautics and Astronautics, Palo Alto, Calif.

Feb. 3-7—Fifth Annual Lectures in Aerospace Medicine, USAF School of Aerospace Medicine, Brooks AFB, Tex.

Feb. 3-7—International Conference on Materials "The Impact of Modern Physics on Materials," Sheraton Hotel, Philadelphia, Pa. Sponsor: American Society for Testing and Materials.

Feb. 5-7—Fifth Winter Convention on Military Electronics, Institute of Electrical and Electronics Engineers, Ambassador Hotel, Los Angeles, Calif.

Feb. 13-15—Golden Gate Metals Conference, American Society for Metals, Fairmont Hotel, San Francisco, Calif.

Feb. 19-21—International Solid-State Circuits Conference, Institute of Electrical and Electronics Engineers, Sheraton Hotel and University of Pennsylvania, Philadelphia, Pa.

Mar. 2-6—Fifth Conference on Applied Meteorology (Atmospheric Problems of Aerospace Vehicles), Atlantic City, N. J. Sponsors: American Meteorological Society; Federal Aviation Agency.

Mar. 4-6—Symposium on Thermal Radiation of Solids, San Francisco, Calif. Sponsors: National Bureau of Standards; National Aeronautics and Space Administration; USAF Aeronautical Systems Div.; University of California at Berkeley.

Mar. 9-10—Aerodynamic Testing Conference, Marriott Twin Bridges Motor Hotel, Washington, D.C. Sponsors: American Institute of Aeronautics and Astronautics; U. S. Navy.

Mar. 23-26—International Convention, Institute of Electrical and Electronics Engineers, Coliseum and New York Hilton, New York, N. Y.

Mar. 25-27—Aerospace Bearing Conference (unclassified), Granada Hotel, San Antonio, Tex. Sponsors: USAF; Southwest Research Institute.

Apr. 1-2—Fifth Symposium on Engineering Aspects of Magnetohydrodynamics, Institute of Electrical and Electronics Engineers, Massachusetts Institute of Technology, Cambridge, Mass.

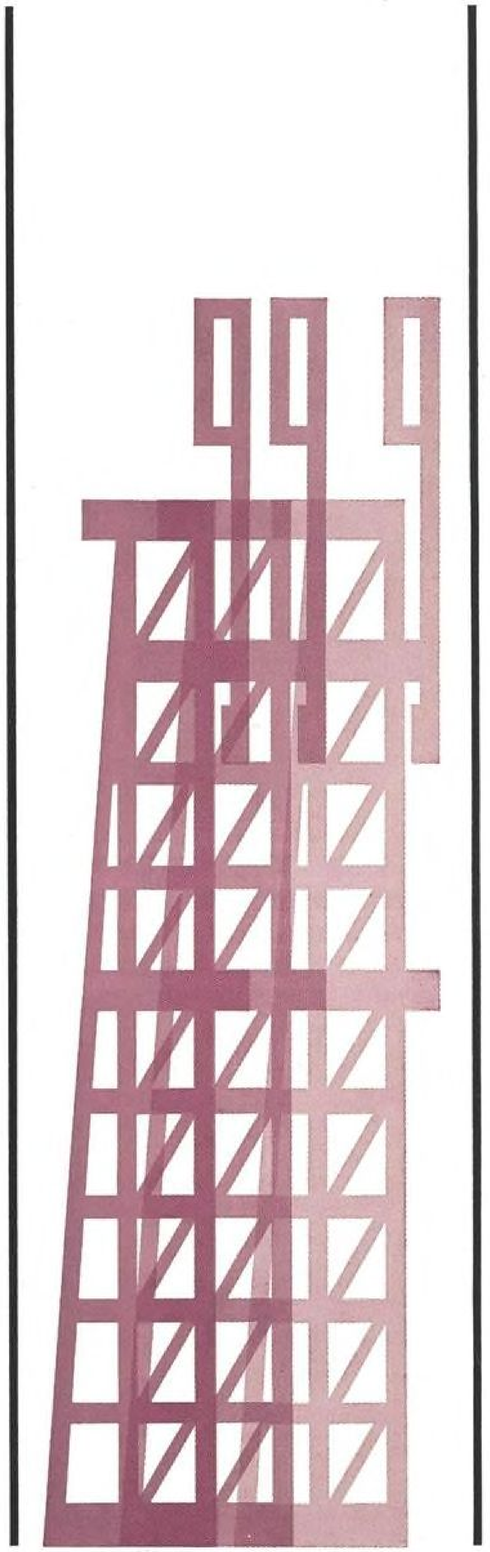
Apr. 1-3—Fifth Annual Structures and Materials Conference, American Institute of Aeronautics and Astronautics, Riviera Hotel, Palm Springs, Calif.

Apr. 6-8—International Conference on Nonlinear Magnetics (Intermag), Institute of Electrical and Electronics Engineers, Shoreham Hotel, Washington, D.C.

Apr. 7-9—Symposium on Parachute Technology and Evaluation, U. S. Naval Air Facility, El Centro, Calif.

Apr. 13-16—Third International Flight Test

(*Continued on page 9*)



AEROSPACE CALENDAR

(*Continued from page 7*)

Instrumentation Symposium, College of Aeronautics, Cranfield, England.

Apr. 19-25—International Conference & Exhibit on Aerospace Electro-Technology, Institute of Electrical and Electronics Engineers, Westward-Ho Hotel, Phoenix, Ariz.

Apr. 20-22—First Canaveral Space Congress, Ramada Inn, Cocoa Beach, Fla. Sponsor: Canaveral Council of Technical Societies.

Apr. 21-23—Spring Joint Computer Conference, American Federation of Information Processing Societies, Sheraton-Park Hotel, Washington, D. C.

Apr. 22-24—Southwestern Conference & Electronic Show, Institute of Electrical and Electronics Engineers, Dallas Memorial Auditorium, Dallas, Tex.

Apr. 24-May 3—1964 German Air Show, Hanover, West Germany.

Apr. 27-30—Air Transport and Space Meeting and Production Forum, Commodore Hotel, New York, N.Y. Sponsors: Society of Automotive Engineers; American Society of Mechanical Engineers.

Apr. 29-May 2—National Aeronautics and Space Administration's Annual Conference on the Peaceful Uses of Space, Boston, Mass.

May 4-6—10th National Aerospace Instrumentation Symposium, Instrument Society of America, Biltmore Hotel, New York, N. Y.

May 4-6—Aerospace Propulsion Meeting, American Institute of Aeronautics and Astronautics, Cleveland, Ohio.

May 4-7—American Astronautical Society's 10th Annual Meeting, "Technical Progress on Lunar Flight Programs," New York Hilton Hotel, New York, N. Y.

May 5-6—Fifth National Symposium on Human Factors in Electronics, Institute of Electrical and Electronics Engineers, San Diego, Calif.

May 7-10—International Air Fair, Biggin Hill, Kent, England.

May 11-13—16th Annual National Aerospace Electronics Conference (NAECON), Institute of Electrical and Electronics Engineers, Biltmore Hotel, Dayton, Ohio.

May 11-14—35th Annual Scientific Meeting, Aerospace Medical Assn., Americana Hotel, Miami Beach, Fla.

May 13-15—20th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D. C.

May 18-21—23rd Annual National Conference, Society of Aeronautical Weight Engineers, Sheraton-Dallas Hotel, Dallas.

May 19-21—International Symposium on Microwave Theory and Techniques, Institute of Electrical and Electronics Engineers, Idlewild Airport, N. Y.

May 25-27—General Aviation Design & Operations Meeting, American Institute of Aeronautics and Astronautics, Wichita.

May 25-29—26th Annual Meeting and News Conference, Aviation/Space Writers Assn., Americana Hotel of Bal-Harbour, Miami Beach, Fla.

May 26-28—Second International Forum for Air Cargo, Sheraton-Mt. Royal Hotel, Montreal, Canada. Sponsors: Society of Automotive Engineers; American Institute of Aeronautics and Astronautics; Canadian Aeronautics & Space Institute.

May 31-June 7—International Air Show & International Airport Equipment Exhibition, Caselle Airport, Turin, Italy.

June 2-4—National Telemetering Conference, American Institute of Aeronautics and Astronautics/Institute of Electrical and Electronics Engineers/Instrument Society of America, Biltmore Hotel, Los Angeles, Calif.

June 2-4—National Symposium on Global Communication (GLOBECOM VI), Institute of Electrical and Electronics Engineers, University of Pennsylvania and Sheraton Hotel, Philadelphia, Pa.

June 16-18—43rd Meeting, Aviation Distributors and Manufacturers Assn., Grove Park Inn, Asheville, N. C.

June 23-25—International Conference on Precision Electromagnetic Measurements, Boulder, Colo. Sponsors: National Bureau of Standards; Institute of Electrical and Electronics Engineers; International Scientific Radio Union.

June 29-July 1—Aerospace Reliability and Maintainability Meeting, Statler Hilton Hotel, Washington, D.C. Sponsors: Society of Automotive Engineers; American Society of Mechanical Engineers; American Institute of Aeronautics and Astronautics.

June 29-July 2—First Annual Meeting & Technical Display, American Institute of Aeronautics and Astronautics, Sheraton Park Hotel, Washington, D.C.

Aug. 10-12—Transport Aircraft Design & Operations Meeting, American Institute of Aeronautics and Astronautics, Seattle, Wash.

Aug. 24-26—Astrodynamics Guidance & Control Conference, American Institute of Aeronautics and Astronautics, University of California, Los Angeles, Calif.

Aug. 24-28—Fourth Congress, International Council of the Aeronautical Sciences, Paris, France.

Aug. 25-28—Western Electronic Show and Convention (Wescon) and Institute of Electrical and Electronics Engineers' Summer General Meeting, Los Angeles Sports Arena and Hollywood Park and Biltmore Hotel, Los Angeles, Calif.

Aug. 31-Sept. 2—Electric Propulsion Conference, American Institute of Aeronautics and Astronautics, Bellevue Stratford Hotel, Philadelphia, Pa.

Sept. 1-4—Third Biennial Aerospace Power Systems Conference, American Institute of Aeronautics and Astronautics, Bellevue Stratford Hotel, Philadelphia, Pa.

Sept. 7-13—1964 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

Sept. 7-13—15th International Astronautical Congress, Warsaw, Poland.

Sept. 9-10—1964 Airwork Symposium, Airwork Corp., Millville, N. J.

Sept. 9-13—18th Annual National Convention & Aerospace Panorama, Air Force Assn., Washington, D. C.

Sept. 14-16—Eighth National Convention on Military Electronics (Milecon), Institute of Electrical and Electronics Engineers, Washington-Hilton Hotel, Washington, D. C.

Oct. 5-9—Aeronautic and Space Engineering and Manufacturing Meeting, Society of Automotive Engineers, Ambassador Hotel, Los Angeles, Calif.

PROBLEMATICAL RECREATIONS 202

Find digits A and B if $A^3 + B^3$ is divisible by the number $10A+B$ and $A^4 + B^4$ is divisible by the number $10B+A$.

—Contributed

We at Litton Industries extend a concise wish to all our Recreationers for an elegant holiday season. Proof of your interest in our series has been shown in the numerous jolly letters we've received during the year. We thank you one and all. Please plan to be with us in 1964. The puzzles just may get better.

ANSWER TO LAST WEEK'S PROBLEM: The parents are 85 and 84; the son and daughter-in-law are 21 and 20.

Namesake of the Army's new jet

Transition accomplished. The breakthrough has been made. In November, the Hummingbird completed a series of tests in the transition mode. It took off vertically, hovered, and then transitioned into full forward jet flight. The dramatic demonstration proves that this twin jet airplane, with the Lockheed jet ejector system, can achieve a vertical lift-off and landing.

Like its namesake, the Army's XV-4A Hummingbird will fly straight up, down, forward, backward or sideways with ease. And after it made the transition from vertical to horizontal, an operational version would fly "on the deck" at more than 500 knots or climb at more than 18,000 feet per minute.

The Hummingbird works on the principle of thrust augmentation, converting engine thrust under 6,000 pounds to over 8,000 pounds of vertical thrust, using only outside air through its jet ejector system to effect this increase.

Now that the transition breakthrough has been made, this unique research aircraft will enter an Army flight test program—the first ever conducted by the U.S. military in the VTOL augmented jet field.

The XV-4A is being developed for the Army by Lockheed-Georgia, and is now undergoing flight test at the Georgia plant.

Lockheed Hummingbird

LOCKHEED-GEORGIA COMPANY
Marietta, Georgia, A Division of Lockheed Aircraft Corporation

Anatomy of a separation system

Unidynamics has achieved extreme reliability with its linear explosive destaging techniques. The basic concept involves pencil-thin charges which run, like veins, beneath a missile's skin—outlining the area of separation.

Currently, Unidynamics is building the stage separation and skirt removal system for the MINUTEMAN ICBM. It is the first to separate stages and also remove the missile's interstage structure. Other reliable explosive assemblies are serving the AEC, NASA and the US Navy.

Unidynamics offers unparalled experience in the use of chemical power for separation. A wide range of components has been developed . . . safety and arming devices, detonators, delay boosters, gas generators, explosive valves and switches. Each offers utmost reliability.

Thus, total systems can be developed and built to individual specifications . . . systems that will perform not only one function, but a series of interdependent operations. Information is available on Unidynamics' experience and capabilities. Write Dept. AW-4 for our brochure.

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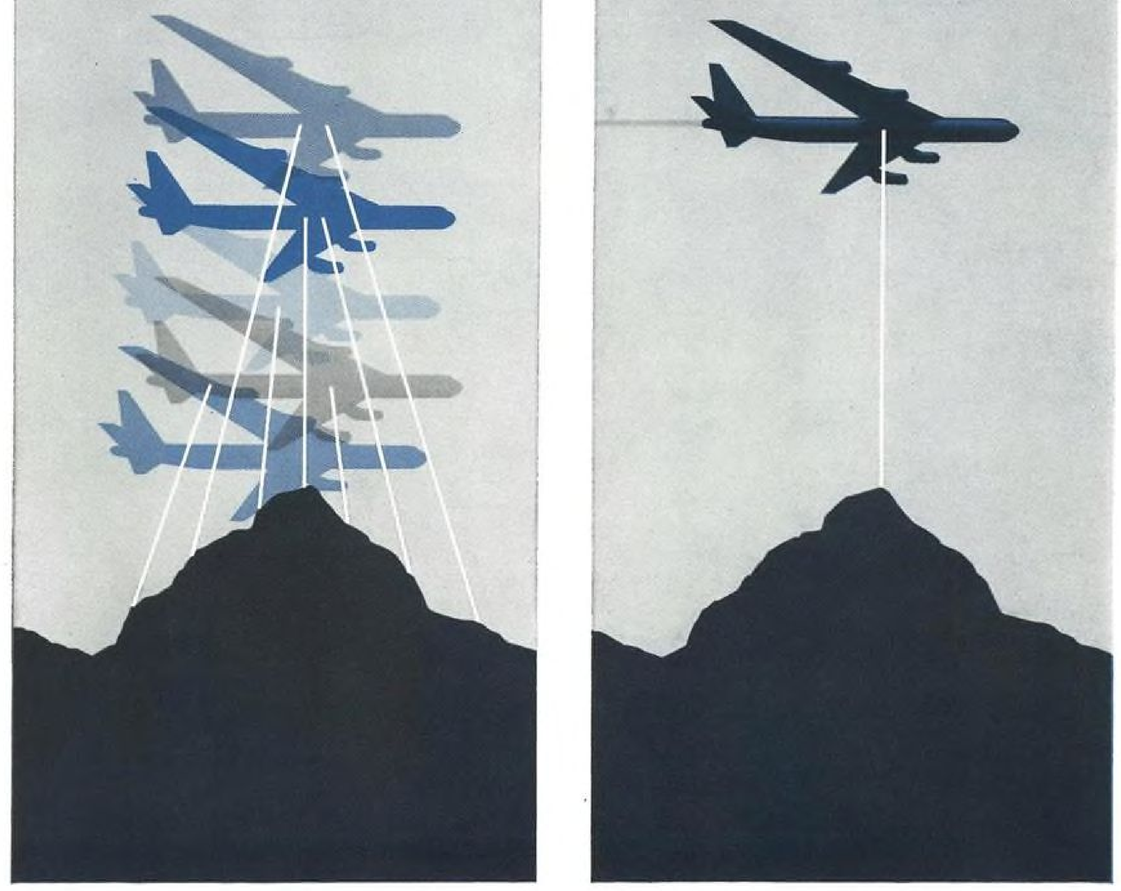
WHICH RADAR ALTIMETER
MEASURES **ABSOLUTE** ALTITUDE?



THE BENDIX-PACIFIC PULSE ALTIMETER

The Bendix-Pacific Altimeter measures absolute altitude over all types of terrain from 0 to 5000 feet. Unlike non-pulse systems which integrate return signals and thus give average altitude readings, the Bendix APN-141 Altimeter provides the pilot with positive measurements to the nearest obstacle below, with a guaranteed accuracy of ± 5% or 5 feet, whichever is greater.

Where positive altitude information is mandatory, such as for high speed, low altitude missions, consider the Bendix Altimeter—the only system selected by the military for a recent supersonic tree-top-level exercise.

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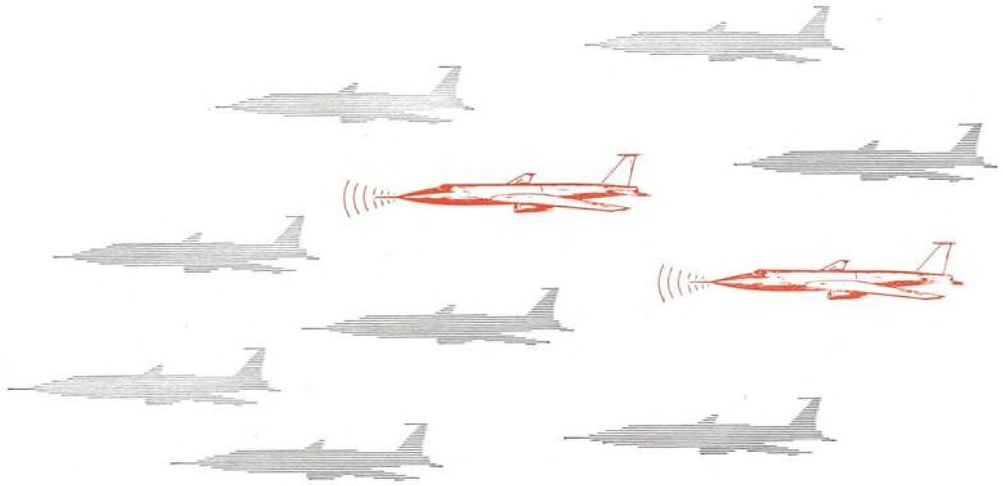

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CONTENTS

COVER: USAF/Northrop F-5A military assistance program fighter, carrying external stores for an extended combat radius bombing mission, is shown landing at Edwards AFB, Calif. External stores are 150-gal. fuel tank on the centerline pylon, 150-gal. tanks on the two inboard wing pylons and 750-lb. bombs on the outboard wing pylons. Note 50-gal., area-rule fuel tanks on the wing tips. External stores station can carry a variety of weapons (AW Sept. 2, p. 27). F-5A has General Electric J85-13 afterburner-equipped turbojets.

PICTURE CREDITS

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EDITORIAL

Man's Newest Challenge

The manned orbiting space laboratory is the most important military program initiated in the Pentagon in the last three years and it should be managed accordingly. Its importance lies in obtaining hard factual data on what man can or cannot do in operationally useful space vehicles. We believe that the data it provides will be the technical foundation for an entire new generation of operational space stations for both military and civil uses. We believe this because we are confident that, given such a chance, man will prove his usefulness in space as completely as he has proved his capability in the air.

Man has already proved he can survive extended periods of space flight in the voyages of Mercury and Vostok capsules. He also proved he can function within the restraints imposed by dimensions of his early spacecraft. By providing a "shirt-sleeve" environment with capabilities up to a month in orbit, the manned orbiting space laboratory will offer an opportunity to find out just how far man's functioning can be extended and to what degree it can be refined to perform valuable military tasks.

It is obvious that the success of unmanned orbital reconnaissance satellites has whetted the military appetite for a major extension of this capability by adding men to the systems loop.

USAF Pioneers

The fruitful possibilities offered by this type of reconnaissance capability are now so obvious that even Defense Secretary Robert S. McNamara has dropped his sarcastic opposition to manned military space exploration, and is now at least willing to substitute factual inquiry for theoretical debate. He should be grateful to a small band of Air Force space pioneers who have been fighting with great technical skill and dogged courage for many years to forge the foundations on which military spacepower can now be built. They endured the scientific sneers of their civilian superiors and at times were almost asphyxiated by cigar smoke, but they persisted. Before the decade is finished, we believe they will have been proved to be far more perceptive in their prophesies on military space roles than their critics.

The manned orbiting space laboratory faces the standard pitfalls of any development cycle. But, with the example of how those pitfalls broke the back of Dyna-Soar so fresh and poignant, there is an excellent chance that the orbiting laboratory may skirt them successfully. To be truly successful, the manned orbiting laboratory must proceed to the flight stage as quickly as possible so that it can begin to yield useful results before the budget-pruners can swing their axes. There is a time scale that can be plotted against funding and technical progress to show that whenever a new development program reaches a certain span without achieving technical maturity, it begins to suffer budgetary starvation. The graveyard of developments that might have been is full of the bleaching bones of projects skeletonized in this manner—nuclear-powered aircraft, the Navaho missile, Dyna-Soar and soon the B-70.

The manned orbiting laboratory can avoid this fate only through program management strong enough to push for maximum progress and skillful enough to achieve tight cost control without slowing the technical pace.

Many of the subsystems required for the manned orbital laboratory are already under development, such as the Titan 3 booster and the Gemini ferry vehicle. The most important new development required is the system capable of providing the proper environment for operational periods up to a month.

Existing Equipment

Basic structure of the laboratory can probably be found among the several types of "cans" already being developed as stages of various other space vehicles. Most of the mission-type equipment for the laboratory can also be adapted quickly from the photographic, electronic and other reconnaissance systems now functioning so well in unmanned satellites.

What will be needed is integration of these systems into a loop that will permit man to exercise his unsurpassed capability for discrimination and judgment on the functioning of these systems and utilize their results for military purposes.

There is also an urgent competitive requirement to speed the manned orbiting laboratory program. The Soviet Union entered a new phase of its manned space flight program with its double Vostok flights aimed at perfecting rendezvous and docking techniques. The official Red Army newspaper Red Star noted recently that all of the veteran cosmonauts are now in a special period of intensive training for new types of space flights (see p. 39). Whether these will be more of the rendezvous maneuvers or the orbiting of several people in a larger spacecraft remains to be seen. But it is certain that despite various fluctuations in Western analysis of the Soviet program, it is proceeding consistently to extend man's capabilities in space to the maximum military utility.

The Air Force has been given a golden opportunity—perhaps its only chance—to show what man can do in space for military missions. It behooves them to devote their best talents and energy to making this one of the most successful technical development programs in history, similar to the supersonic "X series" research aircraft, the ICBM program and Project Mercury. For on its unqualified success depends the future of military man in space.

—Robert Hotz

WHO'S WHERE

In the Front Office

Burt F. Raynes, president and general manager, Rohr Corp., Chula Vista, Calif., succeeding **Fred H. Rohr,** who continues as board chairman and chief executive officer. Also: **F. E. McCreery,** senior vice president; **S. W. Shepard,** vice president (secretary and general counsel); **Fred H. Rohr, Jr.,** vice president; **K. W. Goebel,** vice president-engineering; **J. L. Hobel,** vice president-industrial relations; **C. E. Cantwell,** vice president and plant manager-Riverside Plant.

Benjamin Adler, vice president, Litton Industries; Mr. Adler is president of Adler Electronics, New Rochelle, N. Y., a part of Litton's Systems Group.

M. R. Fallon, vice president-marketing, Astronics Div., Lear Siegler, Inc., Santa Monica, Calif.

Frederic C. Weyburne, vice president and group executive, The Bendix Corp., Detroit, Mich., and **Charles Hummel,** a vice president. Mr. Hummel continues as Bendix comptroller.

D. Scott Bowman, vice president-marketing, FXR, the RF Products and Microwave Div. of Amphenol-Borg Electronics Corp., Danbury, Conn.

Harry S. White, president, Pacific Air Lines, succeeding the late **T. R. Mitchell.**

Dr. Launor F. Carter, a senior vice president, System Development Corp., Santa Monica, Calif.

Joseph Elmo, vice president-manufacturing, Avionic Div., John Oster Manufacturing Co., Racine, Wis.

Changes

Rolls-Royce, Ltd., has announced the following appointments in the Engineering Organization of the Aero Engine Div.: **L. G. Dawson,** chief engineer (projects); **T. L. Metcalfe,** chief engineer (military engines). **S. L. Bragg,** the company's chief scientist, now also responsible for research within the Aero Engine Div.

Ray E. Aarestad, director, Test Dept., Martin Co.'s Denver (Colo.) Div.

George D. Prestwich, manager, General Electric Co.'s Aerospace and Defense Marketing Operation, Defense Programs Operation, Washington, D. C.

Dr. William L. Parker, program director-integrated helicopter avionics system (IHAS) study and system definition program, Nortronics Div., Northrop Corp., Palos Verdes, Calif.

Nicholas Ovuka, Washington (D. C.) Manager-NERVA (nuclear engine for rocket vehicle application) and SNAP-8 (systems for nuclear auxiliary power) programs for Aerojet-General Corp.

Dr. Vincent J. Berinati, assistant general manager, Advanced Planning Div., San Bernardino (Calif.) Operations of Aerospace Corp.

Dr. Joseph Sternberg, manager of research and development, Martin Co.'s Baltimore (Md.) Div.

Adalbert N. Knopp, advisory engineer, Trinistor Design and Development Section, Westinghouse Semiconductor Div., Pittsburgh, Pa.

INDUSTRY OBSERVER

►Alternative configurations for the mobile medium-range ballistic missile (MMRBM) have been proposed by USAF's Ballistic Systems Div. to meet Department of Defense Research & Engineering's demand that system requirements be re-evaluated to reduce cost and development risks (AW Dec. 9, p. 23). Phase 2 funding for MMRBM (Program 325-A) development may be withheld until agreement is reached on requirements.

►**Several rocket propellant manufacturers are working on new, high-energy oxidizers with greater oxidizing potential than the standard ammonium perchlorate. Two of the more promising oxidizers under development are hydrazinium perchlorate and nitronium perchlorate. The manufacturers hope to use the new oxidizers with a variety of solid fuels to improve specific impulse and obtain more energy per pound of propellant.**

►Total wind-tunnel testing to date on General Dynamics F-111A and B models has reached 12,000 hr., with continued tests planned well into 1964. Facilities being used are at Langley, Lewis and Ames research centers, Cornell Aeronautical Laboratory, General Dynamics/Convair and GD/Pomona, and Arnold Engineering Center. Grumman is performing subsonic tests. Total test time of 12,000 hr. compares with 8,000 hr. on the General Dynamics B-58 supersonic bomber before first flight of that aircraft.

►**Project 75 has been established at Ballistic Systems Div. as an in-house extension of USAF's Project Forecast. The new effort will evaluate the division's mission through 1975. Emphasis will be placed on problems anticipated for advanced ballistic missile systems which could be developed by the mid-1970s.**

►Restrictions on the thrust-time profile of the Titan 3C space booster's 120-in.-dia., solid-propellant rocket motors probably could be eased because the profile was tailored specifically to accommodate the canceled X-20 (Dyna-Soar) space glider. Rigid development schedule for the 120-in. motor, however, may prevent any thrust improvements for the booster, now planned to launch the manned orbiting laboratory (AW Dec. 16, p. 30).

►**USAF's Aeronautical Systems Div. is expected to award only one follow-on study contract for the chemical low-altitude missile (CLAM). The follow-on effort may be trimmed to six months from the nine-month period originally anticipated. It probably will involve analyses of as many as four CLAM configurations for use with General Dynamics F-111 and Boeing B-52 aircraft.**

►First Hawker P.1127 VTOL fighter modified for evaluation by the U. S., Great Britain and West Germany will make its initial flight this month or in early January. The aircraft is the last of six ordered by the British Ministry of Aviation, but it incorporates all new modifications first reported by AVIATION WEEK & SPACE TECHNOLOGY (Apr. 8, p. 39), including a longer fuselage, higher vertical tail and anhedral on the horizontal stabilizer. The engine will be a Bristol Siddeley Pegasus 5 producing 15,000 lb. thrust. Nine airplanes will be produced for the three countries by the end of 1964, when a special tripartite training squadron will be established at Royal Air Force Station at West Raynham, Norfolk.

►**Beryllium powder designated Metal X will be used in high-energy, upper-stage, flight-weight solid motors being developed in parallel efforts by Atlantic Research Corp. and Rocketdyne/McGregor for the Edwards AFB Rocket Research Laboratory. The propellants are expected to offer specific impulses exceeding 300 sec. A propellant with beryllium powder also is being considered by Jet Propulsion Laboratory for use in the retrorocket of the Surveyor unmanned lunar soft-landing vehicle.**

►Firing rate for the Athena booster is expected to reach a minimum of four per month within six months after the start of Ballistic Systems Div.'s re-entry vehicle test program, which will include 77 launches from Green River, Utah, to White Sands, N. M. The firing rate is later expected to reach eight per month.

Washington Roundup

Half-Time on the Hill

The subsonic 88th Congress took off for home last week with promises to finish leftover legislation quickly next year and then take a constructive new look at space, defense and aviation policies.

Senate Majority Leader Mike Mansfield felt defensive enough about the performance of the 1963 session to call the adjournment merely the "half-time," not the end of the game. But there was no denying that Congress this year broke down into a feudal society with committee chairman acting like so many independent lords of the manor.

Whether things really will be different next year depends partly on the persuasive powers of President Johnson but more on how the lawmakers judge the mood of the electorate in election year 1964. They already sense a public demand for economy.

This will make 1964 even tougher than 1963 for the National Aeronautics and Space Administration. But besides the congressional budget slashes which cost the agency $620 million this fiscal year, NASA will be asked the hardest questions yet about where it is going and why. In short, Congress will challenge NASA's management.

NASA Indecision

Chairman Clinton P. Anderson of the Senate space committee will be one of the challengers, even though he is one of the space program's enthusiasts. He told AVIATION WEEK & SPACE TECHNOLOGY that NASA is acting too much "like a lady shopping without knowing what she wants rather than a man who steps right up to the counter and buys a tie." He said the space agency has all these alternative programs and cannot decide which to choose. "Until you know where you are going," Sen. Anderson said, "it's awful hard to get the money."

Key members of the House space committee feel the same way, especially Chairman Olin E. Teague of the manned space flight subcommittee and Joseph E. Karth of the space sciences subcommittee. They often find NASA headquarters management exasperating. For example, Rep. Karth tried earlier this year as an economy move to get NASA leaders to eliminate one of the three unmanned lunar programs—Lunar Orbiter, Surveyor and Ranger. NASA said all three were vital, so Karth—"against my better judgment"—went along with authorizing the money requested. But months later, on Dec. 13, NASA announced it was canceling the last five scheduled Ranger flights (see p. 28) to effect "necessary economies in the over-all NASA program."

McNamara's Road

Defense Secretary Robert S. McNamara's management also will be challenged next year in a strange congressional cross-fire. One side will shoot at him for shutting defense installations so suddenly, while a smaller group will shoot at him for not acting sooner. Sen. Henry M. Jackson, whose state of Washington lost thousands of jobs when McNamara cancelled the USAF-Boeing X-20 (Dyna-Soar) program, is in the latter camp. As a member of the Armed Services Committee, he said he will ask defense leaders why they have to spend so much money on programs like Dyna-Soar before they can decide to cancel them.

Much of the executive committee sessions and some of the public ones will be devoted to steps being taken to insure continued nuclear weapons development under the test ban treaty. Sen. Jackson and Chairman Richard B. Russell of the Senate Armed Services Committee are among those who will argue that the treaty dictates more strategic superiority, not less. Air Force plans for a follow-on aircraft to the General Dynamics B-58 and Boeing B-52 (see p. 30) will be discussed in that context.

Some of the most penetrating military research questions will be asked when the newly formed House Armed Services research and development subcommittee headed by Rep. Melvin Price analyzes the new budget. Subcommittee members have been preparing themselves for the last several months through executive hearings on the current military research budget. Rep. Leslie C. Arends, ranking Republican on the full committee, said he is looking to the new subcommittee to help find waste.

Civil Aviation

Chairman Mike Monroney of the Senate aviation subcommittee sees 1964 as the crucial year for the supersonic transport. By then Congress will have the economic indicators—including harder cost estimates—it needs to assess the $1 billion development phase. He said he will introduce legislation specifically authorizing the Federal Aviation Agency to undertake the supersonic transport program to avoid legal challenges.

Other 1964 civil aviation actions in Congress are expected to include: House passage of the Senate-passed airport bill, providing $75 million a year for the three years Fiscal 1965 through Fiscal 1967—though conservatives are in no mood to extend the act again; slashes in FAA's budget request for air traffic control, plus challenges to the program's management; Senate air safety hearings, although Sen. Monroney gives this only an "outside chance"; further attempts to entice aircraft companies to design a DC-3 replacement. Sen. Monroney said he would like to interest the smaller aviation companies in the project, naming Beech, Cessna and Piper.

—Washington Staff

MOL Requirements Will Be Set by Jan. 1

Contracts totaling $1 million to follow; test program calls for six launches in 18-month, $1-billion project.

Washington—Air Force Systems Command has set a Jan. 1 deadline for revising previous military space station development plans to fit its new task of managing a manned orbiting laboratory (AW Dec. 16, p. 30). Industry contracts amounting to $1 million will be let within a week after that deadline.

The flight test program will consist of six manned orbiting laboratory (MOL) launches in an 18-month period, at an estimated cost of $1 billion.

Defense Secretary Robert S. McNamara, who previously had been unconvinced of the need for military manned space projects, changed his mind last June and gave strong support to the Air Force's orbiting space station (OSS) concept.

It has been learned that the principal reason for McNamara's change in attitude stems from his desire to add the human element to optical and electronic sensing systems in orbit. Unmanned systems absorb a wide spectrum of phenomena and are unable to discriminate between what is important and what is not, clogging information systems with a mass of unwanted data. Now it is desired to find out whether man can discriminate and concentrate on what is important.

Gen. Bernard A. Schriever, commander of the Systems Command, told his division heads that the Air Force, after pressing for a military man-in-space role for a long time, now has the opportunity to back its words with action. He has assigned highest priority to the effort, which is now centered at the Space Systems Div. in Los Angeles. It is highly probable that a special system project office that would report directly to Gen. Schriever will be created to accelerate the MOL timetable to fit that of the Titan 3C vehicle, which will boost the laboratory into orbit.

NASA space station planners were taken by surprise by the MOL action, but hope to be able to continue their own studies aimed at developing a much larger station in the more distant future; congressional approval of the MOL project is expected, with little or no opposition.

During a week of intense activity following the MOL announcement, there were developments in these areas:

• **Test program.** Six orbiting laboratories will be launched on missions that initially will be aimed at remaining in orbit for two weeks, building up to four weeks as the program progresses. The total flight test program is tightly scheduled into an 18-month period.

• **Titan 3 booster.** This program now calls for production of 17 boosters. The number of Titan 2A LV-4 vehicles, which form the core of the Titan 3C, will be greater, as some of them will be flown separately. A top Defense Dept. official described this booster program as one of the most tightly controlled and managed in the Defense Dept. First firing is scheduled for December, 1964 (AW Sept. 9, p. 54).

• **Gemini X capsule.** Negotiations between Defense Dept. and NASA over who will manage this part of the laboratory venture are expected to take some months. Air Force will try to assume management of its own Gemini program at the McDonnell plant.

• **Life support.** No determination has been made yet whether the NASA Gemini 100% oxygen system, the Air Force X-20 two-gas system or some other system will be used for the capsule and the laboratory. There is growing support for adopting the Russian system of sea level pressures and sea level mixtures of oxygen and nitrogen. Air Force flight surgeons at the Aerospace Medical Division, Brooks AFB, Tex., have been ordered to make recommendations.

• **Recovery techniques.** Use of parachutes is almost certain. Little enthusiasm is expressed in the Air Force for the paraglider and landing skid system proposed for the NASA Gemini. Reason given is that the paraglider is unproved and would complicate development, while parachutes were proved efficient in the Mercury program (AW Dec. 16, p. 60).

• **Astronauts.** Officials said last week that it is too early to determine whether other than USAF pilots will be used or where they will be based. Air Force said that it will consider Navy and Army needs in the MOL experimental programs, in addition to those of NASA.

• **ASSET.** Aerothermodynamic-elastic structural systems test will be expanded beyond the current program of six launches in which Thor or modified Thor Delta boosters and winged reentry body shapes made by McDonnell are used.

After the initial studies are completed, the Air Force intends to let further studies if needed or enter the program definition phase. Funds requested for Fiscal 1965 will be about $60 million. This will be enough to begin hardware development, most of which will be applied to the laboratory.

Industry interest in the MOL program is so high that company teams other than Boeing, Douglas and Lockheed, which were recommended by an Air Force source evaluation board to conduct paid studies (AW Dec. 16, p. 29), will make studies at their own expense. There is no guarantee that a paid study gives the company doing it an edge in receiving the development and production contracts.

After McNamara on Aug. 30 authorized the director of defense research and engineering to spend $1 million on studies for OSS, a small team in the director's office began the task of simplifying the original concept—which included ferrying and rendezvous—to the MOL concept of launching the laboratory along with the re-entry capsule. Neither NASA, the National Aeronautics and Space Council nor the Air Force were consulted about this from early September until the week before the Dec. 11 announcement.

While the space station concept was being reoriented, McNamara was faced with completing the Fiscal 1965 budget. He decided that the X-20 program would have to be canceled. He was advised that the late President Kennedy would be embarrassed if this action were announced alone. After President Kennedy's death, President Johnson was confronted with the same situation and decided to order the Defense Dept. to assume responsibility for the national space station.

NASA Administrator James E. Webb was not consulted in advance on the plans. When confronted with the decision, he could say only that he would accept it, but would like to keep NASA's modest study program going.

Final action on MOL was accelerated when a high-level White House source in an off-the-record remark Dec. 7 said that the X-20 would be canceled.

Air Force Secretary Eugene M. Zuckert said he was pleased with the decision, and that a good bit of initial study, preliminary design and planning had gone into several different approaches. Asked whether he considered the MOL and ASSET programs adequate substitutes for the X-20 he said: "The manned orbiting laboratory combined with an expanded ASSET program is not intended to be an explicit substitute for the X-20 program. Rather, these new programs reflect a change in emphasis toward on-orbit experimentation rather than re-entry experimentation. It is certainly true that determining man's military mission capabilities on-orbit is of the highest priority."

Slight modifications in the four basic tasks in the space station studies (AW Dec. 16, p. 32) will be made. The third task, which deals with the experiments to be performed in the laboratory, will not be as stringent as before. Complete analysis of the systems and subsystems had been included. The fourth task which would have required preliminary configurations to allow experiments leading to military missions, has been eliminated.

The first and second tasks will remain the same. The first will result in an integrated requirements plan, and the second will result in a test operations plan.

MOL studies will attempt to solve these problems:

• **How the space station** can function as a testbed and as a military platform to generate operational techniques.

• **How to draw on all** existing technology developed in the U. S. space program so far.

• **Plan to use facilities** now in use or those projected.

Weightlessness also will be given special attention in the studies because the Space Systems Div. does not feel the information generated to date with respect to zero-g effects on humans is sufficient. Both zero-g and artificial-g will be investigated, because both modes of operation will be embodied in the laboratory.

Unless it proves too complicated, the laboratory will be designed so that in follow-on programs, ferrying and rendezvous techniques can be tested. None of the six launches now planned includes rendezvous.

Tiros Autopilot Problems

Cape Canaveral—National Aeronautics and Space Administration encountered difficulties with the autopilot in the first stage of the three-stage Delta launch vehicle last week as the agency attempted to orbit Tiros 8 from here. Initially scheduled to be launched Dec. 17, the flight was delayed one day while NASA replaced a gyro in the autopilot.

During re-checking of the system after installation of the replacement part, another gyro began to act erratically and the launch attempt was delayed until later in the week.

Tiros 8 is the first of this meteorological series to carry the Radio Corp. of America-developed Automatic Picture Transmission (APT) camera, which can operate directly, without command links, in conjunction with low-cost ground receiving stations. For this and probably the next few flight attempts, however, the APT camera can be controlled by certain ground stations to maximize test conditions.

House Probes Apollo Guidance Development

Washington—Concern about the reliability of the Apollo guidance system being developed by the Instrumentation Laboratory of the Massachusetts Institute of Technology has prompted a quiet investigation by the House space committee.

Chairman Olin E. Teague (D.-Tex) of the House manned space flight subcommittee is heading the inquiry, although Chairman George P. Miller (D.-Calif.) of the full committee and Chairman Joseph E. Karth (D.-Minn.) of the space sciences subcommittee are actively participating.

Rep. Teague said he was not prejudging the situation, but that "where there is so much smoke, there must be something burning. And we're going to look for the fire." He was referring to the recurring reports that MIT's guidance system worries Grumman Aircraft Engineering Corp. and North American Aviation, prime Apollo contractors.

MIT's Instrumentation Laboratory is associated with AC Spark Plug Div. of General Motors, Kollsman Instrument Corp., Raytheon and Sperry Gyroscope Co. in developing the guidance systems for the Apollo command and service modules and for the Lunar Excursion Module (LEM). North American is the prime contractor on the command and service modules and Grumman is the prime LEM contractor.

Part of the framework for the space committee's investigation are reports analyzing the possible reliability of the MIT guidance system. North American has written a report for the National Aeronautics and Space Administration on the guidance system proposed for its portion of Apollo, while Grumman, General Electric and Bellcom, Inc., have done reliability reports on the LEM guidance system. One industry source said the Apollo program would be delayed up to 18 months unless MIT makes some major changes in its proposed guidance system for LEM (AW Sept. 30, p. 32).

But top NASA officials told Aviation Week & Space Technology that all was well. NASA administrator James E. Webb last week said there was no division of opinion between the contractors and NASA about the guidance system now planned. Dr. George E. Mueller, the director of NASA's manned space flight program, said MIT's guidance development program "is doing well and on schedule." He said no major changes—just refinements—are planned for the guidance system. He said there is general agreement that "the MIT system will do as good as can be done. There never really was a real disagreement. . . . There is no reason to change our plans." He characterized the reliability reports about the system as "working papers."

All the reliability reports except the Bellcom document are classified confidential. The House space committee has obtained copies of them. Rep. Teague said the subcommittee staff is studying these reports and related matters as part of what he termed "a good, hard, deep look" in the guidance system question. He said he has heard so many conflicting reports that he decided to conduct an inquiry. It started with an informal meeting Dec. 19 with Mueller and other NASA officials. No formal hearings are contemplated at present.

James L. Decker recently quit as deputy manager of the LEM program office at NASA's Manned Spacecraft Center at Houston, Tex., reportedly because of a dispute over the guidance system planned for LEM. He declined to comment on the report. He currently is working at The Martin Co., Middle River, Md.

Ling-Temco-Vought Wins Canaveral Role

Cape Canaveral—Ling-Temco-Vought has been selected by the National Aeronautics and Space Administration's Kennedy Space Center here to provide administrative and management services to the agency's Merritt Island Launch Area (MILA), Fla.

The cost-plus-incentive fee contract will run for three years, divided into yearly renewable segments, and is estimated to be worth more than $2.5 million for the first year. Under the contract, Ling-Temco's Range Systems Div. will provide the civilian space agency with support in automatic data processing, technical information, photographic operations and a field printing plant. The division will transfer 350 employes from its Dallas, Tex., operation. Others will be hired in Florida.

Bids for the base operations role at the MILA site, one of four contracts which NASA will award in housekeeping support, were received from 18 firms Dec. 16. Among those aerospace firms submitting bids were Republic Aviation, Boeing Co., Trans World Airlines, Pan American World Airways, and Hughes Aircraft Co.

A proposal request for the fourth and final package, launch support services, is still being drawn up by the center.

Apollo Date Unchanged in Funds Crisis

By Alfred P. Alibrando

Washington—U.S. will attempt to maintain the Apollo schedule for landing men on the moon by 1970, even if this means further cutbacks in the National Aeronautics and Space Administration's unmanned flight and research programs.

There has been some speculation in Congress and elsewhere that President Johnson, in his Fiscal 1965 budget message next month, would announce a stretchout of the Apollo program to 1972 or 1975.

Sources close to the President indicate he is determined to hold to the 1970 Apollo goal, rather than solve space funding shortages by slowing down the U.S. manned space flight program.

NASA's funding crisis resulted from congressional appropriation of only $5.1 billion of the $5.72 billion requested for Fiscal 1964 by the late President Kennedy. The agency had maintained that it needed a minimum of $5.35 billion—the amount authorized by Congress for Fiscal 1964—to maintain current programs on schedule.

NASA acted to meet the budget crisis by the cancellation on Dec. 13 of five Ranger flights—Rangers 10 through 14. NASA said in its announcement that the cutback in the unmanned lunar flight program would save $90 million. Dr. Robert C. Seamans, Jr., associate administrator of the agency, told members of the House space committee prior to the public announcement that the savings in Fiscal 1964 would amount to about $15 million. Some $75 million was to have been spent between Fiscal 1965-67.

The agency earlier ordered a freeze on the hiring of new employes by 11 of its top contractors (AW Dec. 16, p. 34).

Seamans Challenged

In challenging Seamans on the Ranger economy move, members of the committee suggested that the real reason for dropping the Rangers was the overlap and duplication of missions to be performed by Surveyor soft-landing and Lunar Orbiter spacecraft. Both Surveyor and Lunar Orbiter are to take and transmit to earth closeup pictures of the lunar surface, including potential Apollo landing sites.

The Ranger cancellation was a blow to the Northrop Corp., which had built a plant at Hawthorne, Calif., and recruited a force of about 800 employes to build the spacecraft. Northrop appealed the decision but NASA said it was final.

Ironically, about 3,000 employes of Northrop's Nortronics Div. were dismissed during the holiday season a year ago when the Skybolt program was canceled (AW Jan. 7, p. 28).

Northrop will continue to provide support to the Jet Propulsion Laboratory through the remaining series of four Ranger flights. The next launch, Ranger 6, is scheduled in February. Northrop has about 100 employes working at JPL, a government laboratory operated for NASA by the California Institute of Technology.

Aside from the Ranger program, Seamans told members of the House space committee, the agency has not decided what programs it will reschedule or cut back to make up the remaining $235-million deficit in Fiscal 1964 funding. A final decision may hinge on whether the Administration asks for a Fiscal 1964 supplemental appropriation.

Rep. Olin E. Teague (D.-Tex.), chairman of the House manned space flight subcommittee, has urged the Administration to ask for a $250-million supplemental. He contends that a supplemental request would help rather than hurt NASA's cause in Fiscal 1965, by convincing Congress of the agency's true budgetary needs.

Discussions Continue

Discussions between the White House, Budget Bureau and NASA on the Fiscal 1964 supplemental and Fiscal 1965 budget were continuing late last week. NASA maintains it needs the $250 million supplemental and $5.5 billion in Fiscal 1965 to carry out and keep currently approved programs on schedule.

Budget Bureau wants to deduct the amount of the supplemental from the $5.5 billion, making the Fiscal 1965 request total about $5.25 billion. NASA has argued that such a course would merely repeat this year's funding difficulties.

There are also differences of opinion over funding for specific programs. The Budget Bureau wants to cut funding for Rover nuclear rocket development in Fiscal 1965 to about $100 million—half the amount requested by NASA and the Atomic Energy Commission. Dr. Jerome B. Wiesner, the President's science adviser, is urging an even more drastic cut so that the program would get only $50 million.

In opposing a substantial increase for Rover, the Budget Bureau and Wiesner argue that there is no approved mission requiring a nuclear stage.

NASA's position is that development must be carried out now to provide a nuclear rocket for use as an upper stage on Saturn 5 for lunar and planetary missions after 1970.

Funding for the nuclear rocket program was cut back from $118 million to $96 million in Fiscal 1964 because of the slow pace of progress in development of the Kiwi B breadboard nuclear rocket. However, NASA and the AEC report that problems with the Kiwi graphite core are being solved (AW Nov. 25, p. 32). First flight of a nuclear stage is scheduled for 1970.

Virtually the entire NASA unmanned flight and research program is subject to cuts if the Administration decides to subtract a supplemental from the Fiscal 1965 request. Fund reductions are likely in communication satellite development, the 1966 Mars Mariner missions, and scientific satellite programs.

Sen. Clinton Anderson (D.-N. M.), chairman of the Senate space committee, said NASA may have to meet its budget difficulties by being more selective—reducing the number of its programs and presenting forceful and convincing arguments for those the agency retains.

VAL Program Awaits Congressional Action

Washington—Navy has completed evaluation of the four proposals submitted for its interim light attack aircraft (VAL) program, but has encountered delays in obtaining congressional permission to reprogram Fiscal 1964 funds to finance it.

Under the VAL program, Pratt & Whitney TF-30 turbofan engines would be installed in existing airframes, instead of beginning a new light attack project called VAX (AW Aug. 12, p. 26).

Navy has tried to obtain authorization from the House and Senate Armed Services committees, but encountered delays due to the death of President Kennedy and then the holiday season. After obtaining authorization, the next step will be to persuade the appropriations committees of both houses to order the reprogramming. Target date for completing the action and announcing the winner of the competition is Feb. 1.

Douglas Aircraft Corp., North American Aviation, Inc.'s Columbus Div., Ling-Temco-Vought, Inc., and Grumman Aircraft Engineering Corp. have entered proposals.

Russian Budget Cut

Moscow—Soviet Union last week announced a cut in its military budget, equivalent to about $667,000,000, which may be followed by a reduction in armed forces.

Nikita Khrushchev, at a meeting of the Communist Party's Central Committee three days before, had said: "This is not the age of Napoleon that we are living in when the strength of the armed forces of states was measured by how many thousands of bayonets and sabres they had."

Khrushchev then said that nuclear weapons are the key to military might, leaving a clear implication that he also was considering a reduction of the number of Soviet troops located in Eastern Europe.

Soviet Union's military outlay for next year now is the equivalent of $13.3 billion, less than in 1962 but still well above military outlays of the late 1950s.

Five Named for 1963 U.S. Science Awards

Washington—Dr. Luis W. Alvarez and Dr. John R. Pierce were among five scientists named last week by President Lyndon B. Johnson as recipients of the National Medal of Science for 1963.

Dr. Alvarez, professor of physics at the University of California, was cited for leadership in experimental high energy physics, continued development of the bubble chamber, discovery of many states of elementary particles and contributions to national defense. During World War 2, Dr. Alvarez pioneered development of a microwave early warning system, a high altitude bombing system and the ground controlled approach instrument system used for landings in low visibility conditions.

Dr. Pierce, executive director of Bell Telephone Laboratories' communications research, received his award for contributions to communications theory and to this country's satellite communication system. Dr. Pierce first analyzed the possibilities of a satellite communication network in 1954 and proposed such a system in 1955. His work was the forerunner of the Echo 1 and Telstar satellites.

The other three recipients of the medal are Dr. Vannevar Bush, former head of the Office of Scientific Research and Development; Dr. Cornelius B. van Niel, and Dr. Norbert Wiener, Professor Emeritus of Massachusetts Institute of Technology. The late Dr. Theodore von Karman was the first to receive the science award early last year (AW Feb. 25, p. 41).

McNamara Sees Boost for NATO Despite U.S. Spending Cutback

Paris—U. S. defense expenditures can be expected to decline progressively over the next several years at least, Secretary of Defense Robert McNamara said.

McNamara, speaking at the semi-annual ministerial meeting of the North Atlantic Treaty Organization last week, during which most of the major issues dividing the alliance were carefully avoided, said such cuts are possible because of growing U. S. strength and will not affect its qualitative superiority over the USSR.

Present U. S. strength, he told the defense ministers' session at the 15-nation meeting of NATO foreign, defense and finance ministers, will increase substantially over the next several years regardless of expenditure cutbacks. He added that despite the growing threat of a Soviet mobile ballistic missile force and missile-carrying submarines which cannot be accurately pinpointed, the U. S. and NATO do not need to meet this on a ton per ton basis. Such an approach, he said, provides no answer to the over-all problem.

Later, a U.S. spokesman said that "high investments in merely increasing the size of [nuclear force] provide rapidly diminishing returns."

McNamara told the NATO ministers, however, that the U.S. has a very important program under way to improve ranges, accuracies, command and control arrangements and penetration capabilities of its strategic nuclear weapon systems.

This, he said, will permit a decline in defense expenditures in itself by improving the capabilities of hardware presently in or near inventory status without the necessity of heavy outlays for new equipment as such.

Earlier, Secretary of State Dean Rusk told the ministerial meeting that the nuclear test ban treaty represents no detente between the West and USSR but that it marks one step forward to such a goal and that it presented a license to seek better relations. One such move, he said, could be unilateral cuts in defense expenditures.

Reports from Moscow a day later said the Soviet Union plans to cut its defense budget next year by approximately $667 million, probably to meet other pressing economic needs (see box), although Western experts here agree that a realistic figure on Russian defense expenditures is difficult if not impossible to estimate because of the ease with which they can be hidden in an over-all report.

McNamara, reviewing progress in U. S. defense strength, reported that:

- **The U. S. now** has more than 2,000 nuclear warheads available, including those carried aboard strategic missiles and aircraft of the Strategic Air Command, a figure which represents a 100% increase over the past two years, according to McNamara. By 1966, he added, over 1,500 warheads will be attached to U. S.-based ICBMs.
- **SAC now has** more than 500 bombers assigned to air or ground alert.
- **Number of dispersal sites** for ICBMs, excluding seaborne Polaris missiles, will have increased 10 times by 1967, compared with 1961.
- **After Jan. 1,** nuclear warheads will become available for standard 155-mm. howitzers already in the field.
- **Air Force airlift** capability will increase by 400% by 1968, primarily through introduction of Lockheed C-141, giving the U. S. the capability of moving seven Army divisions to Europe in one coordinated move, as compared with one division during the recent Big Lift exercise.

Such improvements in quality, McNamara said, will preclude any need to provide added quantity to the already-planned U. S. nuclear retaliatory force.

McNamara, Rusk and a letter to the ministerial meeting from President Johnson emphasized, however, that the U. S. still hopes the West European nations will increase commitments to NATO ground forces, either qualitatively or quantitatively.

This insistence, which has become an almost traditional U. S. plea over recent years, was accompanied by a promise from President Johnson in his message delivered to the ministers by Rusk that "we will keep in Europe the equivalent of the six American divisions that are now deployed there, so long as they are needed, and under present circumstances there is no doubt that they will continue to be needed. I am confident that our allies will also make their full contribution to this NATO defense, so that the burdens and responsibilities of partnership may be equitably shared."

At Paris' Orly Airport Dec. 18, the USAF/Boeing KC-135 carrying McNamara and members of his staff missed a possible collision in the fog with a taxiing TWA Boeing 707, which had not cleared the active runway after landing. KC-135, piloted by Capt. Meredith Sutton, had been cleared for takeoff, and had accelerated to about 140 mph. when Capt. Sutton glimpsed the tail of the TWA aircraft through the fog on the runway. He aborted, braking heavily to a stop that blew two tires on the left landing gear.

Bell UH-1B Modified to Compound Configuration

Newest modification to higher performance Bell UH-1B helicopter (AW Dec. 10, 1962, p. 52) is addition of two auxiliary Continental J69-T-9 turbojets to explore characteristics of unloaded rotors in actual flight at high speeds. This configuration to date has been flown to speeds of 155 kt. and plans are to increase speed to approximately 180 kt. in this program phase. This series of tests is expected to be concluded in January, and the next phase will be to add stub wings of approximately 26-ft. span. The program is being sponsored by U. S. Army Transportation Research Command.

Air Force Seeks Funds to Begin Work on New Strategic Aircraft

Los Angeles—Air Force is requesting necessary funds in the Fiscal 1965 budget to start development of a new manned strategic aircraft, Gen. Curtis E. LeMay, USAF chief of staff, told a Wright brothers memorial dinner here last week.

LeMay indicated that the Air Force has placed a top-level priority on efforts to sell key policy makers on the need for moving ahead with development of a new strategic aircraft to replace the present fleet of B-47, B-52 and B-58 jet bombers.

Top Problem

LeMay said it was the number one problem facing not only the Air Force but the nation. His views reinforced the demands of other top Air Force generals, such as Thomas S. Power, head of the Strategic Air Command, and Bernard A. Schriever, commander of the Air Force Systems Command (AW Sept. 23, p. 38).

Emphasis on a new manned strategic aircraft is in line with attitudes adopted by top-level Air Force officials to delay plans for development of advanced ICBMs and concentrate on convincing the Defense Dept. of the necessity of a new strategic aircraft (AW Dec. 16, p. 27).

Discussing the individual roles of missiles and manned aircraft, LeMay said that it is not a question of which system is better. "The thing to be recognized is that they are complementary, not competitive . . . and together they make it possible to carry out a counterforce strategy," he said.

The present missile program calls for sustained production of Minuteman 1 and 2 missiles for several years, with improvements in accuracy and ability to be retargeted, but the manned aircraft picture is not as encouraging, LeMay said.

With the phaseout of the B-47 and limited operational lifetimes of the B-52 and the small B-58 force, the facts are that the aircraft on hand cannot be expected to adequately perform their strategic mission indefinitely, he said.

"In my opinion, therefore, we must develop and produce a new manned strategic aircraft," the Air Force chief noted.

LeMay indicated that the strong position the Air Force was taking in urging development of the new airplane was at least in part a direct result of Project Forecast studies.

In support of his case, LeMay stressed the high degree of controllability and flexibility which manned aircraft give to the strategic aerospace force, and listed the following advantages:

- **Manned aircraft can hunt out** and destroy targets that cannot be located precisely in advance.
- **Aircraft can be recycled** in sustained operations.
- **Manned aircraft can react immediately** to re-direction, exploit fleeting advantages, and execute a broad range of missions. They offer the vital power of human observations and evaluation.
- **Presence of manned aircraft** in the over-all force, side by side with the ballistic missile, compounds the offensive and defensive problems of the enemy.

'Overkill' Rebuttal

LeMay also rebutted proponents of the "overkill" philosophy who feel that military spending can be reduced because the U. S. missile force is capable of destroying major Soviet population centers many times over. The overkill philosophy advocates, he said, are talking about the wrong problem. "The primary task of the U. S. armed forces is not to destroy the Soviet population but to protect and save American lives and property," he said.

To provide this protection, U. S. ICBMs must mainly be targeted against the Soviet's aerospace weapons which have the capability of destroying us, he explained. In addition, overkill advocates do not take into account U. S. losses from an initial attack nor limitations in weapon system reliability, he added.

Lack of Technology Utilization Cited

Washington—A breakthrough is "essential" before aerospace technology can be applied effectively to stimulate industrial growth, National Aeronautics and Space Administrator James E. Webb told the Senate Small Business Committee last week.

The committee is one of several congressional committees focusing on various aspects of the economic implications of defense and space spending (see story).

Despite vigorous efforts, Webb said, "we haven't found the solution yet" to translating NASA's research into industrial applications.

Some congressional quarters have been skeptical that NASA's technology utilization program would ever attain its objectives (AW Aug. 5, p. 28).

At last week's hearing, Sen. John Sparkman (D.-Ala.), chairman of the Small Business group, and Sen. Hubert Humphrey (D.-Minn.) urged Webb to push the program in order to get widespread support for space spending—which would be reflected in Congress.

Webb was optimistic about the ultimate success of NASA's approach of strengthening universities, with their groups trained in many scientific disciplines, as its link with business. He anticipated that business will turn increasingly to the universities for research guidance.

Webb called for "more and stronger institutions of high and increasing quality distributed broadly over the nation . . . At the same time, a stronger bridge in the educational process must be built between the scientist who is advancing the frontier of knowledge and the engineer and manager of industrial production who must convert basic science into practical economic application."

Preference Urged for Established Firms in Military Spending Cuts

By Katherine Johnsen

Washington—Cutbacks in military aerospace spending would be least disruptive to the economy if applied to the consumer-goods firms that entered into defense and space business over the past decade as an additional line, Martin Co. President William B. Bergen recently told the Senate manpower subcommittee.

The subcommittee, headed by Sen. Joseph Clark (D.-Pa.), plans to sponsor legislation in the next session of Congress aimed at promoting applications of aerospace technology to stimulate the general economy and guide aerospace firms that are hurt by shifts in military requirements into fields of non-defense production (AW Dec. 16, p. 35).

Bergen said: "These newcomers, which have been historically either commercial or industrial in orientation and to which the aerospace business is a comparatively new area, are in a much better position to re-direct their energies to their previous markets than the companies which have all their experience in the defense area . . .

"More often than not," he said, "these are large industrial companies which have, already in existence, established markets for automobiles, electrical appliances, and other consumer or industrial products—as well as the large sales organizations, marketing outlets and distribution networks essential to a normal commercial enterprise."

Bergen noted that there are only a few companies—"the Boeings, the North Americans, the Lockheeds, to mention some of the best"—that exist almost wholly for the national security. These few companies, he said, "possess the systems capability built up over long periods of time and work and have the scientific, technical and management skills that have kept our defenses from becoming second best."

Other testimony included:

- **Lockheed Aircraft Corp.** Despite vigorous efforts to diversify, the company said, 96% of its sales are military.

"The industry has not been notably successful in developing extensive commercial markets, even though it has long recognized the desirability of doing so," the company said. "Lockheed has made several forays into unrelated commercial fields—aluminum curtain walls, for example—with little success. Other companies have had similar experiences. All this suggests . . . serious but not insurmountable limitations on the part of aerospace companies to enter many commercial fields under existing conditions."

- **Aerojet-General Corp.** Company President W. E. Zisch observed that "higher profit levels in the defense industry would permit a more complete development of the commercial by-products of our military-space programs. In its twenty years of existence Aerojet has invested almost all of its total earnings and accumulated depreciation back into plant and equipment to perform effectively on our military contracts. This seriously limits the resources available for conversion to non-military products."
- **Republic Aviation Corp.** Company vice president John Stack anticipated that space work will drain even more scientists and engineers from commercial enterprises than defense work.

Stack said that the effect of the space program so far "has been to intensify the scarcity of scientists, engineers, and technicians. All of these are engaged in producing the 'one-time-only' type of end item, and then having successfully produced this item, the talent then proceeds to the next more complicated problem . . ."

Continental Director

Los Angeles—Robert C. Jackson, president of Ryan Aeronautical Co., San Diego, has been elected to the board of directors of Continental Motors Corp., Detroit.

Since 1961 Ryan has been buying Continental common stock. At the end of November, Ryan owned 1,069,800 shares, approximately 32.4% of the total outstanding.

Jackson is the first Ryan official to be elected to Continental's seven-man board. He filled a vacancy produced by the resignation of David Van Alstyne, a New York broker.

Ryan has persistently declined to comment regarding its intentions towards Continental, other than to say that its purchases were for investment purposes. Industry observers have stated that Ryan's holdings of Continental stock would be enough to give it practical control of the latter firm.

Underwater Testing

Sacramento—Aerojet-General planned to static fire a 17,000-lb.-thrust pressure-fed Corporal rocket engine 30 ft. underwater last week for 10 sec. as part of a test program to establish the feasibility of sea-launching Nova-class space vehicles. The tests are being conducted from a barge in San Francisco Bay.

Aerojet is funding the project, called Sea Horse, under a no-cost contract with National Aeronautics and Space Administration. Program involves test-firing pressure-fed liquid propellant engines under water at varying depths. The engines are held in place by a submergable rocket firing tower located on the bow of a 110-ft. Army barge.

The project, which began last month, is in support of Aerojet's proposed Sea Dragon concept of sea-launching Nova boosters. Aerojet favors a pressure-fed liquid propellant two-stage vehicle employing a single engine in each stage rather than a cluster of smaller engines.

Swept-Wing F-111 To Use Fuselage Lift

By Erwin J. Bulban

Ft. Worth—General Dynamics/Ft. Worth F-111 (TFX) bi-service fighter embodies a blended wing-body configuration which enables the fuselage to contribute sufficient lift to sustain the airplane's entire weight during supersonic flight at sea level altitudes with wings fully swept.

The concept is so effective that in this flight regime, the best configuration would not utilize its wing, according to E. B. Maske, General Dynamics/Ft. Worth director of aerospace technology.

Maske indicated that the aerodynamic technology embodied in the new fighter, particularly its variable-sweep wings, constitutes technical advances that will be incorporated in many future military and civil tactical and transport aircraft.

Variable-sweep wings, aside from the improved low-and-high speed range they make possible, also contribute markedly to improved range, he indicated. This is possible because they permit improved weight balance of the airplane with fuel consumption, obviating the need for drag-producing trim changes particularly noticeable in delta-wing configurations. Such a characteristic would be of particular economic importance in supersonic transport operation.

Maske credited the National Aeronautics and Space Administration technicians at Ames and Langley Research Centers with developing the basic technology in blended wing-body and variable-sweep wing configurations adapted by the F-111 prime contractor and used to the maximum extent possible. Several of the supersonic transport tests run at Langley showed the blended configuration to have superior drag characteristics to conventional wing-body arrangements, he noted as an example.

The variable sweep wing permitted the desired characteristic of essentially no sweep at the low-speed loiter condition, and high sweep for supersonic flight at sea level, with the desired aspect ratio varying from very low to very high. Varying wing sweep also modifies area, sweep, camber and aspect ratio leading to the acronym Vasca wing for this configuration.

Contractor's Version

The contractor's version of the NASA variable-sweep wing embodies camber and twist in the wing outwards along the span to provide good lift distribution in low-speed flight. In the fully swept condition, there is essentially no camber or twist effect.

High lift system embodies a conventional trailing edge flap and a leading edge slat system with an intermediate position for use in long-endurance cruise or loiter. For some long-range missions, tip extensions are added to the wings to provide higher aspect ratio in the unswept low-speed flight regime.

Even with the wing swept to its maximum, there is no physical overlap with the tail to remove all doubts as to the possibility of physical interference between these surfaces during high-g maneuvering flight, Maske said.

An unconventional approach was also taken in design of the tail, which is planned so that the normal balancing load is an upload, rather than the conventional download. This upload characteristic improves low-speed flight characteristics since it adds, rather than subtracts, to the airplane's total lift providing lower stall speed and attendant improved takeoff and landing characteristics.

Uploading the tail also permitted a structural weight saving in the fuselage since inertia and airloads tend to relieve each other rather than acting in the same direction.

The crew arrangement posed a technical challenge to General Dynamics engineers, considering the maximum length of fuselage permitted by the USAF proposal request. Engineers finally decided on a side-by-side seating plan, which leads to a lower fineness ratio in the nose area and a consequently higher drag than a tandem arrangement, but provides a larger cross-section with major increased fuel volume permitted.

Additional fuel volume more than offsets the added drag—the F-111 has a range considerably in excess of that of any known fighter and of many bombers. Technicians also consider that the side-by-side seating arrangement will provide improved visibility, particularly in the low-level flight configuration.

Technical Challenge

A further technical challenge facing F-111 engineers has been design and placement of the engine inlet. For take-off, the induction system requires a large volume of air for high thrust. At cruise a high pressure recovery is required to provide minimum fuel consumption. Flying supersonically at sea level requires a small inlet area to obtain low drag since the engine cannot use all the air directed into the inlet.

The F-111 is designed with an internal-external compression inlet having a short straight duct to the Pratt & Whitney TF-30, with a movable wedge to adjust for needed airflow. Excess air in the low-level supersonic flight regime is spilled externally. Location of the intake under the airplane also provided for flow-straightening effects of the wing and fuselage during high-g maneuvering, and relatively straight-forward aerodynamic inlet configuration.

Fixed Price Asked for COIN Prototype

Washington—Bureau of Naval Weapons will require bidders for its small, light attack, counter-insurgency (COIN) aircraft to quote a fixed price for the prototype models, and will apply the fixed-price-plus-incentive-fee principle to production. A ceiling will be set on incentive payments.

Requests for proposals for the COIN program, calling for development, fabrication and test of four prototypes plus one static test model, have been sent to 22 manufacturers who indicated their desire to participate after being sent preliminary type specifications in October (AW Nov. 11, p. 43). Companies must have the capability of producing 24 aircraft per month if additional production is ordered. Proposals are due early in March.

In addition to the basic development phase, the request asks for proposals on four other phases, or lots, as follows: lot one, an additional three prototypes; lot two, production of 16 aircraft; lot three, production of 198; lot four, production of 286.

Type specifications which accompanied the requests differ only in minor details from those circulated earlier.

Companies who received the requests are Martin Co.; Lockheed-California Co.; Ling-Temco-Vought, Inc.; Republic Aviation Corp.; McDonnell Aircraft Corp.; Hiller Aircraft Co.; General Dynamics/Convair; Grumman Aircraft Engineering Corp.; Beech Aircraft Corp.; Bell Aerosystems Co.; The Boeing Co.; Piper Aircraft Corp.; Northrop Norair Div.; Cessna Aircraft Co.; Aircraft Marine Engineering Co.; Lear Jet Corp.; Champion Aircraft Corp.; Douglas Aircraft Corp.; Ryan Aeronautical Co.; Goodyear Aerospace Corp.; North American Aviation Inc., Columbus Div.; Helio Aircraft Corp.

First HS-125 Production Batch Awaits Approval

Hawker Siddeley will soon give its approval of the initial batch of 60 HS-125 (formerly DH-125) executive jet transports. The British firm says deliveries to U. S. customers will begin next July. Wing and fuselage assemblies for the 14th aircraft have left the jigs at the Chester, England, plant of the de Havilland Div. The company has scheduled 25 aircraft for completion in 1964. So far, the firm has firm orders for 11 from private customers and 21 more from the Royal Air Force.

F-111 Emergency Escape System Tests Are Scheduled at El Centro

Los Angeles—First flight tests of the General Dynamics-Grumman F-111 (TFX) crew escape system are scheduled early next month at El Centro, Calif., by McDonnell Aircraft Corp., prime escape system contractor.

Emergency escape from the F-111 will be accomplished by ejecting the entire side-by-side cockpit and lowering it by parachute (AW Aug. 12, p. 34). Qualification of the system is considered one of the early milestones of the F-111 test program. Parachute system tests, using an instrumented weight called a test bomb, have been under way since last summer and will be completed this month.

Next spring, a series of boilerplate capsule drops from a Boeing B-52 will begin. The capsule will be attached to a GAM-77 pylon on the B-52 for the tests. Production-type capsules also will be tested in B-52 drops.

Air Force systems program office at Wright-Patterson AFB has program management responsibility for both the Air Force F-111A and Navy F-111B. USAF now is studying plans to drop a boilerplate F-111 nose section from a Convair B-58, followed by ejection of the crew capsule from this nose section. This plan would allow the system to be tested at supersonic speeds at various altitudes.

Sled tests at Holloman AFB with production capsules are planned and are expected to qualify the escape system at maximum dynamic pressure as well as to qualify crew restraint harness. Other early flight testing will be done with a Convair F-106 with prototype avionics on board and a Martin RB-57, which will be used as a testbed for reconnaissance equipment.

Majority of category one and two F-111 testing will be at Edwards AFB. This will involve both Air Force and Navy configurations. Carrier suitability testing, however, will be done at the Patuxent River Naval Air Test Center, Md.

Air Force will fund the majority of the flight testing, which will follow the normal three category sequence: category one performed by the contractor; category two by the prime customer, and category three by the using command with operational aircraft in squadron strength.

Navy will pay for development and testing of the Hughes Phoenix air-to-air missile and subsystems. The Phoenix missile will be carried only on the F-111B. Support mission planned for the F-111A by Tactical Air Command does not require an elaborate new air-to-air missile system.

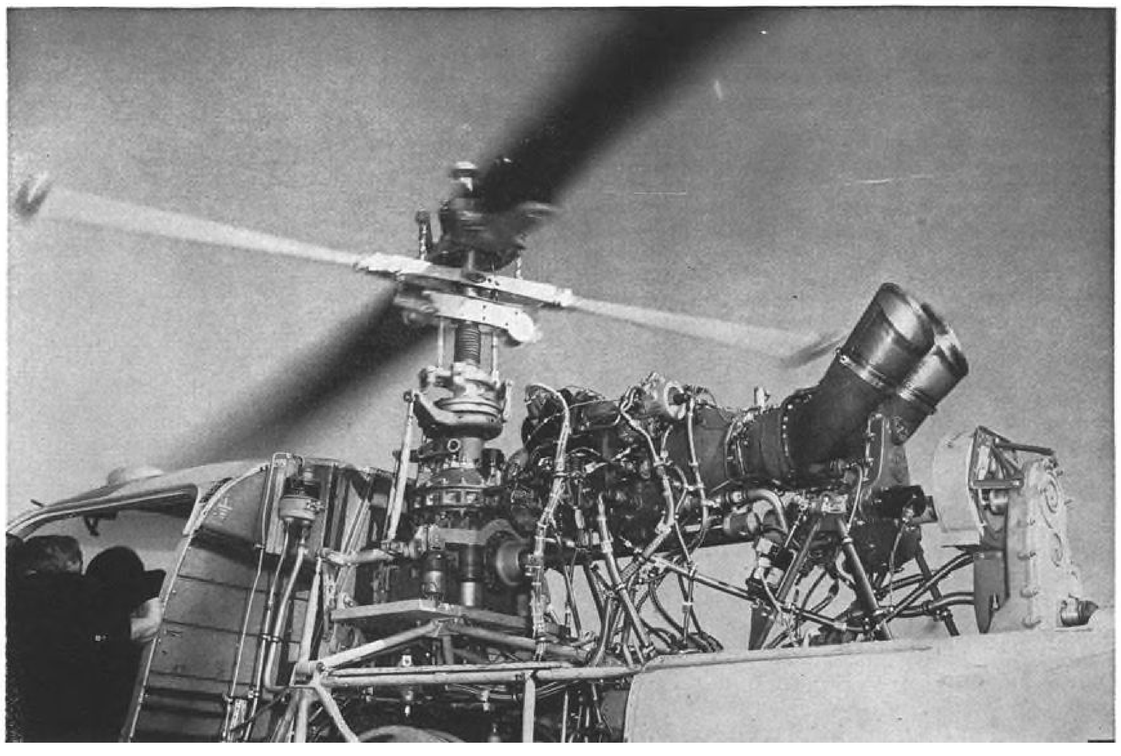
Cost of the over-all test program of both versions of the F-111 is expected to be significantly less than running two separate test programs for two different airplanes, according to Air Force project officials. Savings will be realized by eliminating dual airframe subsystems testing on such things as the hydraulics and electrical systems.

It also is expected that the number of test flights of the Navy version, slightly different in configuration, may be reduced by checking critical areas of the flight envelope and comparing them with F-111A behavior and performance, rather than running a complete new flight evaluation.

Testing for improvement following modification will be reduced somewhat also over that expected in two separate test programs. Only test flights for confirmation of modification to different versions will have to be made.

Continental T65 Flown on Bell Testbed

Flight test program of a Bell UH-13R testbed helicopter fitted with a 250-shp. Continental T65-T-1 turbine engine, is under way. The T65, in the same power class as the Allison T63, was funded by the Army as an alternate engine for the light observation helicopter (LOH) program. Test vehicles of all three LOH competitors, Bell, Hiller and Hughes, now are flying with the Allison engine (AW Sept. 9, p. 86). The UH-13R testbed is one of the two former Navy HUL-1Ms originally fitted with the Allison T63 for flight tests before completion of the LOH vehicles. Bell Helicopter Co., Ft. Worth, Tex., which installed the T65 in this UH-13R, has completed 10 hr. of ground and flight testing. Bell will provide a pilot under contract to Continental for 50 additional hours of flight evaluation. Army will continue evaluation with more flight tests in the Detroit area. Note engine mounting above straight line power shaft to rotor transmission box, for easy access during tests.



SUBROC antisubmarine missile bursts out of the water and streaks skyward during recent test firings in the Pacific. GAC is prime contractor. SUBROC is launched from a submerged submarine, is designed to kill enemy submarines at long range.

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Higher Thrust Saturn 1B Scheduled

Cape Canaveral—National Aeronautics and Space Administration is expected to announce in January its plans to use a version of the Saturn 1B launch vehicle to fly manned Apollo spacecraft on circumlunar reconnaissance missions in 1966-1967. For these missions, the Apollo spacecraft will consist of command and service modules only.

To accomplish the missions, with the Saturn 1B instead of the Saturn 5 vehicle, the space agency will direct Rocketdyne Div. of North American Aviation, Inc., to begin production of a 200,000 lb.-thrust H-1 engine. Eight of these engines, which are rated at 188,000 lb. thrust each, power the S-1B booster stage of the two-stage Saturn 1B vehicle (AW Sept. 16, p. 61). The stage then will have a total thrust of 1.6 million lb. compared with its present rating of 1.5 million lb.

Rocketdyne has been static-firing some H-1s above the 200,000 lb. thrust level for extended time periods between 100-150 sec. NASA has been intrigued with the mission possibilities offered by the higher-performance engine.

The improved Saturn 1B vehicle will have a payload capability of approximately 35,000 lb. compared with the 32,000 lb. capability of the earlier Saturn 1B configuration. These earlier models of the vehicle, the first stage of which is built by Chrysler Corp. and the second stage by Douglas Aircraft Co., fly all three modules of the Apollo spacecraft—command, service and lunar excursion—in earth orbital checkout and training missions.

Saturn Stage Firing Scheduled

Huntsville, Ala.—National Aeronautics and Space Administration will begin static firings of the Saturn 5 booster stage here next November, if the F-1 engine—five of which power the S-1C booster—continues to meet its present development goals. The stage to be used in the static firings will be the S-1C-T non-flying test vehicle.

The 1.5-million-lb. thrust F-1 engine recently began a series of short-duration test firings here at Marshall Space Flight Center (AW Dec. 16, p. 41).

The center hopes to begin static firings of single F-1 engines on the specially-built F-1 stand here by August or September of next year. If they succeed, the center will begin firing the five-engine cluster S-1C-T by Nov. 1.

Marshall is placing emphasis on reliability—rather than design performance—at this stage in the F-1's development. Leland F. Belew, director of the center's Engine Project Office which has management responsibility for the F-1 and other engines, and William D. Brown, his deputy, say that the F-1 is running "about two or three percent" below the designed specific impulse. The important thing, however, is to bring the reliability of the powerplant up to a point, they say, where tests may be conducted with confidence and safety.

"It is easier to get reliable hardware," Belew said, "if you don't try to squeeze out the last drop of performance at the same time." He referred to the time-staggered objectives of the F-1's development plan and said it was standard practice in the growth of a new engine or vehicle to concentrate on reliability first and to strive for higher performance levels only after a workable piece of machinery has been obtained.

Both officials say there is no foundation to rumors that the F-1 is considerably overweight. Since the powerplant has been oriented to the advanced Saturn booster configuration, they say, its weight has not deviated much from the approximate 18,000-lb. figure then estimated. At present, the F-1 is about 200-300 lb. above this mark, but Brown says that this is due almost entirely to revised weight accounting—some thermal protection, instrumentation and plumbing now being charged to the F-1 instead of the S-1C stage.

The injector has been the one component of the F-1 requiring the greatest development effort so far, Belew and Brown say. Several different injector configurations still are under consideration, although Marshall appears to be close to deciding on one final design. It is likely that production-line copies of the engine will be built with baffles.

Cosmonaut Training

Soviet Union's "veteran" cosmonauts are undergoing special intensive training in preparation for new manned space flight missions, the Soviet Army newspaper Red Star has reported.

Meanwhile, the 24th in the Cosmos series of Soviet scientific satellites was launched Dec. 19. Its orbital elements are: apogee, 253.53 mi., perigee, 131.12 mi., and initial period, 90.5 min. Inclination was not immediately announced.

Cosmos 23 was launched Dec. 13, with the following orbital elements: apogee, 375.33 mi., perigee, 142.92 mi., inclination, 48 deg. 58 min., and initial period, 92 min.

News Digest

Scout rocket, which has encountered technical difficulties (AW Nov. 11, p. 34), passed a critical test Dec. 19 when it launched a 12-ft. inflated sphere from the Pacific Missile Range. NASA said early data indicated all four stages burned as planned, and the air density-drag experiment sphere was injected into the planned polar orbit.

First F-111 machined parts, including aluminum wing closing ribs, have come out of shops at General Dynamics/Ft. Worth facility. Machine shops of the F-111 prime contractor are working on a three-shift basis on F-111 parts.

Research and development Titan 2 missile was fired last week from an underground silo at Vandenberg AFB, Calif. The missile, seventh Titan 2 to be launched from the base, tested total weapon system operation and evaluated various missile subsystems.

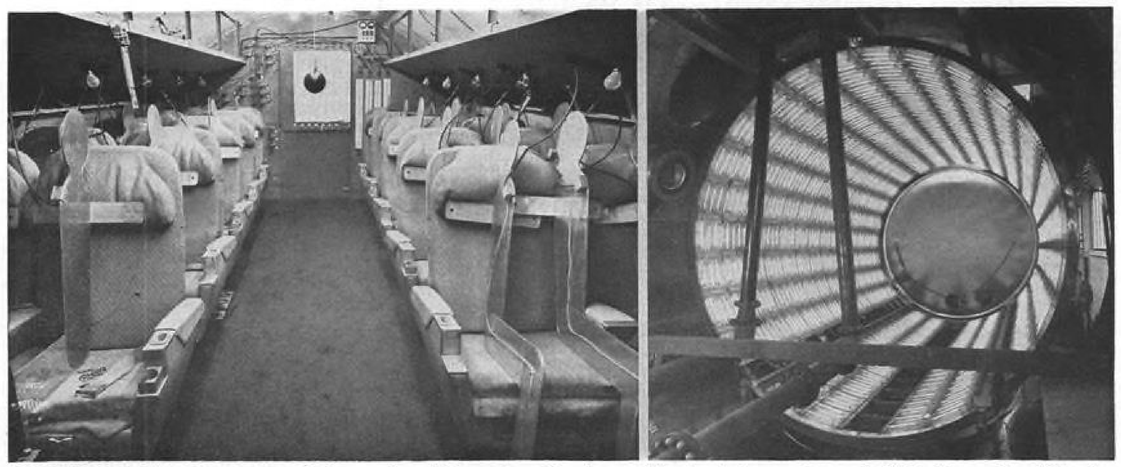
Three Atlas vehicles were launched Dec. 18 at Pacific Missile Range. The first, an Atlas D, boosted an experimental re-entry vehicle in Ballistic Systems Div.'s Advanced Ballistic Reentry program. The second launch was an Atlas-Agena combination. Third was an Atlas F in a Strategic Air Command training launch.

Douglas Aircraft Co.'s Missile & Space Systems Div. has been awarded a $48,064,658 follow-on contract by National Aeronautics and Space Administration for production of four additional S-4B flight stages for the Saturn 1B program. This brings Douglas's S-4B contract awards to a total of $197,325,140.

Congress last week voted Arms Control and Disarmament Agency a $7.5-million budget for Fiscal 1964, half of the $15 million asked by the Administration. It is $1 million more than ACDA's Fiscal 1963 budget.

Martin Titan 2, flown to a range of 5,000 mi. from Cape Canaveral on Dec. 12, was the second flight in which there was only negligible "pogo effect" or longitudinal oscillation. Air Force is now convinced that the oscillations, which were not acceptable in Gemini manned missions, have been eliminated (AW Nov. 11, p. 32).

Two YAT-37D twin-jet counter-insurgency aircraft (AW July 1, p. 57) have been turned over to USAF by Cessna for further testing. One will undergo evaluation at Edwards AFB, the other will remain at Wichita, Kan. Extensive company testing previously has covered stores configurations, including asymmetric loading.



ALUMINUM DUMMIES instrumented for a series of Concorde cabin air conditioning tests are shown (left) in the cooling laboratory mockup at Royal Aircraft Establishment at Farnborough, England. Each dummy emits 110 w. of heat, but output can be varied for testing purposes. Quartz lamps (right) provide heat which is directed onto a converted Bristol Britannia shell, in background. The shell can be moved on rails.

Farnborough Pushing Concorde Research

Royal Aircraft Establishment teams probing several areas; range stretchout is also being investigated.

By Herbert J. Coleman

Farnborough—Royal Aircraft Establishment has accelerated research programs into development of the Anglo-French Concorde supersonic transport with full-scale government backing estimated at about $12 million.

With research teams now reporting directly to L. F. Nicholson, deputy director (air), who maintains a close relationship with the French, the RAE is emphasizing:

- **Aerodynamic improvement** of the existing shape, with data fed into the program from the Bristol T.188 stainless steel Mach 2-3 research plane, and the Handley Page 115 delta wing aircraft designed to explore low speed aspects.
- **Series of drop tests** is under way from RAE helicopters, using instrumented models of the Concorde. Similar system was used in developing the HP115.
- **Considerable work** on creep and fatigue using various aluminum alloys, along with one program on titanium alloys which will be used in the hot sections, near engine nacelles.
- **New instrumentation** and navigation aids, with special section devoted to integration of supersonic transports into subsonic jet flight plans, through system of airborne and ground computers.
- **Blind landing system** specially designed for the Concorde, using considerable feedback from the British Bleu program at RAE-Bedford, and work now in progress at the Federal Aviation Agency facility at Atlantic City, N. J.

Aerodynamics team, now involved in design of droop nose using variable geometry (AW Oct. 28, p. 35), also is working on possibility of stretching the Concorde range, but Nicholson stressed that any increase must be compatible with airline economics.

Range Question

Nicholson feels that, under the present configuration of 100 passengers and gross weight of about 280,000 lb., little extra range can be gained without sacrifice for increased tankage. In his opinion, the range stretch will come as the design progresses, and through improvements in efficiency of the Bristol Siddeley Olympus 593 engines.

"Other than structural changes in tankage, and possibly research into better fuels, I can't see any major advances at this time," Nicholson said. "At least none that make economic sense to an airline."

Nicholson said results of the Farnborough tests on aluminum creep at Mach 2.2 speeds have confirmed the early decision made by technicians when Concorde design was in gestation. All figures on metal life have been established, and in some cases improved, and work is continuing in this area.

In what Nicholson considers the "social" aspects of sonic booms, Farnborough scientists have been collating boom data to establish a criteria based on temperature and weather variations. Team is working out method of estimation of boom under varying conditions, and is collecting reactions, in cases of actual booms, to determine the probable public response.

Sonic Boom

Main job in this field is to work out the degree of predictability of the boom, according to Nicholson. He added: "We are looking for the boom level below the pressure that can cause normal damage. Other than that, it looks like a program of public education will be essential."

Most elaborate series of Concorde tests, nearing completion at Farnborough cooling systems laboratory, has centered on air and fuel as heat sinks and operation of the four air conditioning systems which will be installed in the Concorde.

The laboratory can simulate conditions at 80,000 ft. up to speeds of Mach 4 outside a modified Bristol Britannia instrumented shell, where temperatures can reach 350C.

Britannia shell has 1,000 temperature pickoff points for evaluation of data, according to Frank Grinsted, officer in charge. The program was started two years ago and probably will be contracted to a private firm when unit begins testing of TSR.2 strike reconnaissance aircraft cabin and systems. The lab is still doing cockpit measurements on dummy T.188 section.

Aerodynamic Heating

Aerodynamic heating is simulated by radiant heaters mounted on reflectors around the shell, and cooling which would occur during deceleration is simulated by spraying water onto the shell at controlled rates.

Cooling laboratory has run a series of tests inside the shell, using instrumented aluminum dummies which dissipate 110 w. of heat, and in a number of programed cases, live subjects who volunteer to sit in the rig for two-hour periods.

One conditioning system checked out with humans was developed by RAE for test purposes and centered on upper cabin ducting through main channel which was perforated with hundreds of tiny holes. Conditioned air was dumped into the cabin through the holes, and then extracted through a central grill in the cabin roof, and then spilled into wall ducts.

All conditioned air in the Concorde will be re-used; i.e., in baggage compartments and wheel wells, before being dumped overboard. Technicians figure air will enter intakes at 140C, and after being tapped from the compressor sections is cooled to living room temperature before being fed into the main cabin.

Tests on fuel as a heat sink use water as simulated fuel contained in a 50-gal. tank which can be heated up to 50C. Water is pumped through various chambers at rate of 120 gpm. and chamber inlet temperatures are controlled by electronic devices.

Other fuel work is being done at the Shell Research Center at Thornton, Cheshire, to determine whether existing standards of filtration and quality control will be adequate for supersonic transports. Shell has built a supersonic transport fuel rig system in which fuel can be passed once only through SST components and simulated temperatures.

Thermal Stability

The system is designed to measure thermal stability of fuel system performance in SST aircraft, and also to test operation of pumps under high temperature conditions.

The rig allows fuel from two 12,000-gal. storage tanks to pass through microfilters and a stainless steel heat exchanger which will bring temperature to 100C and, at a 500-gph. flow rate, maintain the level for one hour.

From the heated vessel, fuel passes through two aircraft heat exchangers, which simulate the auxiliary coolers on the SST, and then through an aircraft engine oil cooler. Finally, fuel passes through a filter and high pressure pump, before being cooled and transferred to another tank.

The unit can now simulate fuel temperatures at Mach 2 levels but plans are to expand the rig to investigate stability at Mach 3.

Another British effort in this field is aimed primarily at flow equipment and control instrumentation, at a new high temperature fuel flow laboratory built as a private venture at Rochester, Kent, by Elliott-Automation, Ltd.

Laboratory can achieve a calibration accuracy of ±0.1% at flow rates from 50 to 120,000 lb./hr. and fuel temperatures within a range of from −55C to 180C. Ambient temperatures can be simulated from −60C to 230C.

Concorde Capability

London — Anglo-French Concorde could be stretched to increase passenger load and range capability, according to Dr. A. E. Russell, the British designer, but he warned that the gross weight and mass would rise proportionately.

"If that is the case, I fear that the sonic booms would be so bad we would not be allowed to operate the airplane," he said in reply to a question at a recent meeting of the London Airport Branch of the Royal Aeronautical Society.

Russell predicted that the U. S. supersonic transport will be on the order of 400,000 lb. gross weight and he said this configuration will be "completely unacceptable" as far as sonic boom is concerned.

He added that the shape of the Concorde will do much to keep the boom problem down.

In other comments, Russell told an airline pilot that the Concorde unstick speed will be 212 kt. Landing speed will be 150 kt., he said, although previous figures have been in the region of 135 kt. As far as engine noise is concerned, the Concorde will produce 120 pndb. on reaching the end of the runway, and 96 pndb. at the 4-mi. check point, he said.

Lightning Considered in 707 Crash

Washington—Civil Aeronautics Board investigators have uncovered evidence suggesting that lightning may have caused a fuel-air mixture explosion in the left wing tank of the Pan American World Airways Boeing 707 turbojet transport that crashed Dec. 8 near Elkton, Md. (AW Dec. 16, p. 43).

Pronounced burning and pock-marking on the left wing tip point to the strong possibility of a severe lightning strike, and deformation in the area of the left wing fuel tank provides physical evidence of an explosion. On the basis of such evidence, Federal Aviation Agency last week issued a Notice to Airmen warning of the possible danger of lightning.

The notice said in part that "contrary to prior history of aircraft damage due to lightning strikes, information from recent accident investigation indicates the possibility of lightning igniting fuel vapor in a fuel cell, causing major aircraft structural damage. This possibility requires that pilots continue precautionary measures to avoid thunderstorm areas. . . ."

Late last week, FAA also recommended the installation of static discharge wicks on all jet aircraft. The Pan American aircraft that crashed was not equipped with wicks. Wicks have been installed on later commercial jet models, but FAA previously had not ordered retrofitting of earlier models.

Wicks are used primarily to discharge static electricity, and there is some controversy within the industry as to whether wicks would have any value in coping with the high voltage of lightning.

Soviet SST Pace

Moscow—U. S. and Soviet Russia appear to be moving along at the "same pace" in the development of a supersonic transport, according to Federal Aviation Agency Administrator N. E. Halaby.

Halaby said last week that the Russians agreed that the early 1970s would be a "realistic" date for the introduction of scheduled supersonic transport service. He said the Soviets appear to be thinking along the same lines as the U. S. in the development and construction of the aircraft, and added that the Russians believe there is a need for a new engine for the project.

He said the Russians were concentrating on a Mach 2 or 2.5 design, and indicated that Soviet engineers felt that a Mach 3 capability would be too costly in overcoming temperature, metallurgical and technical problems.

He said both the Ilyushin and Tupolev groups are involved in the Russian program. Halaby was here to work out technical details of a U. S.-Soviet bilateral air transport agreement (see story, p. 44).

C-141 Completes Successful First Flight

By Robert H. Cook

Atlanta—First flight of the USAF-Lockheed C-141 StarLifter jet transport was completed successfully here last week, two days ahead of schedule to coincide with the 60th anniversary of powered flight.

Aircraft No. 6001, the first production line model, lifted from the runway at Dobbins AFB after a 19-sec., 2,500-ft. takeoff roll. Leo Sullivan, Lockheed chief engineering test pilot, was in command.

Fifty-five minutes later the four-engine aircraft landed, completing the first of an extensive series of flight tests scheduled to run through next year. A total of 132 aircraft have been ordered by Air Force, which anticipates having the C-141 operational by the fall of 1964 with delivery of the ninth aircraft (AW Aug. 26, p. 30).

At a gross takeoff weight of 214,000 lb., including 50,000 lb. of fuel, the aircraft rotated and lifted off at 123 kt. Test flight loading resulted in a center of gravity that was 25.1% of the mean aerodynamic chord.

Control Response

The aircraft was climbed to 8,000 ft. over an area about 100 mi. north of Dobbins, where it was tested for control response with 10-deg. bank turns to the left and right. The four-man test crew also evaluated the aircraft's electrical and hydraulic systems and the cockpit noise level. The landing gear was fully extended throughout the flight and the top speed attained was 168 kt.

The landing approach was made at 130 kt. and touchdown, with 88 deg. of flaps, was made at 115 kt. The aircraft was turned off the runway after a 6,000-ft. roll.

Application of full reverse thrust and the anti-skid brake system reduced aircraft speed to 60 kt. Turnoff after the rollout was made at 15 kt.

The StarLifter is designed for a maximum takeoff weight of 316,500 lb. and military takeoff distance at this weight of 5,300 ft. It has a maximum cruise speed of 550 mph. and a fuel capacity of 23,080 gal. or 138,500 lb.

Three days of taxi test runs were concluded on the morning of the flight. Landing gear assembly doors and covers were removed to facilitate easier inspection of the components during these tests. Replacement of emergency brake system lines to eliminate a chatter problem was the only signifiant modification made as a result of the tests. Sullivan reported that the StarLifter was able to stop within 180 ft. after brake application at 60 kt.

Lockheed considers the first flight test successful but plans to evaluate the initial test information in detail and equip the aircraft with more instrumentation before resuming flight tests within the next three weeks.

Joint Testing

Under a joint Lockheed-Air Force flight test program eight production models will be retained for testing. The ninth is scheduled for operational delivery to Air Force by next October. The company will have a production rate of one C-141 a month by next December, and two a month in January, 1965. Production rate is scheduled to reach three in March, four in April, five in July and seven before the end of the year.

The first full squadron of 16 StarLifters will be delivered to the Military Air Transport Service in June of 1965.

The company's test program is aimed at attaining dual certification for the StarLifter under Federal Aviation Agency and military regulations by January, 1965. Lockheed plans to produce a commercial cargo version of the C-141, called the L-300. First five aircraft will be tested by Lockheed and the next three by the Air Force in this sequence:

- **Aircraft 6001** will next undergo flutter flight tests, plus stability and control tests. Shakers will be mounted on the wing and horizontal stabilizer tips to create flutter conditions. Approach to stall maneuvers also will be conducted, and cruise test speed of the aircraft will be increased.
- **Aircraft 6002**, incorporating any modifications suggested by earlier tests, will undergo further speed and performance tests designed to check guaranteed performance characteristics and accumulate FAA flight manual data.
- **Aircraft 6003** will be used to test the design efficiency for troop and cargo delivery. The test will include an air drop of paratroops.
- **Aircraft 6004** is scheduled for subsystems tests required for FAA and military certification. Test areas will include hydraulic, electrical, air conditioning, pressurization, anti-icing subsystems, and aircraft noise and sonic fatigue problems.
- **Aircraft 6005** will serve as a backup for aircraft already being tested and for any miscellaneous tests required by FAA or the military.
- **Aircraft 6006** will be delivered to the Air Force at Edwards AFB for an accelerated flight test program.
- **Aircraft 6007** will be delivered to Air Force Systems Command's Aeronautical Systems Div. for all-weather testing on a global basis. Part of this test program wil be carried out at Elmendorf AFB, Alaska.
- **Aircraft 6008** also will be delivered to the Air Force at Edwards for a general maintenance and serviceability evaluation.

While the company is concentrating on the military order for the StarLifter, it remains optimistic that the proposed L-300 version will find a market among the airlines.

For one thing, they point out that dual certification on the aircraft will assure prospective purchasers there is no danger of federal rejection of the L-300 design or company reluctance to invest in gaining certification for commercial operation. Lockheed estimates the dual certification will cost the company $30 million.

On the basis of the current increase in airline passenger traffic and prospects for increased cargo carriage, the company further theorizes that trunklines now flying Boeing 707-320C and Douglas DC-8F cargo aircraft may eventually convert them to passenger use and require replacement cargo aircraft for their fleets.

Should this happen, Lockheed officials feel, the L-300 could find a ready market because of its growth potential and volume capacity. The Boeing and Douglas aircraft, with wing loadings of 113 and 109 lb. per sq. ft., respectively, are at the top of their design growth cycle, they contend, while the StarLifter, with a loading of 98 lb., is at the beginning of its growth cycle.

The StarLifter carries a maximum military payload of 70,000 lb., but as a commercial airfreighter it can be designed to carry a maximum payload of 96,000 lb. This compares with the Boeing and Douglas aircraft's payloads of a little more than 91,000 lb., the company said.

Answering airline contentions that the L-300's 21,000-lb.-thrust Pratt & Whitney TF33-P-7 fan jet engines are too powerful and costly for commercial operations, Lockheed said the powerplants could be derated for operation at lower power settings. This would provide the operator with lower operational costs on the engine and a greater span between basic overhauls.

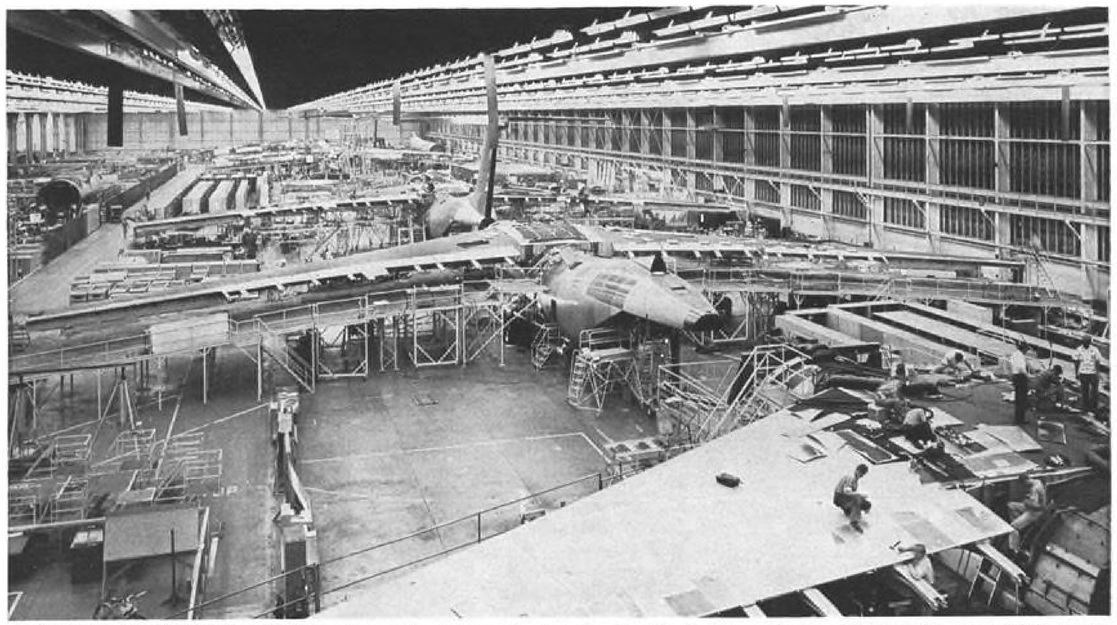
North Atlantic Fare Vote Set

Mail vote on the compromise agreement reached earlier this month on a North Atlantic passenger fare structure (AW Dec. 16, p. 45) has been distributed to North Atlantic carriers by International Air Transport Assn. However, the possibility remained that the group fare issue may bar unanimous approval of the new rates.

Deadline for voting is Jan. 7. Carriers have been warned by IATA that, if the proposed fare structure is not approved, an open rate situation will exist. The group fare was retained in the new tariff in deference to Irish International Airlines and El Al Israel Airlines, but the conditions placed on the application of the group fares are expected to draw opposition from these two carriers.

These are the principal conditions placed on the group fare under the revised rate pattern:

- **Group fares will be increased 5%.**
- **Group fares will apply only during June, July, August and September. All eastbound travel must be completed by Sept. 30, all westbound by Sept. 30.**
- **Group travel will not be valid on eastbound flights between June 26 and July 12, and on westbound flights between Aug. 21 and Sept. 6. Also, group fares may not be applied on Fridays, Saturdays and Sundays on eastbound flights during June and July, and on the same days on westbound flights during August and September.**



STARLIFTER PRODUCTION LINE at Lockheed-Georgia is producing aircraft while its first production USAF C-141 enters flight testing.

British Eagle Appeals Decision

London—Great Britain's newest independent airline, Harold Bamberg's British Eagle, last week appealed an Air Transport Licensing Board (ATLB) decision against allowing increased domestic competition with British European Airways, the state-owned airline (AW Oct. 21, p. 43).

The board had previously ruled against the British Eagle request to increase its services between London, Edinburgh, Glasgow, Belfast and Dublin, and Manchester. The appeal was being heard by Sir Arthur Hutchinson, a commissioner appointed by Minister of Aviation Julian Amery, who has sole right of veto on ATLB decisions.

Outcome of the appeal probably will set the future pattern of independent competition on internal routes with BEA, which has strongly opposed granting of parallel services on any of its routes. BEA contends that independent competition will only result in losses to the taxpayer.

On the contrary, British Eagle contends that competition will stimulate the growth of traffic and claims that the BEA traffic growth forecast is too conservative. In testimony last week, Bamberg told the commissioner that the ATLB decision was harsh and "seemed to be completely prejudiced."

Meanwhile, British Eagle has bought the Liverpool Airline, Starways, which operates to London, Glasgow and Edinburgh, with considerable vacation business to resort centers located in Wales.

British Eagle, which owns four Bristol Britannias, three Douglas DC-6s and two Vickers Viscounts, plans to buy another six Britannias and three more Viscounts.

New Proposal Averts IAM Strike at United

Washington—Negotiations between the International Assn. of Machinists and United Air Lines brought about a new company proposal last week that prevented a walkout against the nation's largest carrier during the height of the Christmas rush.

The new proposal, which union officials agreed to submit to the membership for ratification, was worked out less than 12 hr. before a company-wide strike was slated to begin at midnight Dec. 18 (AW Dec. 16, p. 34). It calls for 39-cent increases by stages to bring the hourly rate for airline mechanics to $3.52 by Jan. 1, 1965.

Western Air Lines meanwhile, has signed a labor contract with the Teamsters union, covering 700 mechanics, inspectors and other maintenance personnel. It is the fourth labor agreement reached by Western this year. The two-year contract provides pay increases of 20-25 cents an hour for personnel, and also increases Western's share of insurance payments.

Supersonic Transport Delivery Priorities

Below are the schedules of delivery priorities established for the U. S. supersonic transport and the Concorde SST under development by the team of British Aircraft Corp. and Sud Aviation:

U. S. SST Priorities

1. Trans World Airlines
2. Pan American Airways
3. Trans World Airlines
4. Pan American Airways
5. Alitalia
6. Trans World Airlines
7. Pan American Airways
8. American Airlines
9. Alitalia
10. El Al Israel Airlines
11. Trans World Airlines
12. Pan American Airways
13. American Airlines
14. El Al Israel Airlines
15. Trans World Airlines
16. Pan American Airways
17. European Foreign Flag
18. Northwest Airlines
19. Japan Air Lines
20. American Airlines
21. Alitalia
22. Northwest Airlines
23. Japan Air Lines
24. European Foreign Flag
25. European Foreign Flag
26. Trans World Airlines
27. Pan American Airways
28. Pacific Foreign Flag
29. Northwest Airlines
30. Japan Air Lines
31. American Airlines
32. Pan American Airways
33. Trans World Airlines
34. Pacific Foreign Flag
35. European Foreign Flag
36. European Foreign Flag
37. European Foreign Flag
38. U. S. Domestic
39. U. S. Domestic
40. American Airlines
41. European Foreign Flag
42. European Foreign Flag
43. Pan American Airways
44. U. S. Domestic
45. U. S. Domestic
46. Japan Air Lines
47. Trans World Airlines
48. American Airlines
49. Pacific Foreign Flag
50. Pan American Airways
51. European Foreign Flag
52. Trans World Airlines
53. U. S. Domestic
54. Pan American Airways
55. Trans World Airlines
56. Northwest Airlines
57. Japan Air Lines
58. Pan American Airways
59. U. S. Domestic
60. European Foreign Flag
61. Pan American Airways
62. European Foreign Flag
63. U. S. Domestic
64. Pan American Airways
65. U. S. Domestic
66. European Foreign Flag
67. Pan American Airways
68. U. S. Domestic
69. Pacific Foreign Flag
70. Pan American Airways

Concorde Priorities

1. Air France
2. British Overseas Airways
3. Pan American Airways
4. Air France
5. British Overseas Airways
6. Pan American Airways
7. Air France
8. British Overseas Airways
9. Pan American Airways
10. Air France
11. British Overseas Airways
12. Pan American Airways
13. Air France
14. British Overseas Airways
15. Pan American Airways
16. Air France
17. British Overseas Airways
18. Pan American Airways
19. Panair do Brasil
20. Continental Air Lines
21. American Airlines
22. Trans World Airlines
23. Continental Air Lines
24. (Unassigned)
25. American Airlines
26. Continental Air Lines
27. American Airlines
28-31. (Unassigned)
32. Trans World Airways
33. American Airlines
34. Trans World Airways
35. Middle East Airlines
36-37. (Unassigned)
38. Trans World Airways
39-48. (Unassigned)
49. Middle East Airlines

Aeroflot Will Fly Tu-114 to U.S.; Il-62 Will Follow Two Years Later

Moscow—Federal Aviation Agency Administrator N. E. Halaby said here last week that indications are strong the Soviet Union plans to use the Tu-114 turboprop transport—rather than its new, four-jet Il-62—for nonstop New York-Moscow operations for two years after service on the route is inaugurated, which could be as early as next summer.

Halaby declined to predict when the direct air service would begin. He said it would take four to six months to work out technical details before proving flights would begin. He noted, however, that both Pan American World Airways, U.S. carrier certificated to operate the New York-Moscow route, and the Russian-owned airline Aeroflot, would like to begin service next summer.

Halaby said the Soviets had indicated to him that the Il-62 would not be ready for the New York-Moscow run until 1966 (see p. 47). Halaby arrived here earlier this month (AW Dec. 9, p. 39) to initiate technical talks on the opening of air service between the two countries.

Halaby flew the Tu-114 during his visit here, but made no comment on its flying characteristics. He said the Russian decision to operate the turboprop on the route rather than the Il-62 jet threw a different light on technical issues to be discussed, particularly such subjects as noise, weight and navigational aids. U. S. has been anticipating operation of the jet on the route by the Russians. Pan American will operate Boeing 707-320 turbofan-powered transports on the route.

He said that agreements made earlier between Aeroflot and Pan American probably would require revision because of the time that has passed since they were signed. Halaby said that when the two governments reach a final agreement, Soviet aviation specialists will visit the New York International Airport and a Pan American technical team will visit Moscow.

Halaby predicted that flying time for the Pan American Boeing would be about 8 hr. 30 min. eastbound and 10 hr. 30 min. westbound. He noted that the Tu-114 would require 2 to 4 hr. more flying time than the Boeing.

Halaby said that alternate fields in Russia would be decided upon at a later date, but mentioned a U. S. preference for Leningrad and Riga as authorized alternate landing airports.

Boyd Reappointment Viewed as Certainty

By L. L. Doty

Washington—Alan S. Boyd this month will finish his third year as chairman of the Civil Aeronautics Board with a record that has earned him the high respect of the airline industry despite the controversy aroused by many of his official actions.

A poll of airline opinion on Boyd conducted by Aviation Week & Space Technology discloses that the positions taken by him in a number of Board decisions have provoked criticism, but that generally, he has emerged as one of the strongest leaders to hold the top CAB post. Industry officials and attorneys close to Board activities have no doubt that Boyd will be redesignated chairman by President Johnson at the end of the year (AW Dec. 2, p. 26).

A Board chairman is designated each year by the President from one of the five Board members. Boyd was appointed to the Board in 1959 by President Eisenhower (AW Nov. 16, 1959, p. 42) to complete the term of Louis J. Hector, who earlier had resigned in protest against the Board's organizational structure (AW Sept. 16, 1959, p. 36).

Boyd was designated chairman by the late President Kennedy in 1961. His current term as a member expires in 1968.

As chairman, Boyd often has been forced into a pivotal position—occasions when his vote has broken a two-to-two deadlock caused by the even division of opinion among the other Board members. This has tended to set him as a target for critics whose carriers lost a favorable decision as a result of the Boyd swing vote.

Boyd Votes

However, even these critics admit that Boyd has never shown any evidence that his vote was not based on perfectly legal findings and conclusions. As one observer here pointed out, "no one can cast any vote that will please everyone in the industry."

Several officials expressed the view in the survey that Boyd appears to operate with one aim in mind: to raise the profits of the airlines to a reasonable level. Several stressed that Boyd, in his votes, has never shown any signs of yielding to political pressure and has demonstrated real courage in making decisions on issues on which there were sharply conflicting opinions.

Two of the major CAB cases during 1963—the American-Eastern Merger Case (AW July 1, p. 38) and the Northeast Route Renewal Case (AW Aug. 5, p. 43)—created storms of controversy with Boyd in the center as a result of his tie-breaking vote. Political pressure in the Northeast case was strong, particularly from the New England congressional delegation, but Boyd refused to budge in his finding that Northeast could not survive financially on the New York-Florida market (AW Aug. 26, p. 38).

In the merger case, Boyd and the other two members who composed the majority disapproving the consolidation, are Democrats, and there were rumors that this group was adhering to Administration policy against reducing competition. Although a written decision in the case has never been released, these rumors have been discounted by those close to the Board.

Boyd lost some popularity in the international field when the Board, with Boyd again casting the deciding vote, disapproved the International Air Transport Assn. North Atlantic and Pacific passenger fares (AW Feb. 25, p. 43).

In retrospect, observers feel that ensuing measures taken by Boyd to force North Atlantic fares downward were done, as one person put it, "without much finesse." He added that "the differences of opinion between the U. S. and European nations on a fare level should have been handled more diplomatically, perhaps by speeches but certainly not by free-wheeling."

In the initial stages of the battle, Boyd did not appear to have full cooperation from the State Dept., and the Administration appeared to have turned its back on the problem. In addition, the Senate, aroused by European pressures to prevent a decrease in fares, handed Boyd some harsh treatment in its investigations of the case.

As a result, Boyd went to the Ottawa meeting of governments, called to seek some compromise settlement of the issue (AW July 29, p. 28), without much support at home and substantial opposition abroad. He emerged from the meeting with an agreement, and since then has been received cordially by the majority of airline and government officials in subsequent talks on the subject.

There is still resentment among many airlines against the government intercession sparked by Boyd's actions, but there is no question that fares are dropping because of his persistent drives.

One person felt that Boyd showed indications of being "trigger-happy" because of his desire for action, but this view was not shared by others interviewed. The majority expressed the feeling that Boyd's opinions carry the weight of much thought, and that he has the capability of combining action with study.

Boyd's position in the recent decision denying Pan American the right to lease cargo space to Japan Air Lines (AW Dec. 16, p. 51) evoked some surprise. Boyd joined the majority in disapproving the proposed agreement between the two carriers, which is similar in content to those approved by the Board between Seaboard World Airlines and three European carriers.

Discriminatory Issues

Because of Boyd's previous stand on discriminatory issues, it had been anticipated that he would approve the Pan American agreement. However, only Member Chan Gurney represented the minority and his dissension is typical of Boyd's independent stand on similar issues. Gurney said:

"The approval of the Seaboard agreements, while disapproving the Pan American-Japan Air Lines' agreement, is grossly discriminatory and cannot be differentiated."

LOT Rejects MD-12; Production Postponed

Geneva—Production of Poland's 20-passenger MD-12 feeder transport is being delayed indefinitely because of LOT Polish Airlines' disapproval of the piston-engine aircraft in its present form.

Under original planning, production was to have begun within the near future with the aircraft earmarked to replace LOT's aging fleet of Soviet Li-2s and Ilyushin Il-14s for use over the carrier's domestic route network. One of two prototypes was lost during flight trials.

A LOT spokesman declined to specify the carrier's objections to the MD-12. A prototype, however, has been put through extensive route proving trials over LOT's internal network for the past year and a half. Subsequent modifications have included improved cabin insulation to dampen engine noise and a change in location of the exhausts for the aircraft's four Polish-built Narkiewicz WN-3 air-cooled engines of 330 hp. each.

SHORTLINES

► **Braniff Airways** has expanded its half-fare military furlough rates to include travel between Panama and the U.S. Rates can be used by U.S.-based military personnel for vacation travel to Panama.

► **Braniff Airways** will inaugurate nonstop service between Bogota, Colombia, and Miami early next year. The service will be conducted in conjunction with the Braniff-Eastern interchange agreement that will provide one-stop service between New York and Bogota.

► **British European Airways** last month sold the last of its 23 Vickers Viscount 701 turboprop transports. The fleet was withdrawn from service in April, about 10 years after the aircraft were first introduced into scheduled service.

► **CSA** Czechoslovak Airlines has ordered two Russian Tupolev Tu-124 twin-jet, medium-range transports for operation next summer over the carrier's European network. Specific routes to be served and service frequencies have not been determined.

► **Delta Air Lines,** Braniff Airways and Northwest Airlines will sponsor exhibits at the New York World's Fair. They will adjoin one another in the Transportation & Travel Pavilion.

► **Four new directors** have been named to the Air Transport Assn. board of directors. They are: C. W. Moore, president, Chicago Helicopter Airlines; Robert F. Six, president, Continental Air Lines; Floyd D. Hall, president, Eastern Air Lines, and Hal N. Carr, president, North Central Airlines. Re-elected were: C. R. Smith, president, American Airlines; C. E. Woolman, president, Delta Air Lines; Robert W. Prescott, president, The Flying Tiger Line; Lewis W. Dymond, president, Frontier Airlines; D. W. Nyrop, president, Northwest Airlines; J. T. Trippe, president, Pan American Airways; Charles C. Tillinghast, president, Trans World Airlines, and W. A. Patterson, United Air Lines chairman.

► **National Airlines** has leased a Douglas DC-8 jet transport from Riddle Airlines to increase its capacity on the New York-Florida route during peak traffic periods.

► **North Central Airlines** carried 91,138 passengers in November—a company record. It was the 16th consecutive month that the airline has broken its own passenger boarding record.

AIRLINE OBSERVER

► U.S. domestic trunklines showed a 16.1% increase in traffic during November, compared with the same month last year. Available seat miles rose 12.1% in the same period, raising the monthly load factor to 51.2% from the 49.4% reported in November, 1962. Local service carriers showed a 13.4% increase in revenue passenger miles in November, and load factor for the group rose to 43.5% from 41.7% recorded in November of last year.

► **Speculation is growing that Pan American World Airways may move to acquire New York Airways through merger or outright purchase. Pan American already is thinking of becoming involved in the helicopter operation by assisting NYA acquire more aircraft (AW Dec. 16, p. 45). Spokesmen feel such a move will benefit both parties. NYA would be released from the financial problems that hamper its buying needed flight equipment. Pan American would gain special promotional benefit by providing service with its own helicopters between Idlewild and the Pan Am Building in New York, if and when the city authorizes use of the building's roof heliport.**

► Argentine government has ordered the Peruvian carrier Aerolineas Peruanas to eliminate its remaining Douglas DC-6 flight between Lima and Buenos Aires in light of the Peruvian airline's inauguration of Convair 990A jet transport service five times weekly to Buenos Aires (AW Dec. 2, p. 40). Argentine move was made to hold APSA's capacity to previous levels and so far, only four of APSA's five jet flights have been approved on a regular basis. Carrier must apply for authority each week to operate the fifth jet flight.

► **Aeroflot has reverted to flying nonstop between Murmansk and Havana after only three flights over the Moscow-Cuba route via Conakry, Guinea, which the Russians hoped would become a regular service (AW Mar. 23, p. 36). However, after the initial flights, Guinea barred the Russians from using the Russian-built airport at Conakry. U.S. pressure is credited as the reason for the ban, which still exists although Guinea has authorized several "special" Russian flights when prior permission was requested. One of the big reasons Russia is eager to sign a bilateral agreement with the U.S. for a New York-Moscow service is to convince Guinea that the U.S. is unconcerned whether Aeroflot operates into Conakry.**

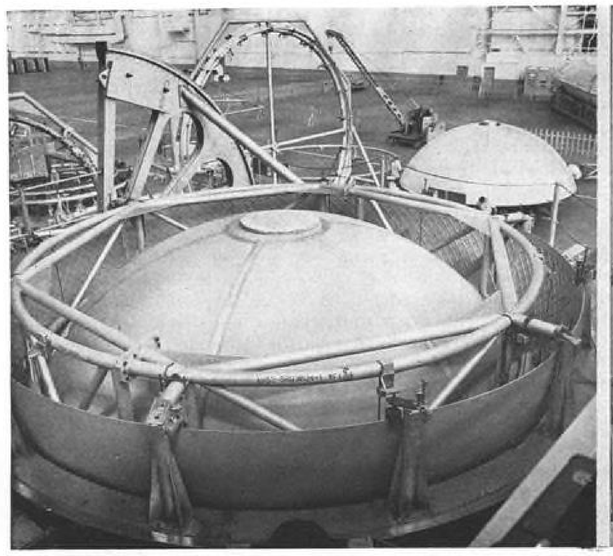
► Results of three-month program in Australia, testing effects of clear air turbulence as it will apply to the Anglo-French Concorde supersonic transport, are being evaluated by Royal Aircraft Establishment at Farnborough. Tests were conducted using specially instrumented English Electric Canberra jet bombers. Similar tests are being conducted by the French.

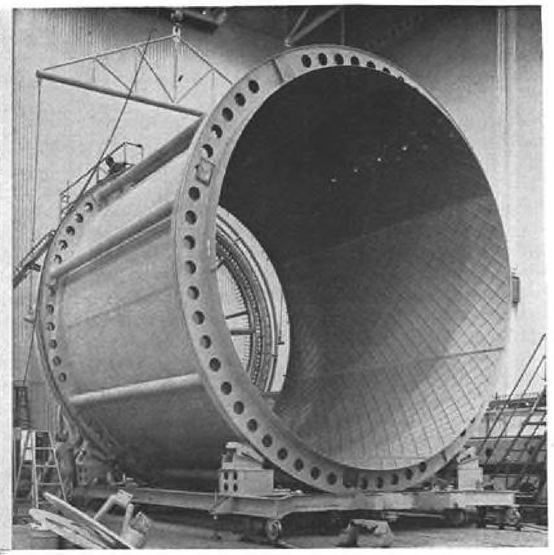
► **National Airlines has asked the U.S. District Court in Miami to prohibit Northeast Airlines from operating into the Dade-Broward County area, which contains Miami and Ft. Lauderdale. Northeast is operating under a court order obtained in Boston after the Civil Aeronautics Board canceled its Florida route certificate. National contends that the Boston court order is invalid because it grants a stay of Northeast's route certificate—a certificate National says does not exist because of the earlier CAB cancellation (AW Sept. 9, p. 40).**

► Ilyushin Il-62 180-passenger, four-jet transport is now flying an all-cargo proving operation between Moscow and Khabarovsk in Siberia. Aeroflot does not plan to use the new aircraft for passenger service before 1965.

► **First flight of the Short Belfast turboprop transport for Royal Air Force (AW Oct. 21, p. 45), is set for Dec. 31 at Short Bros.' Northern Ireland production facility. Aircraft is now undergoing taxi tests.**

► Central African Airways will continue as the national flag carrier for Southern and Northern Rhodesia and Nyasaland even though the governments of the three countries have dissolved their federation. Governments of the three nations have formed a new corporation giving them joint ownership of the airline, which will retain Salisbury, Southern Rhodesia as its home base (AW Feb. 11, p. 45). Carrier operates Vickers Viscounts, Douglas DC-6s and de Havilland Beavers.





COMMON BULKHEAD for Douglas S-4B propellant tanks sits inside the tank's aft dome in preparation for welding. The operator and the welder enter the cavity between the two domes through a tank dome manhole. The welder remains stationary while the fixture in which the dome sits is revolved. The space formed by the common bulkhead and the aft dome of the propellant tank is the liquid oxygen tank section of the S-4B. Note ring of waffle-grid chemically milled into the upper portion of the aft tank dome's inner surface. A foam pad has been placed, for handling purposes, on the welded dollar-fitting atop the bulkhead. First complete production-type S-4B propellant tank cylinder yet assembled is prepared (right) for butt-welding of angle rings to cylinder ends. The large wheel-welder fixture, which can be partly seen through the cylinder, clamps the rings to the cylinder end using air and nitrogen pressure. The fixture, and the cylinder, are rotated by a motor on the jig upon which the cylinder rests. The arc welding head is on the tower at upper rear where worker is positioned. Liquid hydrogen would fill the cylinder portion on a flight article. This cylinder is being built for S-4B-S, the structural and hydrostatic testing vehicle.

Different Missions Altering Basic S-4B

By Harold D. Watkins

Huntington Beach, Calif.—Douglas S-4B upper stage for two of the three Saturn launch vehicles now planned represents a technological stretch capitalizing on basic design features of the earlier S-4 Saturn stage, but with its own set of problems. Among the more pressing concerns are re-start capability, weight, and a tight schedule ordered by the National Aeronautics and Space Administration.

Douglas Aircraft Co.'s Missile & Space Systems Div. has the contract with NASA's Marshall Space Flight Center for the liquid hydrogen-fueled S-4 and S-4B. Douglas has a major propulsion stage, as a result, on each of the three Saturn launch vehicles.

Distinct Configurations

While similar to the S-4 in primary dimensions and other key features (AW Sept. 16, p. 54), the S-4B will be produced in two distinct configurations:

• **S-4B/1B will be** the upper stage of the two-stage Saturn 1B vehicle, designed to permit earth orbital testing of the entire three-module Apollo spacecraft. As presently planned, the S-4B/1B will operate with a single, continuous burn to provide the final thrust to place the spacecraft in orbit.

• **S-4B/5 will serve** as the third stage of the three-stage Saturn 5, the vehicle intended to boost the Apollo spacecraft to the moon. In its more sophisticated mission, the S-4B/5's engine will burn initially for about one-third of the eight min. burn time required to place the Apollo spacecraft in an earth parking orbit. After a 4½ hr.-maximum coast period for checkout and navigational calculations, the S-4B/5 rocket engine will restart and propel the spacecraft into its translunar trajectory.

Both versions of the S-4B will be powered by a single J-2 engine produced by the Rocketdyne Div. of North American Aviation, Inc. Utilizing liquid hydrogen fuel LH_2 and liquid oxygen (LOX) oxidizer, the J-2 is designed to produce 200,000 lb. of thrust. As currently planned, the two S-4B models also will have identical propellant tank assemblies which will use the common bulkhead and internal insulation technique that is utilized in the S-4.

But their different missions produce some important differences between the S-4B/1B and the S-4B/5. Most critical operational distinction is the re-start capability requirement for the S-4B/5, which requires such features as a tank repressurization gas supply, a more elaborate venting system for LH_2 boil-off and greater auxiliary propulsion and ullage motor capabilities.

Interstage Flared

The auxiliary propulsion system will be utilized for attitude control during lunar transit and for steadying the Lunar Excursion Module of the Apollo spacecraft as the command-service module conducts its nose-to-nose transposition maneuver with the LEM. After this maneuver is completed, the S-4B/5 is to be separated from the spacecraft. Current plans for this separation do not involve retro-rocket firing on the S-4B/5.

The S-4B/5 also will have sturdier skirts and aft interstage due to heavier loads to be experienced on the more powerful Saturn 5. Its aft interstage will be flared to match the broader diameter of the S-2 stage, whereas sides of the S-4B/1B interstage will be vertical to mate with the slimmer S-1B.

Added equipment and structural strength of the S-4B/5 make it heavier than the S-4B/1B. Present design status for early research and development flight articles shows a dry weight, not including the aft interstage, of 25,500 lb. for the S-4B/5 and 21,700 lb. for the S-4B/1B. An unfueled S-4, by contrast, weighs 14,100 lb.

Major elements of the two S-4B vehicles are presently scaled as follows (with S-4B/5 given first): airframe structure—14,000 lb. and 13,000, propulsion system and accessories—6,300 and 5,000, and equipment and instrumentation including auxiliary propulsion system—5,100 and 3,700.

Weight Reduction

A growth trend in weight of the S-4B is conceded to be undesirable, although Douglas maintains that most of the weight gains have been produced by changes ordered at Marshall. Douglas and NASA officials are anxious to restrain the growth trend, and discussions are under way to establish specified weights for both vehicles. Indications are that these weights could be as much as 2,000 to 3,000 lb. less, respectively, than the present weight status of the Saturn 1B and 5 configurations of the S-4B.

A Douglas official contends, however, that "weight is not a matter of great concern." He said it is considered feasible that a combination of weight shaving and performance gains will produce a possible weight reduction equivalent of more than 3,000 lb. for the operational version of the S-4B/5, and perhaps less than 3,000 lb. for the S-4B/1B.

Items include a reduction in instrumentation from the R&D vehicles to the operational versions, a review of structural margins, improvements in internal insulation which could reduce boil-off or trim weight, and movement to the aft interstage of some equipment that is not needed following the separation.

Approximately 1,000 lb. was added to the tankage in late spring when it was necessary to increase the skin thickness of the LH_2 cylinder wall to .134 in. from the .117 in. originally calculated by Douglas engineers. A more precise definition of tank pressure requirements, including a clarification of engine operation data, resulted in an upward revision of 6 psi. which necessitated the thicker skin. Provisions for coast and re-start have also contributed to the growth trend in poundage.

Basic design features inherited by the S-4B from the S-4 include:

• **Both are self-supporting cylindrical** structures with a single propellant tank in which the aft LOX tank is separated from the LH_2 tank by a common bulkhead. This bulkhead sandwich consists of two aluminum domes with a fiber glass honeycomb layer in the middle. The structure provides both insulation and structural stiffening. Douglas engineers estimate roughly that the single tank and common bulkhead design provides length savings of 6 ft. and a consequent reduction in weight of 500 lb. over a similar vehicle with two separate tanks.

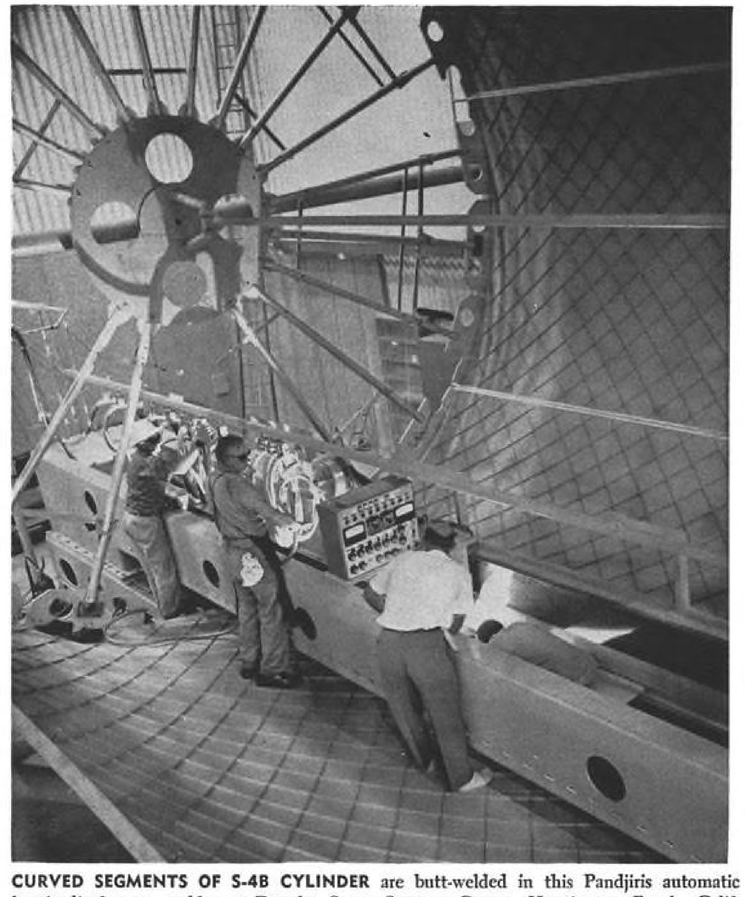
• **Cylindrical portion of both tanks** is 2014-T6 aluminum alloy, in which a waffle-grid for integral stiffening is machined. Segments of these panels are then butt-welded to form the cylinder walls. This is basically how Douglas builds the tanks on its veteran Thor booster.

• **Thrust structures of S-4 and S-4B** are conical and tie in directly at a tangent to the aft dome of propellant tank. Douglas designers are quick to point out that this provides a short load path and distributes the thrust load over the entire circumference of the cylinder.

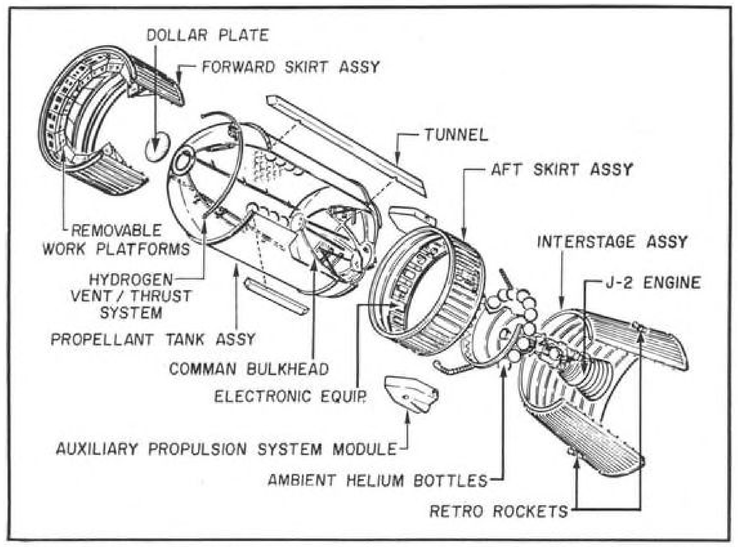
• **Douglas-developed internal insulation** is used in the LH_2 tanks.

Despite these strong traces of a common heritage, the S-4B clearly shows it is a member of a later generation. Most obvious differences are stage size and the engines. The Rocketdyne J-2-powered S-4B is about 58 ft. long with a cylinder of 21 ft. 8 in. in diameter. In contrast, the S-4 is only 41 ft. tall and 18 ft. 4 in. in diameter. Six Pratt & Whitney RL-10A-3 engines, each generating 15,000 lb. of thrust, will push the S-4 to a total of 90,000 lb., compared with the 200,000-lb.-thrust J-2.

Other changes made in the S-4 concept, either to accommodate the differ-



CURVED SEGMENTS OF S-4B CYLINDER are butt-welded in this Pandjiris automatic longitudinal seam welder at Douglas Space Systems Center, Huntington Beach, Calif. Seven segments are progressively joined on the welder to form the entire propellant tank cylinder. Arc welding head is beneath the instrument panel over the left shoulder of the worker in white shirt. The welder is of the metal transfer type, using wire rod of the same 2014-T6 aluminum alloy of which the segments are made. Each weld, 22 ft. long, is completed in 7 min. with the welding head moving over the seam. Spokes at the end of the cylinder are part of the jig supporting the tank as successive segments are added.



EXPLODED VIEW of S-4B/5 stage shows location of common bulkhead between liquid hydrogen fuel tank and liquid oxygen oxidizer tank. Note auxiliary propulsion module pod, formerly called the attitude control system. S-4 and S-4B contracts held by Douglas now total $364,105,000.

ent S-4B mission or for other reasons, include:

• **S-4B will be built** on the modular principle dictated by NASA for the Saturn 5 vehicle. Main subassemblies of the S-4B—skirts, thrust structure and aft interstage will be bolted on and detachable from the central propellant tank. On the S-4, only the aft interstage broke away as other structures were welded on. Modular concept will also be used to simplify replacement of propulsion accessories and other S-4B equipment.

• **Skirts and aft interstage** of the S-4B represent a return to aircraft-type skin and stringer construction. In S-4, these were made of aluminum honeycomb. Heavier loading on S-4B permitted the change to the more-easily-fabricated skin and stringers.

• **Factory, test-firing** and pre-launch checkout of the S-4B will be made with an automatic, computer-controlled system developed by Douglas. S-4 checkout is done with a manual system.

S-4 Competition

Douglas was chosen in April, 1960, among 11 companies competing for the S-4 contract. The company was subsequently given a NASA contract in August, 1962, to modify the vehicle for the more powerful Saturn 5, as the S-4B. A later contract was extended in October of that year to make design changes to utilize the S-4B in the Saturn 1B. Although its contract was awarded later, the S-4B/1B will be tested and produced before the S-4B/5. The changes to utilize the S-4B in the Saturn 1, scheduled to make its first test flight with a live S-4 late next month (AW Dec. 16, p. 39), will enable the launch vehicle to place the Apollo command module into earth orbit.

Total value of the Douglas S-4 and S-4B contracts to date is $364,105,000. Development and production of four test and six flight articles of the S-4 is worth $116,834,000. Another six S-4 flight vehicles had been tentatively planned, but were not contracted. NASA's decision to reduce the number of Saturn 1 launches has eliminated them (AW Nov. 4, p. 27). Other current Douglas Saturn contracts are $143,731,000 for development and production of five test and six flight vehicles for the S-4B/5, and $53,540,000 for four flight stages of the S-4B/1B. For the most part, the S-4B test stages will be used first to examine the 1B configuration, and then will be converted to the Saturn 5 design for testing.

NASA and Douglas are negotiating for the production of four more S-4B/5 flight articles, two of which would be for inert flight.

Structural Assemblies

Main structural assemblies of the S-4B are the forward skirt, the propellant tank, the thrust structure and the aft skirt. The aft interstage, connecting the S-4B to the stage below, is being built by Douglas.

Forward and aft skirts each are built with the riveted skin and external, hat section stringer method from 7075-T6 aluminum alloy. Only minor differences exist between the two S-4B ver-

sions in the forward unit which encircles the front end of the propellant tank. In both instances, .032 in. gauge skin is used in the 10 ft., 2 in.-long structure. There are 108 hat section stringers on both versions but stringers on the S-4B/5 are somewhat heavier. Three intermediate frames and two closing rings, also of 7075-T6, support the forward skirt. The rear ring is bolted to an angle ring welded to the forward end of the propellant tank cylinder, and that is mated with the vehicle guidance instrument unit to be furnished by the Marshall center.

The 7 ft., 1½ in.-long aft skirt, between the propellant tank and the aft interstage, encircles the aft dome of the tank. Skin on the S-4B/5 version is .040 in. gauge, compared with .032 in. on the S-4B/1B. There are 144 stringers on the Saturn 5 vehicle, 32 more than on its 1B version. Three intermediate frames and two closing rings are also used in the aft skirt.

Four Retrorockets

Inner surfaces of each skirt will be used to mount electronic gear. An umbilical panel will be on the aft skirt. A shaped-charge in the aft skirt will separate the S-4B from its aft interstage just forward of the joint. Four solid propellant retrorockets, each with a nominal 35,000 lb. of thrust, will be mounted 90 deg. apart on the aft interstage to assist in separation.

The propellant tank has cylindrical sides and a forward and aft dome. The common bulkhead is attached to the aft dome. The LOX tank section, formed by the aft dome and the common bulkhead, is assembled as a unit and then attached to the cylinder. The main cylinder section is the LH_2 tank.

Propellant tank domes are hemispheres made of nine butt-welded, truncated pie-shaped segments made from 2014-T6 aluminum alloy. Dome sections are curved by stretch-forming and are etched to desired thickness by chemical milling. Pie-shapes are trimmed to provide circular holes in the center of each dome.

In the forward dome segments, weld pads around four edges are .129 in. thick and the center is .064 in. gauge. A removable manhole cover 36 in. in diameter is bolted over the forward dome hole to provide access for insulation and helium bottles in the LH_2 tank, and to permit other servicing.

The aft dome is a much stouter component, because of heavier loadings. A 30 in. wide band around the hemisphere's open end is chemically milled in a waffle-grid for integral stiffening. Weld and attachment pads for the common bulkhead, thrust structure and sump, where LOX line is attached, are .191 in. thick. Thickness of the dome skin's smooth part varies from .082 in its upper portion to .092 at the aft end.

Cylinder walls are formed from seven 2014-T6 rectangular panels ¾ in. thick, which are machined while still flat. Waffle patterns are 9½ in. squares, from rib center to rib center, set at 45 deg. to the vertical. Panels are then brake-formed and butt-welded longitudinally. Angle rings for attaching adjoining structures are welded to ends of the completed 22 ft.-long cylinder.

Butt-Welded Domes

Common bulkhead fabrication presented Douglas engineers with problems, that in words of one of them, "were a real nightmare." Forward and aft domes of the common bulkhead are made of 2014-T6 aluminum alloy. The center layer of fibre glass honeycomb is 1¾ in. thick. Nine pie-shaped segments are stretch-formed and then butt-welded to form the two bulkhead domes. Center of each dome is a 36 in. dia. dollar-plate. Forward dome is somewhat thinner varying from .032 in. gauge to .100 in. at welds, while aft one is .055 in. to .105 in. at welds.

Each dome is butt-welded to a "T"-shaped ring prior to bonding fibre glass sandwich "filling" to first the aft and then the forward dome. Hand-sanding of fibre glass is necessary to assure a 100% bond. Space between the "T"-rings at dome's edge is then filled with a foam insulating material and is sealed by welding. The entire common bulkhead structure is then both fillet-welded and secured by two rows of bolts to the aft dome of the propellant tank. No bolts enter the LH_2 section.

Slosh baffles are placed in the LOX tank only. These are conical rings supported by trusses attached by some of the bolts that hold the common bulkhead in place.

Internal Insulation

Propellant tank ends are completed by lap-welding domes inside the cylinder, using interference fits.

Insulation is applied internally to the LH_2 section only. The carefully guarded insulating process also presented Douglas engineers with some serious problems such as adhesion, absorption and structural integrity of the insulating material in the −423F environment of LH_2.

Primary insulating material is polyurethane foamed-tile blocks cut to fit waffle-grids of the tank's interior surface. Over-lapping lips interlock over ribs. A three-dimensional weaving process using fibre glass thread is used in forming foam blocks to provide reinforcement. A layer of a fibre glass-like material is placed over the blocks and this in turn is covered by layers of other resins. The common bulkhead end of the LH_2 tank is only covered with insulation to about 1½ ft. in from the tank walls.

Fuel tank pressurization will be provided by gaseous hydrogen which will be ducted away from the main flow of gas to the engine pump, after LH_2 has been warmed by being used to cool the engine bell. The LOX tank will be pressurized by gaseous helium carried in eight titanium spherical tanks placed inside the LH_2 tank. From these tanks, helium will pass through a heat exchanger on the engine to raise pressure prior to entering the LOX tank.

Repressurization for engine restart on the S-4B/5 after an orbital coast will be provided for with 10 spherical helium tanks to be mounted on the exterior of the thrust structure. Eight of these ambient gaseous storage tanks will be for LH_2 repressurization and two are for LOX make-up pressure. LH_2 pressure during the second burning period will be maintained between 35 and 38 psia., compared with 28 to 31 psia. during initial burning. One key reason for elevating pressure during second burning is to insure a liquid state of hydrogen by eliminating the possibility of gas pockets.

LOX tank pressure during both periods is 37 to 40 psia.

Total usable propellant tank capacity is approximately 230,000 lb. with a nominal oxygen-to-fuel mixture ratio of 5-to-1. That results in an LH_2 capacity of some 38,000 lb. and a LOX capacity of about 192,000 lb. Fuel and oxidizer tanks each are drained by a single,

S-4B Subcontractors

Huntington Beach, Calif.—Major subcontractors and suppliers to Douglas Aircraft Co. on the S-4B Saturn vehicle stage include:

- **Marquardt Corp., Van Nuys, Calif., $3,315,000—ullage rocket engines.**
- **Control Data Corp., Minneapolis, over $2 million—ground support equipment computer systems.**
- **TRW Electromechanical Div., Thompson Ramo Wooldridge, Inc., Cleveland, $1,300,000—auxiliary propulsion engines.**
- **Consolidated Electrodynamics Corp., Pasadena, Calif., over $100,000—magnetic tape recorders.**
- **Honeywell, over $100,000—Aeronautical Div., Minneapolis, sensing probes, and Brown Instruments Div., Philadelphia, oscillographs.**
- **Frebank Co., Glendale, Calif., over $100,000—propulsion system pressure switches.**
- **Moog Servocontrols, Inc., East Aurora, N. Y., over $100,000—hydraulic actuator assemblies.**
- **Reynolds Metals Co., McCook, Ill., and Aluminum Co. of America, Davenport, Iowa, both over $100,000—aluminum alloy sheet and plate.**

flexible, low pressure insulated line. The LH_2 outside diameter is 11 in. and the LOX line is 8 in. in diameter.

The thrust structure is a conical-shaped, skin and "J"-stringer riveted assembly of 7075-T6 alloy. Skin gauge ranges from 0.32 in. forward to .062 in. at the aft end. A thrust casting of 356-T6 aluminum alloy is bolted there for attaching the J-2 engine, the two feed lines and two actuators for gimballing. The gimbal block will be provided by Rocketdyne. No heat shield will be built into the S-4B.

Stop-to-stop gimbal capability of the engine will be 7½ deg. While the engine will provide pitch and yaw control, the auxiliary propulsion system must be used to control roll on the single-engine S-4B. Two self-contained auxiliary propulsion modules will be mounted 180 deg. apart on the aft skirt and lower edge of the cylinder of both S-4B versions. The S-4B/5's larger system has five motors, compared with three on the S-4B/1B. The two additional ones are a large and a small ullage motor, pointed aft.

Positive Expulsion

The auxiliary propulsion motors are fed from two common tanks, one containing unsymmetrical dimethyl hydrazine fuel and the other holding the oxidizer, nitrogen tetroxide. The hypergolic propellant is fed to motors by a positive expulsion system using stainless steel bellows pressurized by helium carried in tanks within the auxiliary propulsion module.

The two large ullage motors in the S-4B/5's auxiliary propulsion system are fired prior to the first and second burning periods of the J-2. The smaller ullage motors are used in the process of venting the LH_2 intermittently during the earth orbit coast before restarting. These small motors will be used prior to venting cycle to settle LH_2, as a back-up to a centrifugal-type vent separator, designed to prevent liquid from accidentally being dumped overboard during venting.

In the S-4B/1B, the LH_2 tank will vent directly overboard through ducts. Tank settling prior to single ignition will be provided by three solid-propellant ullage motors mounted at 120 deg. distances around the aft skirt.

Skin and hat section stringers on both models of the aft interstage are made of 7075-T6 aluminum, with the Saturn 5 skin gauge .040 in. and the Saturn 1B version .032 in. The heavier S-4B/5 has 144 stringers and the S-4B/1B has 112.

The truncated cone-shaped interstage of the S-4B/5 is 19 ft. in vertical height, 21 ft. 8 in. in diameter at the forward end and 33 ft. dia. where it meets the S-2. Seven frames and two closing rings form the core.

J-2 Rocket Engine Production Line

Thrust chamber production line for hydrogen-fueled J-2 engine is under technical direction of National Aeronautics and Space Administration's Marshall Space Flight Center. Rocketdyne, a division of North American Aviation, is producing the J-2 to power the upper stage of Saturn 1B, and, later, Saturn 5. It produces 200,000 lb. of thrust. Engine simulators already have been delivered.

Interstage of the S-4B/1B is a cylinder 18 ft. 8 in. high, with 21 ft. 8 in. diameter. This structure is built up around eight reaction beams 9 ft., 7 in. high. The beams match the eight load-points of the spider beams of the S-1B booster on which this S-4B sits. Each of these 7079-T652 aluminum reaction beams weighs 66 lb. Eight frames plus two closing rings are used in the interstage.

Most of the manufacturing facilities of Douglas will be used in turning out the S-4B. Bulk of the work, however, will be concentrated at the new Space Systems Center here and at the Missile and Space Systems Div. plant at Santa Monica, Calif. Final assembly and checkout will be carried out here and Santa Monica will produce most of the fabricated parts. In general, no attempt has been made to duplicate here the manufacturing facilities that Douglas has elsewhere.

Douglas' engineering effort on the Saturn program is now headquartered at Huntington Beach, following a personnel move last month from the division's Culver City, Calif., facility. Approximately 2,000 are involved in Saturn engineering here.

Among the S-4B work being done at other Douglas plants, the Tulsa Div. is engineering and manufacturing the auxiliary propulsion system module structure and the panels for the S-4B/5 interstage. Some of the S-4B handling equipment, including the transporters, also are being made at Tulsa.

The Aircraft Div. plant at Long Beach, Calif., will brake-form the cylinder panels for the propellant tank. Some of the jigs and tooling are being built at the Aircraft Div.'s Torrance, Calif., facility.

Six-Tower Complex

Following assembly of the propellant tank cylinder in automatic welding machines located in the 120,000 sq. ft. manufacturing and assembly building here, normal production flow will route the cylinder to the 117 ft.-high tower complex, which contains six towers. Like several of the other facilities at the Space Systems Center, the tower complex is still under construction but Douglas officials believe most of the buildings will be completed soon. First assembly work here began last August.

In the tower complex, the propellant tank cylinder will be placed in one of two assembly towers. The forward dome and the LOX tank assembly, completed

ELDO Blue Streak Stage Shipped

First flight round of Hawker Siddeley Dynamics Blue Streak launcher, first stage for the European Launcher Development Organization (ELDO) space vehicle, was to be shipped last week from Stevenage, England, production plant of Hawker Dynamics to Woomera, Australia, rocket range (AW Dec. 16, p. 40). Markings in center section are tracings for Woomera cameras (AW Dec. 9, p. 66).

in Santa Monica, will be welded to the cylinder here, using a rotating table. (There is a total of 1,384 ft. of welding in each S-4B.)

Next step will be to the hydrostatic test tower for pressure and leak tests. From there the emerging S-4B is shifted across the aisle to the cleaning and degreasing tower where tanks are vapor degreased with tricholoroethylene and then dried with heated, filtered air. Following a leak test of joints, the tank is moved to one of two adjacent insulation chambers where in a horizontal position the insulation is placed in the LH_2 tank. Helium tanks also are installed at this time. The tank is then returned to the cleaning tower, where the LH_2 section is cleaned with a detergent solution, rinsed and dried with controlled air.

Next step is to an assembly tower where the skirts and thrust structure are bolted on. The aft interstage is not connected at Huntington Beach, but will be shipped separately to the Atlantic Missile Range and attachment will be performed there.

The final step here is in one of two checkout towers, where the engine, auxiliary propulsion system modules and tunnels are installed, as are remaining electronics and other miscellaneous equipment. Final factory checkout will be made with the automatic checkout system which Douglas is designing and building under its S-4B contracts. Douglas will supply five of these systems. Two will come here—one for factory checkout and one for research and development purposes—two will go to the S-4B static test firing stands at the Douglas field station near Sacramento, Calif., and one will be sent to Cape Canaveral, Fla.

Following completion of the checkout here, the routine S-4B schedule for flight articles calls for shipment to Sacramento for acceptance firing, followed by transfer to Cape Canaveral for mission firing. At present, shipment by water is contemplated.

About 60% of the production drawings on the S-4B/1B have been released by NASA. This includes virtually all the tanks, on which release later for S-4B/5 is regarded, at this point, as a formality. While cold-flow battleship tests are expected to begin on schedule early next spring, hydrostatic tests of the first production type tank will be approximately two months or so late. It was first planned these tests would be initiated in January or February of 1964, but March or April look more likely now. Problems of acquiring necessary engineers and getting them oriented and operating effectively is the principal cause of the slippage to date, rather than tank design changes say Douglas officials.

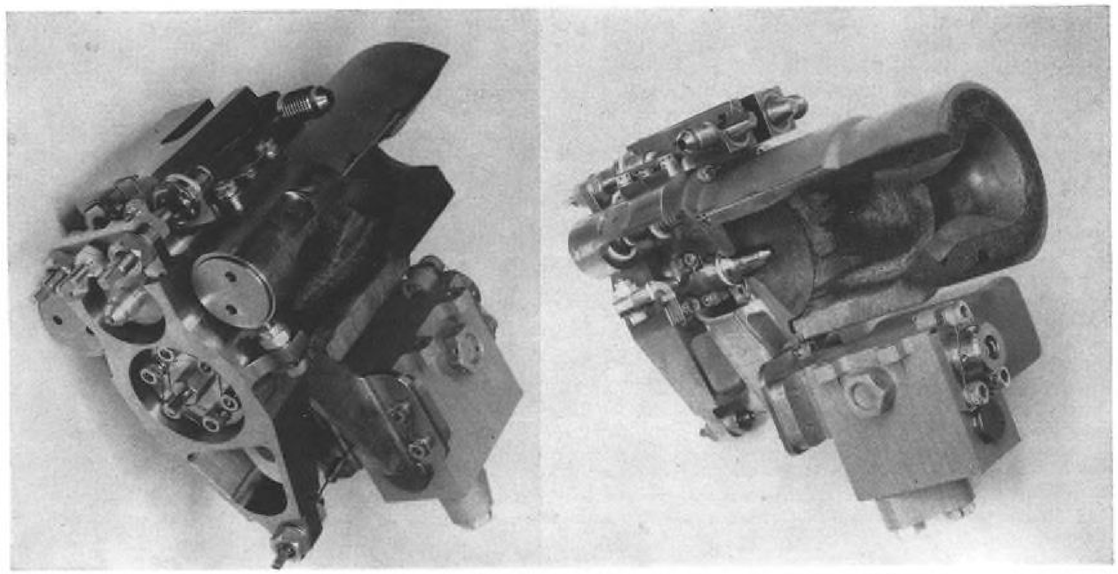
The battleship vehicle tank, built at Sacramento of heavy gauge stainless steel, is undergoing final preparation before installation in a static test tower at the field station. The cylinder wall of the first production-type propellant tank, for the structural and hydrostatic test vehicle S-4B-2, has already been welded together here. Although other major structural components will not be attached to the tank of the structural test vehicle, a set of skirts, thrust structure and aft interstage will be built for each of the S-4B versions for separate testing.

Work also is just getting under way here on assembly of the second ground-test vehicle (S-4B-D), the dynamic testing stage scheduled to be delivered to NASA at Huntsville in late 1964. It will be built in the S-4B/1B configuration, initially.

At the conclusion of Saturn 1B tests it will be converted to the Saturn 5 version.

The remainder of the S-4B schedule is presently laid out as follows:

- **S-4B-A/S.** The all-systems ground-test vehicle on which tests are scheduled start in January, 1965. This vehicle will be tested at Sacramento and will remain there indefinitely for a continual checkout of systems and improvements during the S-4B program. This will be the first vehicle with a complete automatic checkout system and will also be the first flight S-4B to be static fired. It will start as a S-4B/1B and will be converted to the S-4B/5 configuration.



Surveyor Mid-Course Guidance, Landing Engine Shown

Details of variable-orifice injector design proposed for the Surveyor mid-course guidance and landing engine are shown in this cutaway. TRW Space Technology Laboratories of Thompson Ramo Wooldridge designed the engine as an alternate for the Hughes-Surveyor spacecraft under a contract with the Jet Propulsion Laboratory (AW June 3, p. 31). Monomethyl hydrazine fuel is introduced through a variable-area orifice between the injector tip and the sleeve. Nitrogen tetroxide oxidizer flows through the ring-shaped opening between the injector face and the sleeve. Phase two specifications, under a recent $645,000 contract, are for throttling over a 20 to 180-lb. thrust range using fuel as a working fluid for the valve-injector servo actuator, rather than hydraulic oil. Throat is tungsten, while the remainder of the chamber is a standard ablative material.

- **S-4B/1B-1.** This is the first flight vehicle and is due to be acceptance-fired in February or March of 1965, then shipped to Cape Canaveral. It will be a part of vehicle SA-201, which will be composed of S-1B-1, the S-4B second stage, guidance package S-IU-201, and presumably some Apollo spacecraft payload. August, 1966, has been mentioned as a tentative date for launching the first Saturn 1B.
- **S-4B/1B-2.** Another flight article, for SA-202.
- **S-4B-F.** The facilities checkout vehicle for testing S-4B loading equipment at the Atlantic Missile Range. Originally planned as part of the Saturn 5 program, there are discussions now between Douglas and MSFC about moving this vehicle up on the schedule, in order to assure that it is ready for first Saturn 1B launch.
- **S-4B/1B-3 and S-4B/1B-4.** Two more flight articles.
- **S-4B/5-3.** This is the first Saturn 5 configuration contracted for, and would be a flight article for vehicle SA-503. It is scheduled to be acceptance-fired in the early spring of 1966. Following this vehicle there would be five more flight S-4Bs in the Saturn 5 configuration—S-4B/5-4 through S-4B/5-8.

At the present time there are no inert flight vehicles contracted for in either the 5 or 1B configuration. Negotiations, however, now being conducted between NASA and Douglas would provide for two inert Saturn stages—S-4B/5-1FD and 5-2FD—which would be produced before the first flight article for Saturn 5—S-4B/5-3. If ordered, the first inert vehicle would be completed in the fall of 1965. The present Saturn 5 program includes two flights with inert upper stages. SA-501 would have a live S-1C booster and inert S-2 and S-4B. SA-502 would have live S-1C and S-2 stages and an inert S-4B.

Average production time for a S-4B flight vehicle is estimated at approximately 11 months to a year from time of the first fabrication until checkout is completed at Huntington Beach. Acceptance firing at Sacramento probably will consume an additional three months.

Fuel Freezing Dynamics Studied

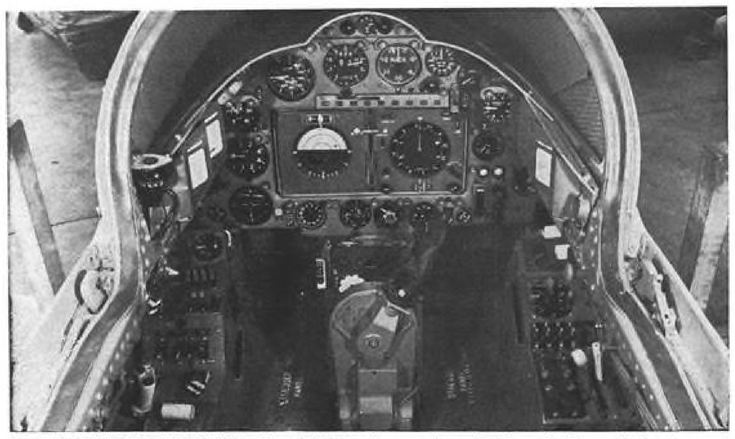
Washington—Freezing dynamics of liquid rocket propellants in space are being studied by Atlantic Research Corp. in its recently completed high-altitude combustion research tunnel which uses a five-stage steam ejector to maintain a constant vacuum.

The liquid-propellant studies are financed by a one-year, $200,000 National Aeronautics and Space Administration contract, and involve exposing liquid propellants, such as hydrogen, nitrogen, oxygen, alcohol and hydrocarbon fuels, to instant vacuum in the chamber.

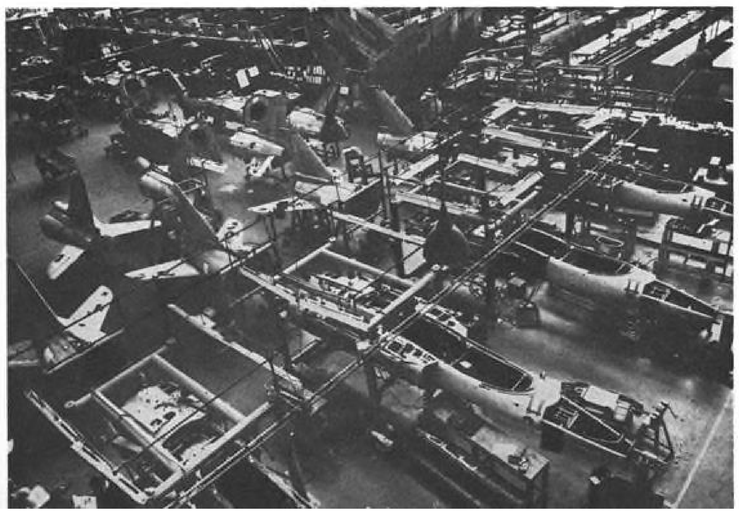
Liquid fuels released in space erupt into a boil and then cool quickly and freeze, according to Dr. Raymond Friedman, Atlantic Research vice president. Propellant freezing characteristics can affect the restart capabilities of rocket engines in space, the venting of unused fuel from tanks and the leakage rate from tanks pierced by meteorites, he said.

Aerodynamic studies of rocket wakes and plumes in a vacuum also will be conducted in the 25-ft. long, 6-ft.-dia. chamber. These company-funded experiments will involve firing a 15-lb. thrust rocket motor in the chamber, which will be continuously evacuated to maintain a constant vacuum. Friedman said light emissions and other identifying characteristics of the plumes will be studied. Data on the characteristics of rocket plumes and wakes could be of value to Air Force for its anti-ICBM program and to NASA as a visual tracking aid.

FORMATION OF THREE Hawker Siddeley Gnat trainers, flown by students of Royal Air Force Training Command, shows general arrangement of slipper tanks on the aircraft.



PROMINENT POSITIONING of artificial horizon and navigation display unit is shown in photo of Gnat's front cockpit (above). Warning lights are in strip over the two instruments and below altimeter and airspeed indicators. Relight button is atop the throttle at left. Over-all view of main Gnat production line (below) is shown at Hawker Siddeley's Folland Div. plant. Note complete single-section wings at the top of the photo.



STUDENT PILOT GAINS a high degree of visibility from the front cockpit of the Gnat trainer, as shown above, but visibility is sharply limited in the rear cockpit.

Aviation Week Pilot Report

Gnat Trainer Demonstrates Reliability, Maneuverability

By Herbert J. Coleman

London—Hawker Siddeley's tiny Gnat jet trainer, now replacing the de Havilland Vampire in Royal Air Force Training Command, is a rugged airplane with a high degree of reliability and maneuverability in speeds through the transonic range.

Training Command recently graduated its first class of pilot officers from RAF Valley Station, Anglesey, North Wales, in six weeks over the normal six months' tour. Delay was due to harsh winter conditions that virtually shut the station down.

Minimum Problems

Gnat has been phased into the advanced trainer program with a minimum of teething troubles, according to Air Marshal Sir Augustus Walker, commander-in-chief of Flying Training Command. He cited these factors:

- **High reliability** of the Bristol Siddeley Orpheus 101 turbojet engine, which now produces 4,230 lb. thrust but is being uprated to give 4,400 lb.
- **Aircraft utilization** rate, pegged at 25 hr. per month during the first year, was reached in first three months of operations.
- **Excellent flight** safety characteristics considering the 40-deg. sweep in the wing. Stalls are only demonstrated to students and the airplane is not spun except by qualified flight instructors (QFIs). However, three students have inadvertently spun the Gnat and recovered safely; method is simply to neutralize the controls.

The air marshal, who has checked out the Gnat despite the fact that he lost his right arm during an attempt to rescue the crew of a burning Lancaster during World War 2, took over Flying Training Command during last stages of Gnat evaluation at Central Flying School.

At Valley, the Gnat force is being built up to 60 airplanes. Walker said the airplane will go into service next spring at the School of Refresher Flying.

One reason for success of the Gnat program so far, the air marshal continued, is concentrated use of a Redifon simulator, first ever built for an RAF training airplane. Each student gets 13 hr. simulator time, backed up by 6 hr. on Link trainers and another 8 hr. on a cockpit procedures trainer, essentially a mockup. Four hours are completed on the simulator before the first flight.

Flying Program

Flying program for students who come to Valley from RAF basic training schools using Hunting Jet Provosts includes 70 hr. of which 48 hr. is dual and 22 hr. solo. Night flying begins after a total of 30 hr. and students are checking out at night after only three dual missions.

From Valley, students are sent to operational conversion units—fighter and bomber—and a selected few go to Central Flying School for instructor training.

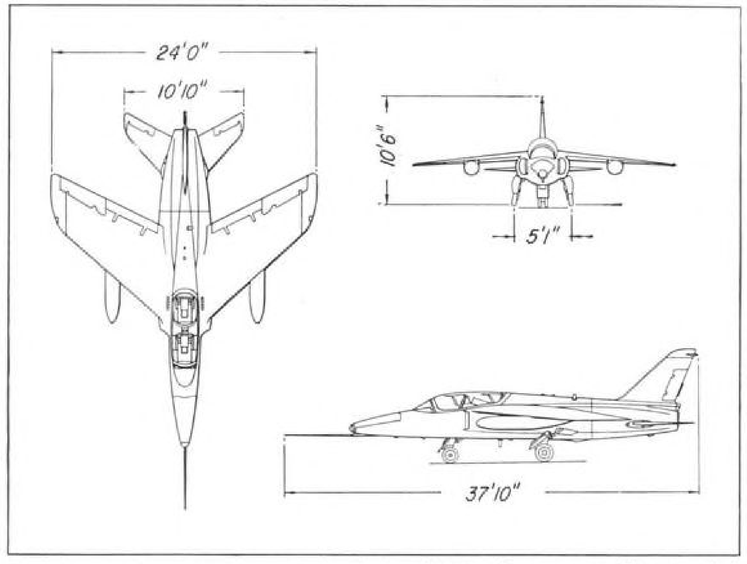
Gnat used by Flying Training Command is a trainer version (T.Mk. 1) which was developed by Folland Aircraft, now a Hawker Siddeley division, as a private venture from the Gnat fighter. Designer was W. E. W. Petter, who was responsible for English Electric Canberra and Lightning P.1 series.

Prototype Gnat trainer first flew on Aug. 31, 1959. Airplane, of which a total of 105 were ordered by RAF, went into service at Valley last October, when the 82nd Class of the RAF College, Cranwell, reported for instruction.

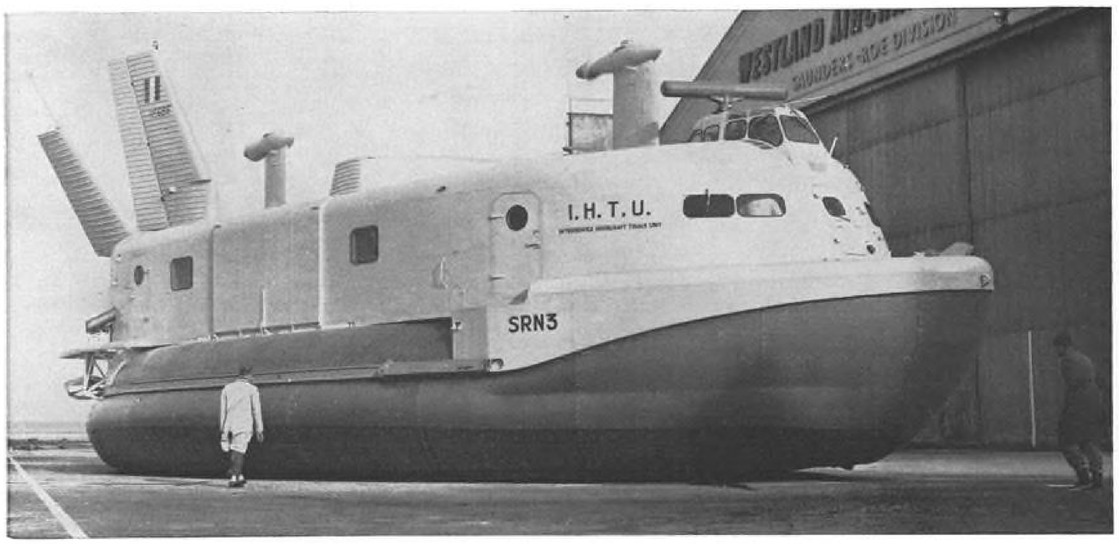
First reaction to flying the Gnat by this AVIATION WEEK & SPACE TECHNOLOGY pilot was surprise at its small size; pilots literally strap the airplane on and take off. The Gnat is 37 ft. 10 in. long and height to top of the canopy is only 6 ft. 5 in.

The airplane was flown with USAF Capt. Wade Green, assigned to RAF Training Command under an exchange agreement and who entered the program after flying the Northrop T-38A Talon. Despite his 6 ft. 3 in. height, Green has little trouble fitting himself into the small front cockpit.

The Gnat is an all-metal shoulder-



THREE-VIEW shows dimensions of the Hawker Siddeley Gnat trainer. The aircraft is replacing the de Havilland Vampire in Royal Air Force Training Command.



SRN.3 Hovercraft Undergoes Hover Tests

First photo of the Westland SRN.3 Hovercraft, fitted with 4-ft. skirts, was taken during initial hover tests at Saunders-Roe Div. plant at Isle of Wight. The vehicle, a development of the SRN.2, was built for the Interservices Hovercraft Trials Unit on orders from British Ministry of Aviation (AW Apr. 8, p. 111). The commercial version, designated SRN.2 Mk.2 (AW May 6, p. 83) will carry up to 150 passengers at 75 kt. Powerplants for the entire Westland Hovercraft family are Bristol Siddeley Gnome turbine engines.

wing monoplane. Landing gear well covers act as dive brakes; when actuated, the gear extends one-third and reaction time is comparatively slow. The airplane also is fitted with a braking parachute, but this is rarely used even though Valley's longest runway is only 5,300 ft.

Instructor station is the rear cockpit and latest modification is an airspeed indicator mounted at eye level, since forward visibility is restricted by the top of the Folland-built ejection seat. An 80-fps. ejection gun is fitted to the seat.

An external power source supplies low pressure air (35 psi.) for starting. Sequence is simple—master switch on, boost pump on, h-p cock on and button is pushed for lightup, which occurs in about 2 sec. In-flight relight is controlled by button recessed on top of throttle lever.

Fuel is carried in 10 internal tanks and two under-wing slipper tanks; for student flying the latter hold only 30 gal. each and burnout is shown by eyelid indicators in the cockpit. Total fuel capacity is 388 Imp. gal. The Gnat has a swept-back, variable incidence tailplane which is hydraulically operated. Setting for takeoff is −6 deg. along with 20 deg. of flap.

Before takeoff, brakes are checked at 90% rpm., released and then full throttle is applied. Rudder becomes effective at about 50 kt. and nose wheel is rotated at about 100 kt.; climbout is at 135 kt. and, in this flight, about 200 kt. was attained before reaching the end of the runway.

Power controls are delicate and the new pilot has the usual tendency to overcontrol during initial phases. However, controls are light and responsive although care must be exercised in the vertical plane because of moving tailplane.

The Gnat is extremely maneuverable at high altitudes, with a roll rate of about 210 deg. per sec. The fighter version had a roll rate even higher, but trainer has been fitted with aileron stops, cutting travel from 28 deg. to 16 deg. at speeds above 150 kt., thus preventing inertia coupling.

Stalls were not attempted on this flight, but Green said the airplane is docile and recovery is quick when the stick is eased forward. Aerobatics are accomplished with ease, particularly rolls to right and left, and loops are made by setting the g-meter at four and following through all the way.

Students make transonic runs as a matter of course over the Irish Sea and Cardiff Bay, by putting the Gnat into a shallow dive. Stick forces become fairly heavy and speed brakes are not used for deceleration because of a strong nose down trim change. Entering the sonic range, there is a nose-up change of trim until Mach 0.9 to 0.92, when nose-down change occurs.

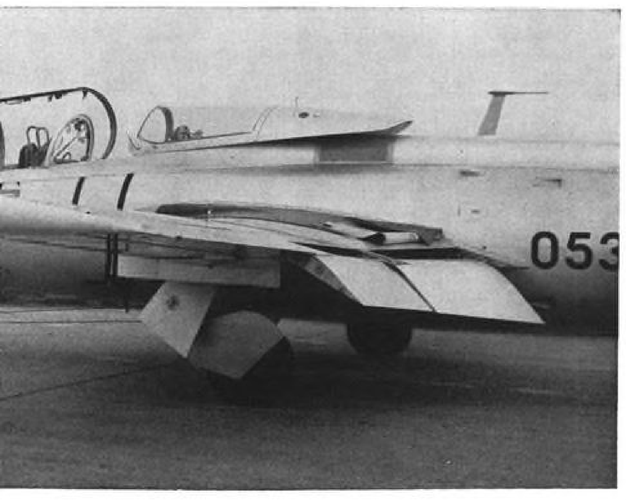
First tendency on landing is to level off too high, but even a hard landing is possible with rugged landing gear and soft oleo struts. Shortest landing made yet is 850 yards at Central Flying School during Gnat evaluation.

Speed is reduced on downwind leg, using speed brakes, and gear is lowered below 250 kt., and an automatic datum shift of about −3 deg. tailplane movement removes the trim change. Flap is lowered 10 deg. on downwind leg and the rest during turn onto final, where the Gnat is flown at 125 to 135 kt., depending on weight. Usual practice is to retain 65% power on the approach.

The Gnat can carry a wide variety of weapon stores, including four Martin Bullpup air-to-surface missiles for attack training, an important factor in current negotiations with South Africa, which is using the Blackburn Buccaneer operationally.

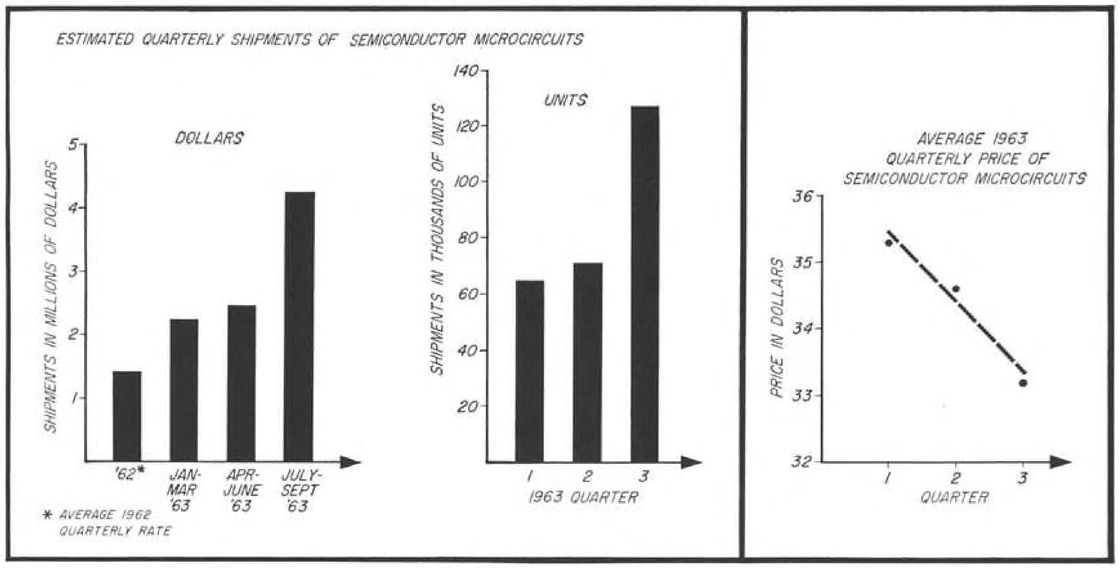
Fuselage structure is semi-monocoque, with light alloy skins, frames and stringers. The airplane is constructed as two main assemblies secured by eight bolts which carry the rear fuselage shear, bending and torsion loads. In the front fuselage unit, the shear and top skin bending loads are continuous over the center section through structure attached to the upper wing skin. The rear fuselage is easily detachable for shipping and engine removal.

Single wing unit is of light alloy, multi-spar construction. Main structural box is formed by the spars and chemically etched one-piece tapered main skins. Wing center section and inboard portion of main box form integral tanks. Wing tips are detachable.



Czech L-29 Aimed At Foreign Markets

Czechoslovakian L-29 two-place jet trainer, designed for use through both basic and advanced training cycles (AW, Apr. 22, p. 89), is aimed at potential foreign markets to take advantage of its reported ability to operate from sod runway systems common in such areas as East Europe, Africa and Asia. Details shown in these close-up photographs include speed brakes (above) set on each side of the rear of the fuselage, flaps set at about 45 deg. (right), two-place cockpit in which both seats have ejection capability (lower, left) and T-tail design (lower, right). L-29 reportedly has a maximum speed in level flight of 382 mph. at sea level, and 407 mph. at 16,400 feet. Addition of external fuel tanks, not apparent in these photographs, boosts endurance at high altitude from 107 min. to 150 min. Mid-wing aircraft can be adapted to both intercept and close-support missions and can carry either air-to-air or air-to-ground missile systems. M-701 turbojet engine has a 1,962-lb. thrust.



SEMICONDUCTOR MICROCIRCUIT SHIPMENTS took a significant jump during the third quarter of 1963 and are expected to rise further next year under the impetus of a growing number of aerospace and military avionics systems being committed to microcircuitry. Quarterly figures in dollars (left) and units (center) are supposed to be for single-chip semiconductor microcircuits only. Average quarterly price, right, of microcircuits (shipments) during the first nine months of the year remained reasonably steady, probably reflecting industry-wide production limitations. Spread of prices varies from considerably less than the average (about $32) for off-the-shelf digital types up to about $100 for custom analog units.

Avionics Demands Spur Microcircuit Sales

By Barry Miller

Los Angeles—Microcircuit sales may expand severalfold during 1964 to satisfy a growing demand for these devices in new or retrofitted avionics systems, a recent Aviation Week & Space Technology survey indicates.

Major aerospace and military systems progressing beyond the design and prototype stages will account for the largest share of the increase; the remainder is spread among a widening number of equipments and systems, now in design phases, being committed to microcircuitry.

Shipment Figures

This projection finds partial support in recent Electronic Industries Assn. figures for shipments of semiconductor microcircuits during the first nine months of the year. Unit sales for the third quarter were 127,337, up 80% from the previous quarter, while the dollar value for these shipments was $4,242,793, up 73% from the preceding quarter. Normally, third quarter semiconductor shipments slide slightly as a result of vacation shut-downs during the summer.

Year-to-date dollar figures for semiconductor microcircuits reached $8,963,606 at the end of September, 55% higher than the shipments reported by EIA for all of 1962. EIA figures are not supposed to encompass multiple-chip semiconductor microcircuits, of which at least modest quantities were delivered, hybrid microcircuits of various types or thin film microcircuits.

Despite the anticipated market growth, many industry observers believe that microcircuit demand will not rise as fast as optimistic predictions and studies indicate (AW Dec. 10, p. 95). Part of the difficulty is that a few large systems which might otherwise use quantities of microcircuits have not been so committed, pending assurances of adequate microcircuit sources. For while there are many announced suppliers of microcircuits, particularly the semiconductor types, only a handful of companies have shipped appreciable quantities.

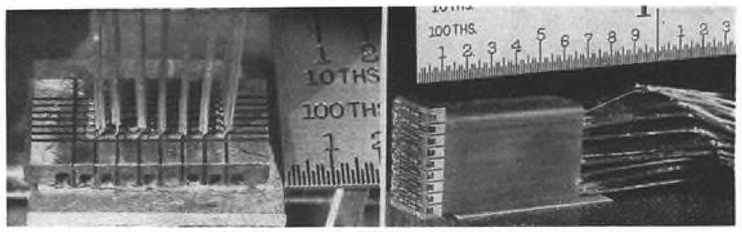
The principal attraction of microcircuitry is its potentially low cost, high reliability, small size and weight and perhaps low power consumption, with the first two becoming the most compelling. Major customers to date are the Air Force, National Security Agency, National Aeronautics and Space Administration and the Navy.

By virtue of a number of inherent advantages, microcircuits could offer solutions to tough design and tactical problems not practicable by other means. Their small size and low power consumption, for example, may permit expansion of capacity for airborne handling and processing of data from on-board sensors. This is an acute need in airborne reconnaissance and electronic countermeasures (ECM). Processing of reconnaissance data in the air could save time and boost mission effectiveness of strike reconnaissance aircraft. Should the RF-111 (reconnaissance version of the TFX) materialize, a substantial amount of first order processing of sensor data may well be done in the aircraft with an indispensable assist from microcircuits.

ECM Requirements

Similarly, ECM processing requirements may increase with improvements in hostile radar techniques. Sanders Associates, a leading supplier of ECM systems for naval carrier-based aircraft, is expected to launch a sizeable microcircuit equipment effort late in the year.

Contractors for most new military avionics systems, as one of their chief



Miniature Infrared Detector Encapsulated

High-density miniature lead sulfide infrared detector array with densities of 1,200 cells per square inch has been fabricated by Infrared Industries, Inc., using recently developed techniques for welding multi-connector cables to the tiny land areas. Company has fabricated 3 x 30 arrays and says it can fabricate 30 x 30 arrays with present techniques. Unit shown (left) is a 6 x 7 array. Encapsulation of the cables as shown in larger array in photo (right) provides rigidity and relieves cable stress.

requirements, are under pressure to explore extensive use of microcircuitry (AW Mar. 11, p. 237) even in more difficult-to-adapt analog sections of equipment. The new Integrated Helicopter Avionics System (IHAS), in program definition phase studies at Nortronics, Teledyne System Corp. and Texas Instruments (AW Aug. 19, p. 31), will emphasize use of microcircuits. So too will the Integrated Light Attack Avionics System (ILAAS) now in competition. Key part of the latter system will be a large capacity central digital processor capable of handling inputs from and managing all aircraft avionics. The heavily miniaturized computer is to be ready for operational use in 1965.

USAF's Standardized Space Guidance System for which potential program definition study contractors were recently picked (AW Dec. 16, p. 39) also will need a large capacity digital computer for which microcircuits will be essential.

Typical aerospace systems and hardware incorporating or planning to use microcircuits (semiconductor types unless otherwise indicated) include:

• **Apollo**—Guidance computer of Apollo spacecraft will employ about 4,000 direct coupled transistor logic (DCTL) NOR gates (three transistors plus resistors) and sense amplifiers, packaged in multi-lead flat TO-47 cans. Associated ground support computers will use two to three thousand of the same circuits. To date, most of the microcircuits ordered (approximately 50,000) were from Fairchild Semiconductor, with smaller quantities from Raytheon and Westinghouse. In addition, the control unit of a radioisotope fuel gaging system, being developed by Giannini Controls Corp., that is to measure under zero-g conditions remaining fuel of the service module's reaction control system also will be built around microcircuits. The supplier is Signetics Corp.

• **Phoenix**—Computer and displays systems being developed by Litton Industries for the Navy's Phoenix air-to-air missile, primary anticipated armament of the F-111B (Navy version of the TFX) fleet defense interceptor, are designed around microcircuits. Two types of digital gates, a dual four input gate and an eight input gate will be used. For flexibility, two of the latter can be combined in a single package to equal a dual four input gate. Circuits are reported to be designed to be within the grasp of current technology with emphasis on noise immunity over the complete temperature range, relatively high speed (70 to 90 nanosec. for sum of turn on and off propagation delays), and optimum fan-in and fan-out capability. The circuits will be in flat packages fitting within a ¼ in. square form factor, permitting each supplier to choose a package suitable to its manufacturing process. Each Phoenix computer will use 5,000 to 7,000 microcircuits and ground support equipment between 2,000 and 4,000, industry sources indicate. Litton reportedly has orders for 14 computers, but this figure may climb if all of the anticipated 200 F-111Bs carry the air-to-air missile.

Hughes Aircraft, prime contractor for the missile system, also is investigating microcircuits for other portions of the system, probably the fire control section. Initial Litton suppliers are expected to include Motorola, Fairchild, Sylvania and TRW Semiconductors, subsidiary of Thompson Ramo Wooldridge. Average circuit prices will range between about $20 and $25, according to industry estimates.

• **MMRBM**—Guidance computer of the Air Force's Mobile Medium Range Ballistic Missile (MMRBM), which Univac Div. of Sperry Rand is developing for General Precision, the guidance subsystem contractor, will be a version of the system disclosed in AVIATION WEEK & SPACE TECHNOLOGY (Dec. 24, 1962, p. 45). First run for MMRBM will consist of eight machines, each using in excess of 1,200 microcircuits, mostly digital types, but including sense amplifiers, high current output drivers and other linear circuits. Circuit prices are running up to about $50. The suppliers are Signetics and Westinghouse. In addition, Martin Marietta is investigating use of microcircuits in the missile's command and control subsystem, which is in an earlier phase of development.

• **Sable**—Advanced computer (Sable) system for USAF's Maneuverable Ballistic Re-entry Vehicle being developed for Ballistic Systems Div. by Univac will first employ the company's Model 1824 (similar to the MMRBM machine), then go to an expanded computer including larger memory. Suppliers are Signetics and Westinghouse.

• **Tactical Data System**—Shipborne computer system Univac has developed for Navy's Naval Tactical Data System uses multi-chip semiconductor microcircuits contained in TO-5 cans. Supplier is Motorola.

• **Project A-New ASW System**—Airborne computers Univac is developing for the Navy's ASW program, known as Project A-New (AW July 8, p. 64), will be similar to its MMRBM machines. Suppliers are Fairchild, Signetics, Texas Instruments and Westinghouse.

• **Minuteman**—Guidance and control system of USAF's improved Minuteman ICBM (AW Oct. 28, p. 70) uses microcircuits extensively. Bulk of the 180,000 circuits ordered to date are being supplied by Texas Instruments and Westinghouse, with Radio Corp. of America and General Electric providing one circuit each in small quantities. Should this system be retrofitted into Wings 1 through 5 Minuteman (in addition to the Wing 6 missiles and beyond, for which it is initially intended) this effort may grow into an enormous program. In addition, Sylvania Electric Products is planning to use microcircuits in Minuteman silo command and control gear it is developing for USAF. Companies which have supplied circuits include General Instrument (multi-chip microcircuits), Signetics, Texas Instruments and Westinghouse. Orders to date are believed to be less than 5,000 units.

• **Pershing**—Retrofitted guidance systems for Army's Pershing battlefield missile will be using microcircuits, probably direct coupled transistor logic. Companies which have supplied sample quantities include Fairchild and Amelco Semiconductor. General Instrument has provided for a prototype of the system its "nano" circuits (multiple chips on a single header or multiple active chips with thin films on a separate substrate but all mounted on the same header). Microcircuit quantities for Pershing in the next calendar year may run between 30,000 and 100,000 units.

• **Mauler**—Digital data processor Burroughs is developing for the Army's mobile Mauler tactical missile may employ microcircuits should funds be made available for the effort. Possible supplier is Fairchild.

• **TOW**—Microcircuits suitable for the tube-launched, optically controlled, wire-guided anti-tank missile (TOW) are under evaluation by Hughes Aircraft, prime contractor for the Army Missile Command weapon.

• **Typhon**—Navy's surface-to-air Typhon missile probably will employ thin film microcircuits with discrete active elements, although Melpar-developed cadmium selenide field effect transistors capable of operating at relatively high frequencies have operated for lengthy periods and may be attractive for this.

• **Hawkeye**—First AN/ASA-27 computer system using microcircuits and earmarked for the Grumman E-2A early warning aircraft may go into naval operation this month. Each computer system has 2,000 microcircuits (shift registers) mounted on 65 conventional plug-in circuit cards to make them compatible by substitution with conventional circuits for which the system initially was designed. Microcircuits account for about 6% of the system's circuits and replace magnetic core-transistor registers. At least 26 systems using microcircuits are to be built. Reason for microcircuit use is increased reliability and lowered servicing costs. Litton is contractor. Supplier is Texas Instruments.

• **Advanced Inertial Navigator**—Navy AN/ASN-44, a new miniature inertial navigator which Litton is developing under BuWeps contract (AW Apr. 29, p. 76), uses Texas Instruments standard Series 51 microcircuits for timing functions and a greater number of Series 52 analog circuits in the platform electronics. In all about 200 microcircuits will be in each system. Litton is building eight systems; two are development models and six are service test models, with the former scheduled for delivery in June. Principal supplier is Texas Instruments.

• **Solomon**—Westinghouse Air Arm Div. is building a large data processing complex for the government that will employ semiconductor microcircuits. Motorola has supplied multi-chip devices and now has a letter of intent on an $11-million order for single chip semiconductor circuits. Westinghouse Molecular Electronics is expected to get a smaller order.

• **Titan 3**—Martin may use diode transistor logic (DTL) units of special design in portions of the Titan 3 space booster, probably including ground support equipment. Orders to date are in excess of several thousand. Suppliers include Westinghouse.

• **Nike X**—Guidance system of the terminal ballistic missile defense missile being developed at Bell Telephone Laboratories may use multi-chip or hybrid microcircuits.

The application of microcircuits to the Polaris fleet ballistic missile and their introduction into the Army's Lance missile are under study. A potentially large series of inter-related government electronic programs heavily based on microcircuits are in varying stages of development. Contractors include Honeywell, Raytheon and Space Technology Laboratories with Fairchild the principal microcircuit supplier. International Business Machines Corp. and Texas Instruments are suppliers on another phase of the effort.

Perhaps typical of the larger and pioneering users of microcircuits is Airborne Instruments Laboratory, a major airborne reconnaissance and space systems contractor. It is using or plans to use both thin film and semiconductor microcircuits in three major systems.

For one advanced reconnaissance system, it has placed about $400,000 in orders with Fairchild ($315,000), Amelco ($68,000) and Westinghouse ($22,000). For what is believed to be a satellite-borne digital processing system it has $100,000 in semiconductor microcircuit orders with Signetics. Texas Instruments has received a sizable contract for microcircuits and associated engineering in connection with the third system. Another $25,000 in orders for test quantities has been placed with Amelco, Fairchild, Signetics and Texas Instruments.

Cockpit Recorder

Cockpit communications recorder, called the Checkmate, provides three channels for recording IFR clearances off the air through a connection to the aircraft audio panel. The unit provides three channels for recording up to 2 min. each, with pushbutton selection of operating modes. Transmit mode would permit the receiving aircraft to transmit the recorded clearance back to the traffic controller through the aircraft's transmitter, the manufacturer says. A fourth channel provides for a permanently-recorded check list. Panel lights indicate operational readiness. Completely self-contained, the Checkmate mounts in a standard 3¼-in. instrument panel opening, and has a depth of 6¼ in. Weight is 3 lb., and power requirement is 0.4 ampere, according to the manufacturer, Michigan Magnetics, Vermontville, Mich.

Besides the semiconductor microcircuits, AIL has about $200,000 in thin film orders at Varo, Inc., and Corning Glass Works, with another $117,000 for the two in the offing. These are generally analog or linear circuits, not realizable in semiconductor form.

Much of the marketing of semiconductor microcircuits in the recent past has centered around becoming qualified and selected for the microminiature airborne computer lines of the various domestic and foreign computer manufacturers. A number of these, particularly Univac and Honeywell, are in existing programs. Typical of these, and their microcircuit suppliers, are AC Spark Plug's Magic line (Fairchild), Autonetics' Monica series (Motorola), Honeywell's Pico series (Westinghouse, Amelco, Fairchild and Signetics), Librascope's L-90 (Sylvania), Nortronics (believed to include Signetics and Westinghouse) and Saab (Fairchild).

Both Air Force and Navy have extensive microcircuit research and development programs (AW July 1, p. 89; June 17, p. 81) involving application of microcircuits to a wide range of prototype equipments. These involve relatively small quantities.

Equipments emerging from the programs could have a commercial future, however. A simple, lightweight potentially low-cost Loran C receiver, made by Sperry Gyroscope under Navy BuWeps sponsorship (AW July 1, p. 89; Nov. 25, p. 93) is a case in point. The company says its plans to produce 100 models of the system, AN/ARN-76. Companies which have supplied microcircuits for this effort include General Instrument (multi-chip), General Micro-Electronics, Fairchild, Texas Instruments and Westinghouse.

Air Force is known to be seeking approval for converting to microcircuits a number of specific avionics systems now in production. These include Tacan and ILS airborne radio navaids, IFF, UHF communications, a central air data computer, an intercommunications set and various other radio equipment.

Like the regular NASA centers, Cal Tech's Jet Propulsion Laboratory, which is responsible for the space agency's unmanned lunar and planetary programs, is exploring use of microcircuits in many breadboard and prototype equipments. Some will probably see duty in the Mariner B planetary spacecraft, more in the later Voyager planetary spacecraft.

JPL has placed the standard micro-

circuit lines of Texas Instruments and Fairchild on its preferred parts list, signifying their successful passage of a series of vibration, shock, storage and temperature, and operation under temperature tests. Devices of other vendors regarded as electrically acceptable will be put through similar tests. Presumably, these could then find their way into different equipments.

The laboratories are sponsoring a number of in-house and industry development efforts relating to microcircuitry. Among them is a spacecraft digital subsystem for radio ranging over planetary distances. The system, initially built at JPL with welded cordwood techniques, has 150 digital elements which generate desired binary codes. Four companies have the task of separately building and packaging microcircuit versions of this. The four are Texas Instruments (using its high speed, higher power Series 53), Fairchild (using its milliwatt logic), Westinghouse (DTL) and Philco (DTL).

Other funded development efforts include microcircuit analog-to-digital converters at Motorola and Texas Instruments and a microcircuit gating element, analogous to a relay, offering sizeable weight and power savings, at IBM.

FILTER CENTER

► **Military Satellite Countermeasures**—Watch for accelerated efforts to develop electronic countermeasures (ECM) techniques and hardware to defend U.S. military satellites, now that Air Force has been assigned task of developing a two-man orbiting space laboratory. The space laboratory would be an excellent test vehicle for evaluating new satellite defense ECM techniques, several of which are under investigation by industry with support from USAF's Aeronautical Systems Div.

► **Predicting Flight Control Reliability**—Battelle Memorial Institute will investigate the use of analytical techniques for predicting reliability of flight control systems under contract to Air Force's Aeronautical Systems Div.

► **Advanced Anti-Radar Missile**—Navy's Butcher Bird anti-radar missile (AW Oct. 28, p. 19), being investigated by the Naval Ordnance Test Station at China Lake, Calif., will be a second generation air-launched electromagnetic homing missile capable of homing on highly advanced hostile radars. NOTS currently is completing development of the earlier Shrike anti-radar missile which homes on radar signals monitored by ECM receivers in the launching aircraft. It does not have noise or deception jamming capability.

► **Starmapper Assembly**—Avionics companies interested in designing and fabricating Starmapper flight assemblies which are to be used in National Aeronautics and Space Administration's Project Scanner have been asked to submit bids by Jan. 6 to Langley Research Center. Three flight units are required.

► **Project Trump Control System**—A single-plane, attitude control system which is capable of processing a spin-stabilized Nike Javelin rocket through 90 deg. and then controlling its attitude will be used aboard the test vehicles in USAF's Project Trump (AW Apr. 2, 1962, p. 63). Attitude is controlled by a cold gas jet system actuated by signals from a miniature attitude reference system. The complete system is provided to Eglin AFB by Whittaker Controls & Guidance Div. of Telecomputing Corp., Los Angeles. Trump (target radiation measurement program) is an Air Force program designed to measure short wavelength (optical) radiation from USAF ballistic missiles launched from Cape Canaveral.

► **Reducing Re-Entry Vehicle Cross-Section**—Technique for reducing radar cross section of a re-entry vehicle—the area of the vehicle which effectively returns echoes to a searching radar transmitter—with the use of adaptive electronic techniques is being studied by American Nucleonics Corp., Glendale, Calif., for an unspecified contractor under contract to USAF's Ballistic Systems Div. Method involves creation at exposed portions of the vehicle of signals which are equal and opposite those generated by illuminating radar. These tend to cancel one another, thus diminishing the returns. To some extent, the technique may also reduce the reflective character of the plasma, or ionized sheath, created by the reentering body, that tends to behave as a large reflector for illuminating radar.

► **Raytheon's Research Div.** will study use of plasmas and pyrolytic graphite structures (anisotropic media) as structures to support electromagnetic waves. Object is to use technique as a millimeter wave generator having electronic tuning and simple construction. Feasibility of using pyrolytic graphite in microwave tubes also will be investigated. Program is sponsored by Army Electronic Research & Development Laboratory.

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12/23/63

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AVIATION WEEK,
DECEMBER 23, 1963

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

ADVERTISERS INDEX

LETTERS

Ultimate Transport

It really is getting just a little trying to continually keep hearing about the financial and development problems of this country's proposed supersonic transport. It gets particularly annoying knowing that the British and French SST has now progressed to the mockup and hardware stage. Your excellent editorial (AW Nov. 11, p. 21) tipped the scales for me.

With the FAA apparently wanting to get going in a hurry with SST development, I would like to suggest how this might best be accomplished. It might be best to have the FAA do all of the work, i.e. fully develop, design, build, test, sell and provide customer service for the SST. Then, since it would be unethical and maybe even illegal as you indicate for one agency to both develop and certificate, we would hire an old reputable aircraft manufacturer to make sure that the FAA was complying to specifications and building a quality and reliable product. When the FAA finally met all requirements, the old aircraft workers would issue the type certificate and the individual aircraft airworthiness certificates. Eventually a production certificate would be issued to the FAA. The aircraft workers would be capable of conducting this inspection and approval because they have been exposed over and over again to the details in the requirements and they have learned to cope with the many trials and tribulations that go with certification.

More seriously, however, there is the possibility that we should forget about the supersonic transport altogether and get on with the hypersonic airplane, an airplane that would come closer to what I call the UST or Ultimate Speed Transport. Without a doubt there is an ultimate speed for passenger carrying aircraft, a speed at which it really doesn't pay, either economically or time-table wise to go any faster. We may be coming close to this ultimate when we talk about transports with cruise speeds somewhat in excess of Mach 3.

An Ultimate Speed Transport on the world airways would assure a good production market for a long time to come, or at least until someone figures out how to travel from city to city or from country to country on a ballistic trajectory. We certainly should think twice before we spend billions of dollars on the SST. We might find out that before it flies it will be made obsolescent by the next and possibly final generation of commercial air transports, the UST.

Since corporation taxes have been so high for so long, it has become quite difficult, if not impossible, for an aircraft company to finance a one- or two-billion dollar development project. There is really only one other way these days and that is to make the project a military venture to start with. Rather than the suggested 750-million/250-million split for SST development, might I suggest a 100% Air Force funded UST development program on a cost, schedule and reliability incentive contract going to the bidder with the highest number of evaluation points. This much needed military transport (reference: the successful Big Lift operation) would then develop into a commercial version with an appropriate FAA type certificate. This would make everyone happy: the Air Force, the FAA, the aircraft manufacturers, the airlines, the public, and the many readers of AVIATION WEEK & SPACE TECHNOLOGY.

In conclusion, I believe you should check with your Boeing friends regarding your statement that "the C-135 . . . developed into the 707 series." Boeing started on this project at least 15 years ago and unless my memory has let me down, the first 707 was financed entirely by the Boeing Co. as a private commercial venture. The first brown and yellow 707 test bed flew almost a year before the first Air Force C-135 was flown. The technology that Boeing picked up in developing the Air Force B-47 and B-52 was invaluable to them but let us give credit where credit is due, the 707 was developed out of company funds and it turned out to be quite successful.

W. F. CHANA
San Diego, Calif.

(Reader Chana has a point. The prototype of the Boeing 707 was company-financed and made its first flight July 15, 1954, just about a month before the Air Force ordered the KC-135 tanker versions. However, the first KC-135 made its initial flight on Aug. 31, 1956, about 15 months before the first commercial 707 scheduled for delivery to Pan American World Airways flew on Dec 20, 1957. Flight test experience with the military tankers was valuable in development and improvement of the airline transport versions.—Ed.)

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.

PERT Supporter

Mr. S. Fierston's "Management Maze" (AW Nov. 18, p. 134) indicates a possible mismanagement of a management aid. PERT is basically, good program planning, which will reflect management skills of applying available resources to varying conditions in order to attain maximum objectives. However, I do believe that DOD should work with industry to ensure that there is a complete understanding of the various degrees in the application of PERT. Mr. Fierston sounds as if he is PERTing himself into production problems. He states, "it implies conscientious personnel at every level in the project." Believe me, if I found I had personnel who were not conscientious I would replace them—but quick. PERT nor any other system will work unless made to work by conscientious people. There are plenty around. Try some and see.

WILLIAM J. SLADE
Chester, Pa.

Where's That Engine?

Re: Photograph bottom p. 54, AVIATION WEEK & SPACE TECHNOLOGY, Nov. 4, 1963.

If this was taken looking through No. 2 engine tail pipe where is No. 2 engine?

WALLACE L. BROWN
Norman, Okla.

(The view showed the No. 2 engine ducting through the tail section with the engine removed.—ED.)

Cape Name

In many cases there is a fine line separating propriety and impropriety. In persuading President Johnson to rename Cape Canaveral "Cape Kennedy," I feel that Mrs. Kennedy has crossed this line.

To affix the late President's name to the missile test center may well be a fitting thing, but in altering the name of the Cape, President Johnson has destroyed something of great historical, as well as sentimental, significance.

Frankly, this act galls me. I hope that you will not dignify this imposition by referring to the Cape as "Cape Kennedy," but will continue to call it Cape Canaveral, as before.

EDWIN W. MEYER
M.I.T.
Cambridge, Mass.

Moon Program Credit

You inform us (AW Dec. 9, p. 28) that the late President Kennedy's proposal for a joint U.S.-USSR moon program "was inspired by a paper written for" the Arms Control and Disarmament Agency by an IDA consultant. It's always nice to get inside information, but I fear you are overlooking a previous paper, issued on Jan. 20, 1961, which said in part: "Let both sides seek to invoke the wonders of science instead of its terrors. Together let us explore the stars, conquer the deserts, eradicate disease, tap the ocean depths, and encourage the arts and commerce."

Comparing these words of the Inaugural Address with those cullings of the ACDA paper that you apparently considered most pertinent in the matter, I wonder if "inspired by" might have been an uninspired choice of words.

CHARLES L. MACK, JR.
Lexington, Mass.

ALPA vs. CAB (Cont.)

Re "ALPA vs. CAB" letter (AW Nov. 11, p. 126).

As a frequent airline traveler I would appreciate knowing the name of the airline with the pilot who takes 6.9 sec. to react to an unexpected situation.

I look forward to each issue of your excellent magazine.

J. A. MOYLES
Ex-Fighter Pilot
Santa Ana, Calif.

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