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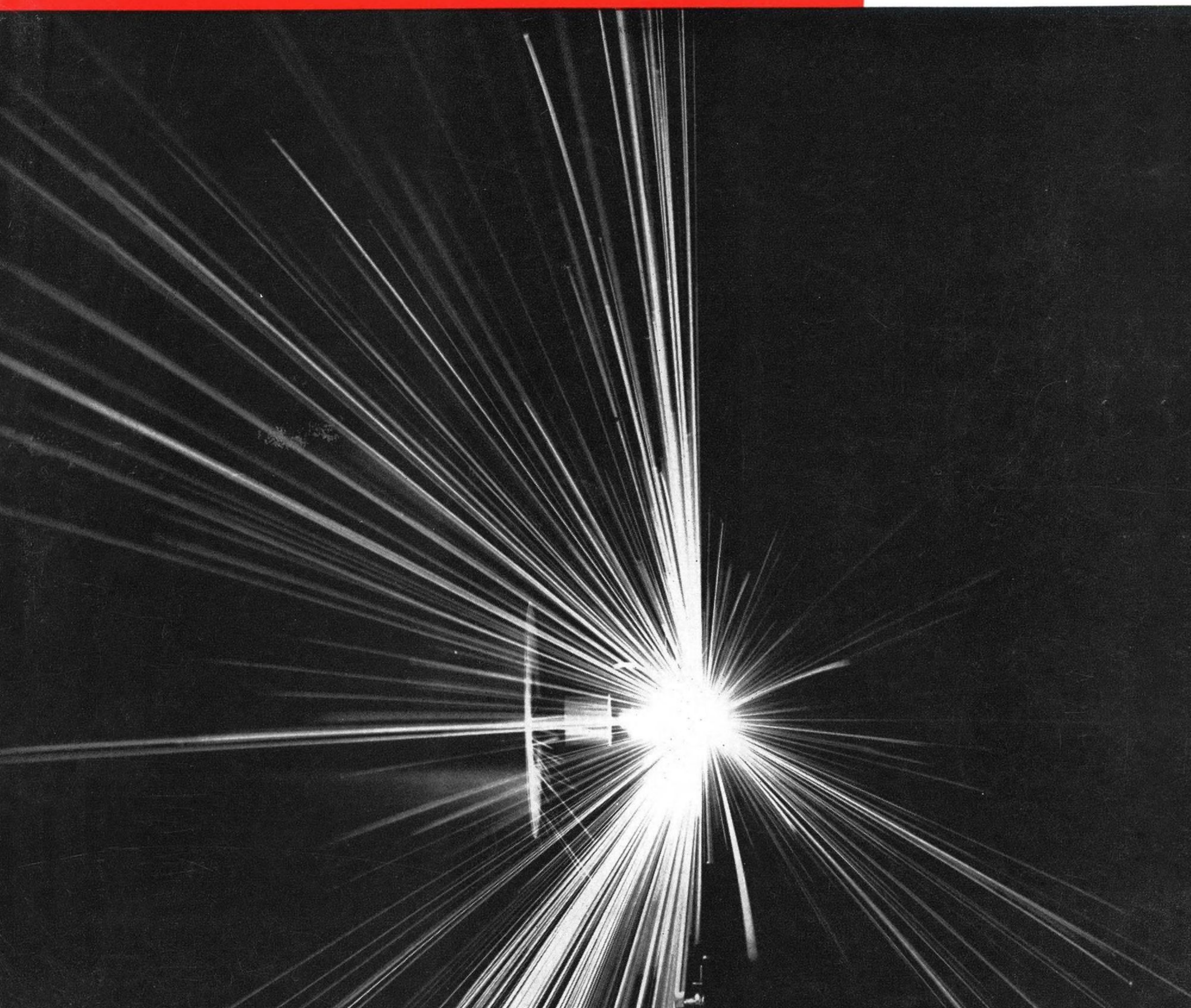
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December 24, 1962

IMCC to Direct NASA Manned Space Flights

Hughes Laser Drills Hole in Tantalum



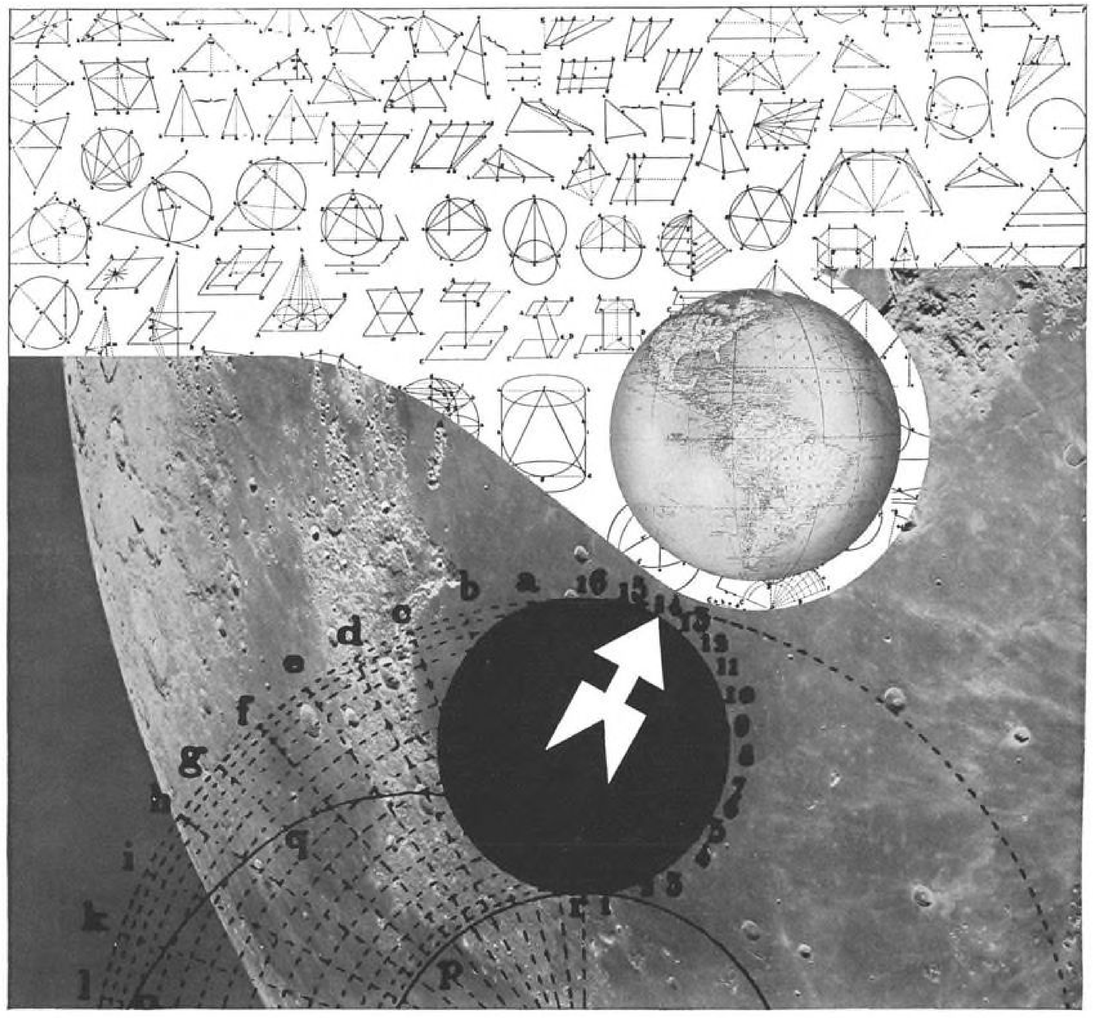


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Jan. 7-10—Millimeter and Submillimeter Conference, Institute of Radio Engineers, Cherry Plaza Hotel, Orlando, Fla.

Jan. 13-16—15th Annual Convention, Helicopter Assn. of America, Cabana Motor Hotel, Palo Alto, Calif.

Jan. 14-18—Automotive Engineering Congress and Exposition, Society of Automotive Engineers, Cobo Hall, Detroit, Mich.

Jan. 15-16—Supersonic Transport Navigation Conference, Ann Arbor, Mich. Co-sponsors: Institute of Navigation; University of Michigan.

Jan. 15-17—Ninth Annual Meeting, American Astronautical Society, Statler Hilton Hotel, Los Angeles, Calif.

Jan. 21-22—Annual Meeting, Assn. of Local Transport Airlines, National Aviation Club, Washington, D.C.

Jan. 21-23—31st Annual Meeting (including Wright Brothers Lecture), Institute of the Aerospace Sciences, Hotel Astor, New York, N.Y.

Jan. 21-24—43rd Annual Meeting, American Meteorological Society, New York, N. Y.

Jan. 22-24—Ninth National Symposium on Reliability and Quality Control, Sheraton-Palace Hotel, San Francisco, Calif.

Jan. 28—Fifth Annual Army Aviation Contract Services Symposium, International Inn, Washington, D. C. Sponsor: National Aeronautical Services Assn.

Jan. 30-Feb. 1—Fourth Annual Solid Propellant Rocket Conference, American Rocket Society, Bellevue Stratford Hotel and The Franklin Institute, Philadelphia.

(Continued on page 7)

AVIATION WEEK and Space Technology

December 24, 1962

Vol. 77, No. 26

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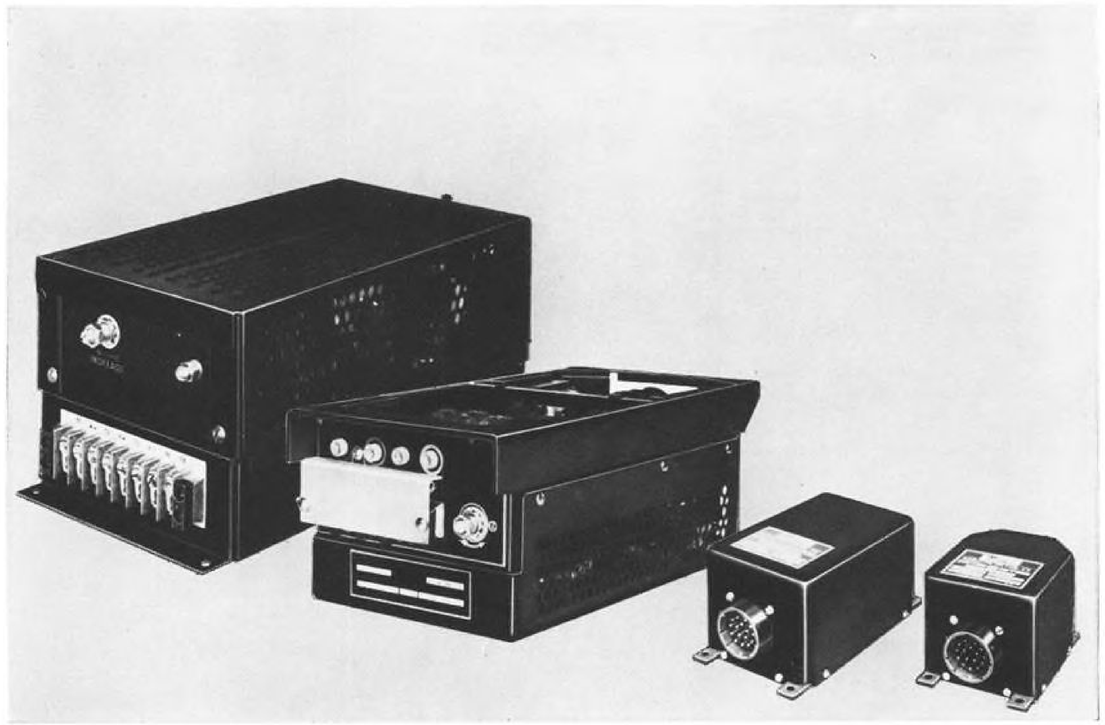
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A number of challenging positions are currently available at our Guidance and Control Systems Division for engineers who are well acquainted with airborne digital computers or have general inertial guidance experience. If you would contribute to inertial technology, electronic computers and aerospace instrumentation, look into Litton. Send a résumé to Mr. J. T. Lacy. You may expect immediate attention.

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AEROSPACE CALENDAR

(Continued from page 5)

Jan. 30-Feb. 1—National Winter Convention on Military Electronics, Institute of Radio Engineers, Ambassador Hotel, Los Angeles, Calif.

Feb. 1—Fundamental Phenomena in the Material Sciences Symposium, Hotel Sheraton Plaza, Boston, Mass. Sponsor: Ilikon Corp.

Feb. 5-6—Symposium on Engineering for Major Scientific Programs, Georgia Institute of Technology, Atlanta, Ga.

Feb. 5-7—Advances in Metalworking Seminar, American Society of Tool and Manufacturing Engineers, Park Sheraton Hotel, New York, N. Y.

Feb. 6-7—59th Meeting, National Aerospace Standards Committee of the Aerospace Industries Assn., Ambassador Hotel, Los Angeles, Calif.

Feb. 11-15—Third International Symposium on Quantum Electronics, UNESCO Building, Paris, France. Sponsors: International Scientific Radio Union; Office of Naval Research; La Federation Nationale Des Industries Electroniques.

Feb. 12-13—Space Vehicle Thermal and Atmosphere Control Symposium, conducted by the Aeronautical Systems Division, Engineers Club, Dayton, Ohio. Sponsor: ASD's Flight Accessories Laboratory.

Feb. 15-Apr. 14—International Aeronautics and Space Fair, Congresses and Competitions, Ibirapuera Park, Sao Paulo, Brazil. Sponsor: Santos Dumont Foundation.

Feb. 20-22—1963 International Solid-State Circuits Conference, Philadelphia, Pa. Sponsors: Institute of Radio Engineers; American Institute of Electrical Engineers; University of Pennsylvania.

Mar. 3-7—Seventh Annual Hydraulics, Gas Turbine, Aviation and Space Meeting, American Society of Mechanical Engineers, Statler Hilton Hotel, Los Angeles, Calif.

Mar. 7-8—Propulsion Meeting, Institute of the Aerospace Sciences, Cleveland, Ohio.

Mar. 11-13—Electric Propulsion Conference, American Rocket Society, Broadmoor Hotel, Colorado Springs, Colo.

Mar. 18-20—Space Flight Testing Conference, American Rocket Society and Institute of the Aerospace Sciences, Cocoa Beach, Fla.

Mar. 18-21—1963 Western Metal Exposition and Congress, Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles.

Mar. 19-21—Second Air Force-sponsored Symposium on Bionics, Biltmore Hotel, Dayton, Ohio.

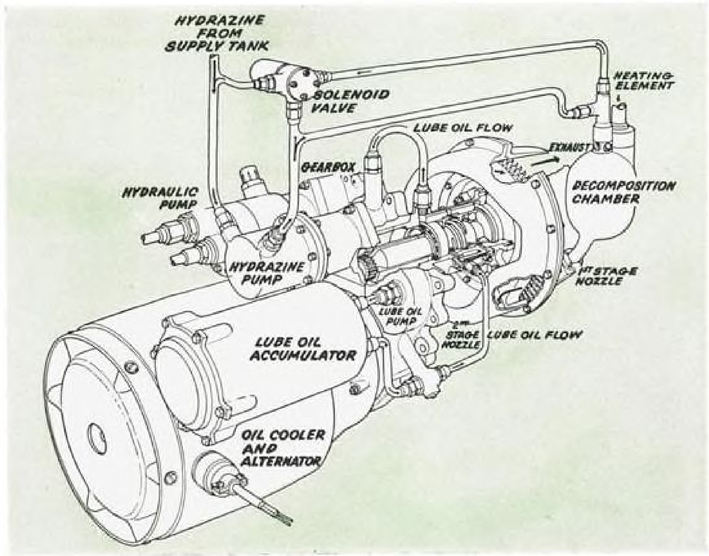
Mar. 25-28—International Convention, Institute of Radio Engineers, Waldorf-Astoria and Coliseum, New York, N. Y.

Apr. 1-3—Fourth Annual Structures and Materials Conference, American Rocket Society and Institute of the Aerospace Sciences, El Mirado Hotel, Palm Springs.

Apr. 2-3—Eighth Annual Business Aircraft Safety Seminar, Flight Safety Foundation, Barbizon Plaza, New York, N. Y.

Apr. 2-5—Spring Conference, Airport Operators Council, Shoreham Hotel, Washington, D. C.

Apr. 10-11—Fourth Symposium on Engineering Aspects of Magnetohydrodynamics, University of California, Berkeley.



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CONTENTS

SPACE TECHNOLOGY
MARINER SUCCESS MARRED BY DATA DISPUTE 16
Goddard to Improve Satellite Specifications 16
JPL Undergoes Major Shakeup 17
Ranger Program Criticized by Board of Inquiry 17
Extensive Russian Mars Probe Data Claimed 18
Norstad Considered for Comsat Post 19
MA-9 Flight May Last 34 hr. 23
Explorer 16 Provides Excellent Micrometeoroid Data 23
Slim Hope Remains for Success of Relay 24
Construction of Nerva Test Stand Delayed 25
House Unit Urges NASA to Assume Large Solids Program 26
Space Control Center to Open in 1964 52

AIR TRANSPORT
ALTA DRIVES FOR EARLY SHORT-HAUL TRANSPORT 28
Boyd Warns Mohawk on BAC 111 Purchase 28
Pan Am, TWA File Merger Plan 29
Summer Atlantic Traffic Topped Million 30
Trunklines Expected to Break Even With 8% 1962 Traffic Increase 31
Settlement Nears on American, Varig 990s 32
Airline Observer 34
Shortlines 34

AERONAUTICAL ENGINEERING
ARMED HELICOPTERS PROVIDE ESCORT FOR TROOPS IN VIETNAM 38
USAF Tests YC-123H on Soft Field 71

MISSILE ENGINEERING
British May Get Polaris Instead of Skybolt 20
British Accelerate TSR.2 Due to Skybolt Uncertainty 21
Redeye Missile Undergoes Extensive Testing 19
Modified Jet Cell Tests Missile Motors 64

AVIONICS
MICROCIRCUITS SLASH SIZE OF COMPUTER 43
Laser Bores Holes in Tough Metals 42
Gatwick, RAF Will Use Radar Simulators 46
Filter Center 51

MANAGEMENT
BOEING, IAM AWAIT ADVISORY BOARD REPORT 22
Who's Where 13
Industry Observer 13

BUSINESS FLYING
ANTONOV SCORES SOVIET SPORTS AUTHORITIES 72

EQUIPMENT
MARINES TESTING 'PACKAGE AIRFIELD' DESIGNS 67

SAFETY
MISSING SAFETY WIRE CAUSED ELECTRA CRASH 77

Washington Roundup 15
News Digest 27
Letters 94
Aerospace Calendar 5

EDITORIAL
Laurels for 1962 11

COVER: Hughes Aircraft Model X 400 ruby laser drills a hole through a sheet of tantalum in a burst of less than a millisecond. Melting point of tantalum is 2,996C. Photos of other metals tested by Hughes Ground Systems Group, Fullerton, Calif., are on p. 42.

PICTURE CREDITS

Cover—Larry Foster, Hughes Aircraft; 18—UPI; 25—Los Alamos Photo Lab; 26, 67, 69—U. S. Navy; 29—Sud Aviation; 32—Swissair; 38, 39, 41 (top)—Pacific Stars & Stripes; 41—Bell Helicopter Co.; 42—Hughes; 43, 45—Sperry Rand; 46—Ronald A. Chapman; 60—NASA; 62 (top)—U. S. Navy, (bot)—Beckman Instruments; 64 (top)—USAF; (bot)—U. S. Army; 65—U. S. Rubber; 71—USAF; 85—Westland; 87—Bell Aerosystems.

Q.

What's new in the semiconductor industry?

A.

What's new at Fairchild?

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Laurels for 1962

The pattern of basic changes in the aerospace industry that we forecast for this year (AW Jan. 1, p. 11) certainly materialized, with some major surprises such as Cuba added to the predictable trends. The economic and technical shifts in 1962 occurred during a period of continuing acceleration for the aerospace industry's technical and industrial capabilities and point toward a year of peak activity during 1963. This process of fermentation during 1962 produced less than a bumper crop of the type of achievements that we traditionally pay tribute to on this page at the year's end, but it indicates some excellent vintage years ahead.

Here are the individuals and organizations that we think contributed efforts of major significance to U.S. aerospace progress during 1962:

Gen. Thomas S. Power, commander of Strategic Air Command, and all of the men under him for their performance in effectively exercising the nuclear deterrent power of this nation during the Cuban crisis. Greatest tribute to the effectiveness of this performance was paid by the USSR's Nikita Khrushchev, in his recent Moscow speech defending his abrupt removal of Soviet ballistic missiles from Cuba, when he warned his Chinese allies that contrary to their belief, the U.S. was not a "paper tiger" but had "nuclear teeth."

John Glenn, Scott Carpenter and Wally Schirra, NASA astronauts, for their successful orbital flights in McDonnell Mercury capsules, which confirmed the growing U.S. capability in manned space flight and laid the basic foundation for the Apollo moon mission.

Dr. Hugh L. Dryden, deputy administrator of National Aeronautics and Space Administration, and **Dr. Edward Welsh,** executive secretary of the National Aeronautics and Space Council, for simply being who they are and doing what they have done.

John Houbolt of NASA's Langley research laboratory for his development of the lunar orbital rendezvous concept now accepted as the primary U.S. method of attempting to achieve manned landing on the moon before the end of this decade.

Clarence (Kelly) Johnson of Lockheed Aircraft for his continued ingenuity in the "Skonk Works."

Byron Gordon McNabb and the General Dynamics/Astronautics crew he bosses at Cape Canaveral for their tremendous five-year effort on the Atlas ICBM test program, completed this year, and their solid success in 1962 with the Atlas as a space vehicle booster for Mercury, Ranger and Mariner.

Lt. Gen. Thomas Gerrity for his indefatigable and effective ramrodding of the site activation program for the USAF ICBM program during its most critical phase when he was head of the Ballistic Systems Division of Air Force Systems Command.

E. F. O'Neill, A. C. Dickieson and their team of Bell Telephone Laboratories scientists and engineers for building, launching and successfully operating the Telstar communications satellite with corporate funds and demonstrating the tremendous potential of space communication systems.

Col. Arthur C. Lowell, USMC, head of the Navy's BuWeps avionics division for his hard-driving, often controversial efforts to accelerate application of new microcircuitry construction techniques in Navy equipment, thereby providing impetus required to move this promising new technology out of the laboratory into practical operational use.

C. E. Woolman, president of Delta Air Lines, who at the age of 73 is still demonstrating new managerial tricks to his younger competitors in the jet age that result in passenger acclaim and profits.

Dwane Wallace, president of Cessna Aircraft Co., for the managerial talent that has built an organization that this year led the business aircraft industry in sales volume and unit deliveries for the sixth consecutive year, delivering more than 3,000 aircraft and light helicopters, which comprised about 45% of the industry's unit delivery total and 38% of its dollar volume.

Jack Kline, Delta program manager at Douglas Aircraft Co. and **Gary Hanson,** Delta launch chief at Cape Canaveral, for the continuing reliability of the Thor-Delta space launch vehicle. Thor-Delta placed nine successive payloads into orbit during 1962, enhancing its reputation as the most dependable U. S. space booster.

John Stack for many things, including his leadership of the NASA Langley Research Center team that developed the variable sweep concept into a practical application for the TFX bi-service fighter design competition, and speaking some astringent truths at the Wright Brothers Memorial Dinner on the future role of aircraft that dissolved much of the unctuousness of this traditional speaking program.

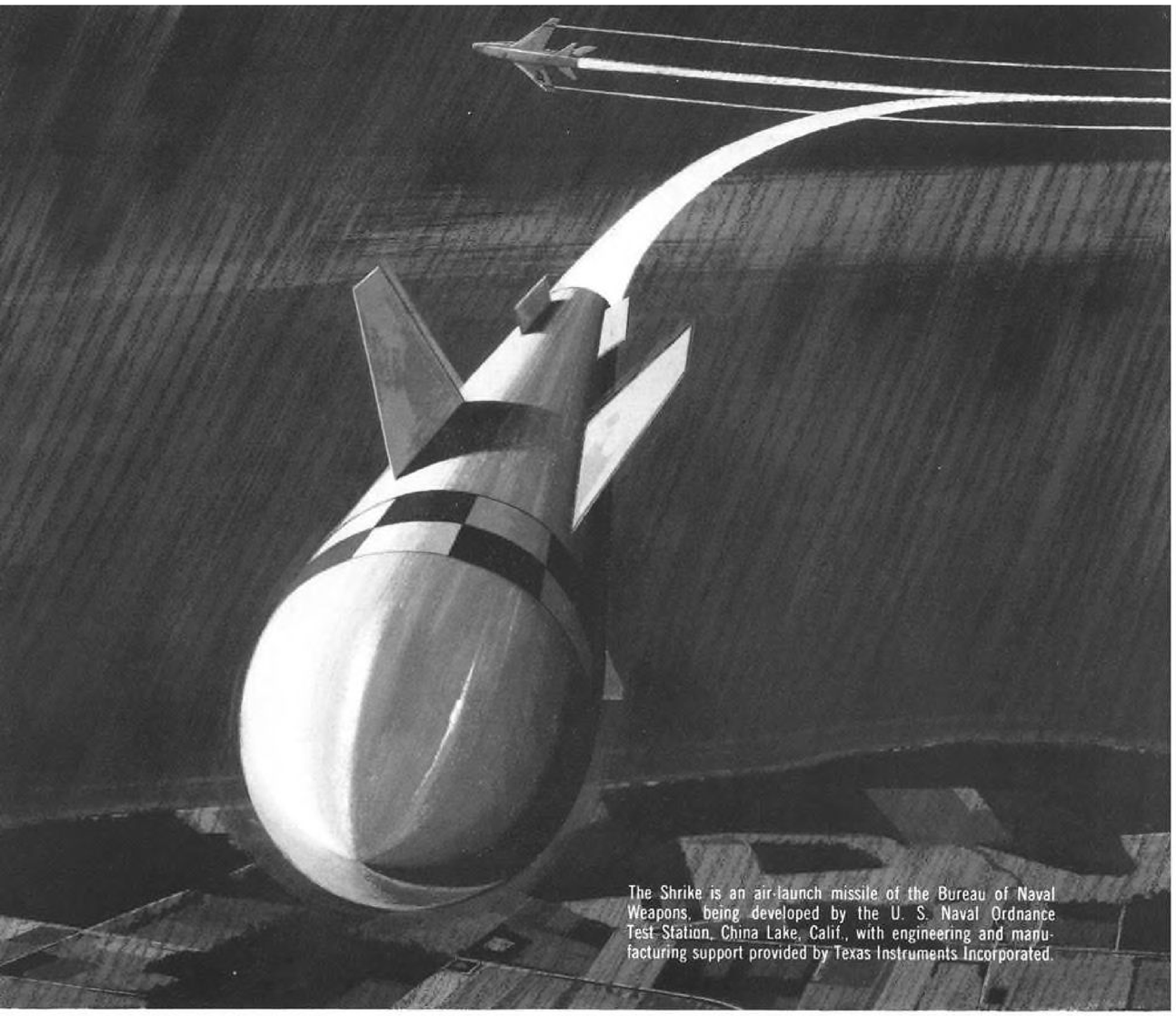
Three Boeing C-135 squadrons in Military Air Transport Service serving with the 1611th Transport Wing at Maguire AFB and the 1501st Transport Wing at Travis AFB for their tremendous demonstration of the value of high-speed jet airlift in all of the international crises during the year.

Jack James, Robert Parks and Fred Kotchendorfer, key managers of NASA's Mariner program, and all of the people stretched from Cape Canaveral through Jet Propulsion Laboratory, Woomera, Australia and Johannesburg, South Africa, whose overtime labors during the 109-day flight period of Mariner 2 contributed to the success of this deep space probe to Venus.

Maj. Jack Albert, Air Force Systems Command Space Systems Division, for his work in whipping the Atlas Agena combination into a reliable space booster after the first two Ranger fiascos.

T. A. Wilson, Boeing Co. vice president and manager of the Minuteman branch of the company's aerospace division, for his work in getting the Minuteman into its first operational silos, ready for combat less than two years after the first test flight of this solid-fueled missile.

—Robert Hotz



The Shrike is an air-launch missile of the Bureau of Naval Weapons, being developed by the U. S. Naval Ordnance Test Station, China Lake, Calif., with engineering and manufacturing support provided by Texas Instruments Incorporated.

new war-club for nation's arsenal

The Navy's Shrike missile is the first of a new breed of weapons designed specifically to increase air-to-surface striking power. Shrike will provide a new attack capability against heavily defended tactical target areas, combined with increased protection for the Navy's pilots and aircraft under operational conditions. Texas Instruments is the prime contractor for the guidance and control sections of the Shrike missile, applying skills in electronics and aerodynamics. TI contributes to the development of this high-performance weapon more than 20 years' experience in recognizing and solving tactical performance problems. ■ In addition to its systems management capabilities, TI possesses a unique combination of proved skills in many areas of endeavor. Expanding from a broad research base, TI interweaves its various technologies to provide a continuous flow of improved products and services for its customers. *Write Department 48.*

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WHO'S WHERE

In the Front Office

John H. Carter, president and chief executive officer of Allied Research Associates, Inc., Concord, Mass., succeeding **Lt. Gen. Roscoe C. Wilson** (USAF, ret.) who continues as board chairman.

Space-General Corp., El Monte, Calif., has elected the following as vice presidents: **Seba Eldridge** for space vehicles; **Jack D. McKenney** for space missions; **Charles E. Roth** for space operations; **Ray W. Sanders** for electronic systems equipment; **Irving Stokes** for electronic systems programs.

Dr. James C. Fletcher, vice president-advanced systems, Aerojet-General Corp., Azusa, Calif. (AW Dec. 3, p. 37).

Heinz Fornoff, vice president-engineering, California Division of Menasco Manufacturing Co., Burbank, Calif.

Monson Hayes, Jr., corporate vice president, Telecomputing Corp., Los Angeles, Calif., and general manager of the Electronic Systems and Data Instruments Divisions.

Dr. Bernard Murphy, vice president-international operations, Electronic Associates, Inc., Long Branch, N. J.

Peter V. Ricciardi, vice president and sales manager, National Ultrasonic Corp., Somerville, N. J.

Douglas L. Heisler, vice president-purchasing, Vickers, Inc., Detroit, Mich.

Group Capt. J. B. Veal, chief inspector of accidents, Ministry of Aviation, London.

Arthur F. Flood, president, Bede Aircraft Co., Springfield, Ohio.

Honors and Elections

A. J. Kwawer, project engineer for the Atlas missile and space booster propulsion system at Rocketdyne Division of North American Aviation, has received the Commander's Award for Merit from the Air Force Space Systems Division for "typifying the technical skills of Rocketdyne employes . . . which have contributed to the success of the USAF Atlas Space Launch Vehicle Program."

Richard E. Horner, vice president and general manager of Space Laboratories, Northrop Corp., has been elected 1963 chairman of the Missile and Space Council of the Aerospace Industries Assn.

Changes

Dr. Lester C. Van Atta, chief scientist, Lockheed Missiles & Space Co., Sunnyvale, Calif., succeeding **Dr. Roy A. Smelt** (AW May 28, p. 30).

Allard G. Russell, director of flight research, Textron's Bell Aerosystems Co., Buffalo, N. Y.

E. R. Horwinski, director of European special projects, Electronic Systems and Products Division of the Martin Co., with offices in Paris, France.

William F. Eicher, manager of the newly formed MMRBM Division of Hughes Aircraft Co., Culver City, Calif.

Peter N. Dudeney, manager of electronic engineering and chief electrical engineer, Research and Engineering Department, Baird-Atomic, Inc., Cambridge, Mass.

INDUSTRY OBSERVER

► Extensive infrared background measurement program may be conducted by Air Force Space Systems Division in a move widely regarded in industry as long overdue. Midas missile alarm system troubles have been attributed to the lack of such data (AW Sept. 24, p. 54). Wavelengths to be examined will be in the near-infrared, overlapping the areas of interest in the Midas program. SSD asked 18 avionics companies to submit proposals for studies of payloads in the program earlier this month.

► **F-111A and F-111B (TFX) fighters being developed for Air Force and Navy by General Dynamics/Ft. Worth and Grumman Aircraft Engineering Corp. will incorporate provisions for zero-length launch boost rockets.**

► Designs for lunar reconnaissance module (LRM) may be studied in an industry competition if it is conducted shortly after the first of the year as now planned by National Aeronautics and Space Administration's Manned Spacecraft Center. Mission of the LRM (AW Dec. 3, p. 33) would be to orbit the moon and take detailed pictures of the lunar surface as an aid for selection of Apollo landing sites. Among spacecraft to be considered for the mission are the Apollo command module and a lunar-excursion module in addition to entirely new design concepts.

► **Navy is considering increasing the range of its Polaris missile system by incorporating engine stages of greater diameter than in the current versions. The proposed submarine-launched Lockheed-built missile would be designated Polaris B-3. Existing nuclear-powered submarines would require launch-tube modifications to accept the new missiles.**

► Two types of variable-thrust control systems are features of the favored proposals for parallel development of a landing engine for the NASA/Grumman Apollo lunar excursion module (AW Dec. 10, p. 35). Gross aeration principle with upstream injection is proposed by Rocketdyne Division of North American; Thiokol's Reaction Motors Division chooses a mechanical device. Lunar takeoff engine for the LEM probably will be developed by Bell Aerospace.

► **Television guidance system for the Army's Shillelagh anti-tank missile is being investigated as a means of giving the weapon capability to strike at targets beyond the horizon. Initially, Shillelagh was to have been guided by an infrared system; currently projected system is command guidance.**

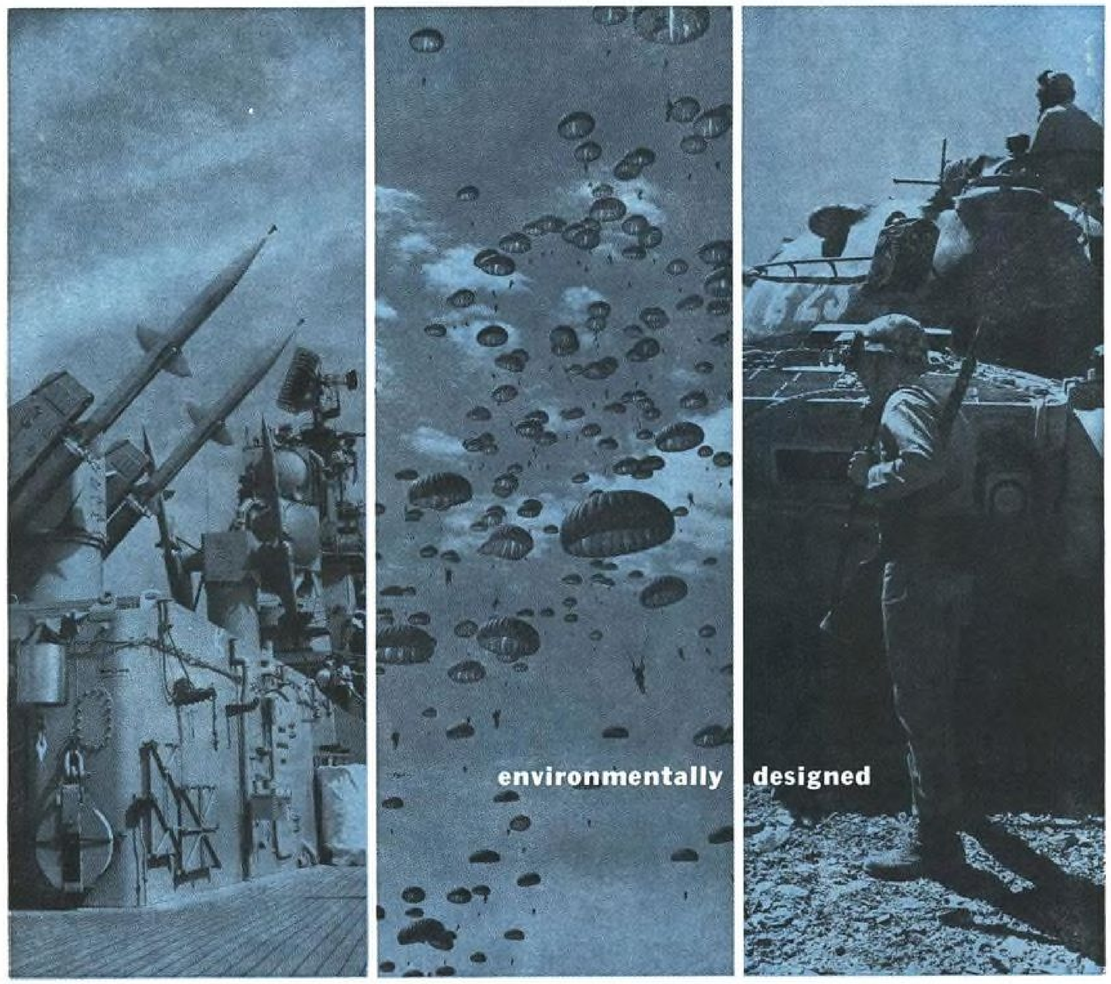
► Studies of the Saturn C-5 stage boosted by a cluster of as many as eight solid-propellant rocket motors are being made by North American's Space and Information Systems Division. Solid motors under consideration are the 120-in.-dia. type now under development by United Technology for Titan 3.

► **Concepts for a medium anti-tank weapon (MAW) will be submitted to Army by March, 1963, in response to recent briefing at the Ballistic Research Laboratory, Aberdeen, Md. Industry will submit schemes to meet a projected Army requirement; concepts may lead to a formalized specification and competition for such a weapon.**

► Light-metal additives to increase performance in hybrid and conventional solid-propellant rocket motors are being investigated by Edwards AFB's rocket group. Additives increase the mass of exhaust products and therefore increase the thrust of rocket motors.

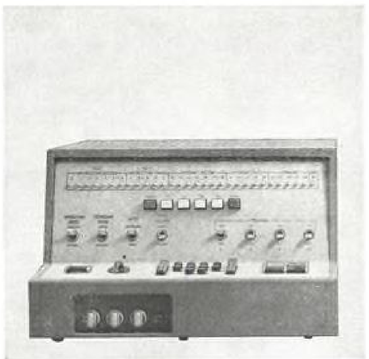
► **Stage separation of the S-1C cluster of five Rocketdyne F-1 engines in the Saturn C-5 probably will be done with eight retrorockets. Request for industry bids for the retrorockets is not expected to be issued before Mar. 1 by the Boeing Co., which will build the stage at Michoud, La.**

► Large performance disparity between Lockheed Ping-Pong (AW Dec. 10, p. 23) and Fairchild-Stratos USD-5 reconnaissance drone systems indicates that "replacement" of the USD-5 by Ping-Pong is based on budgetary rather than tactical reasons. Ping-Pong radius range is about 1¼ mi. USD-5 design radius range was 1,500 mi. Ping-Pong payload is only a small fraction of that of the USD-5.



. . . to operate dependably in tough military situations: Librascope L-2010 computer

Low-cost, highly versatile, general-purpose L-2010 digital computer goes where it is needed. Fully portable*, the L-2010 is built to ride in jeeps, tanks, vans, and aircraft—and on board ships. It can be used off-line for system simulation, supply-depot inventory control, military-records keeping, preventive-maintenance scheduling. Can operate in real time for naval weapons fire control, radar data processing, navigation, and missile-system checkout. □ L-2010 weighs 60 lb, occupies just 2.0 cu. ft. of space. Memory capacity: 4096 30-bit words. All solid-state construction. Circuit modules welded and encapsulated for high component density and maximum reliability. Easily maintained. Minimum skill required to operate. Performs with most peripheral equipment. Designed for desk top or rack mounting. FIELDATA code compatible model available soon. Engineered from Librascope's 25-year experience in computer technology. Send for data.



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Washington Roundup

UN Congo Aircraft

U. S. and five other countries have been asked by the United Nations to supply fighter aircraft for possible use in the Congo. An eight-man U. S. military team, headed by Army Lt. Gen. Louis W. Truman, went to the African republic last week to survey UN military needs there. Increased need for overt U. S. military activity in the Congo is being attributed to the failure of extensive undercover operations by Central Intelligence Agency.

Five other nations expected to contribute aircraft are Sweden (four Saab J-29s in addition to the three there now); the Philippines (six North American F-86s); Iran (Republic F-84Gs); Italy (F-86s) and Ethiopia (F-86s).

Disagreement between the services and Defense Dept. over the proposed counter-insurgency (COIN) aircraft (AW Dec. 10, p. 26) has grown into active opposition. Navy prefers a turboprop and Air Force wants the Cessna T-37. Army, heavily committed to rotary-wing aircraft, favors a close support helicopter.

CIA, Pentagon Attacked

Central Intelligence Agency, which undergoes almost no congressional scrutiny, and the Pentagon, which sits at the opposite extreme, have been attacked by Supreme Court Justice William O. Douglas for roles they play in domestic and foreign affairs. In a pamphlet entitled "Freedom of the Mind," published by the American Library Assn., the liberal jurist decried the secrecy surrounding CIA's operations, and said: "The reasons why it supports feudal regimes, the results of its policies, the dangers that it generates are not known even to many of the informed press. . . Yet why should the CIA efforts to influence elections abroad be a secret to the American people when they are notorious in the foreign nation?"

Douglas said "the Secretary of State is the voice that is heard, but the true policy-forming group is often the Pentagon's political bureaus—all this being contrary to our theory of the supremacy of the civilian authority over the military." In the area of science, Douglas said the "new centers of power are in the hands of those who control science, and one who traces the controls back to origins often finds the Pentagon in the central position. Those who finance the scientific revolution usually control those who work for them. The impact of this control on our universities is so great that their autonomy is threatened."

Teddy Bugs Keating

Sen. Kenneth B. Keating (R.-N. Y.) has proposed "a brief tour of installations and firms in Massachusetts" by New York congressmen to retaliate for Senator-elect Ted Kennedy's recent visit to Grumman's plant (AW Dec. 17, p. 25). Sen. Keating called the Kennedy visit "a virtual campaign of pirating New York [defense] work," and "a strong and subtle form of pressure," since Ted Kennedy is "the President's brother."

NASA definitely will not ask for supplemental funds for Fiscal 1963 to close its $450-million money gap (AW Dec. 10, p. 27). Brainerd Holmes, manned space flight chief who favored a supplemental appropriation, found himself in a minority at a recent meeting President Kennedy held with NASA leaders and the Budget Bureau.

Aerospace Industries Assn.'s board of governors has been unable to induce any of the top aerospace industry candidates to accept the post of association president and is now trying to find a top trade association executive who has no previous experience with aerospace industry problems. The job has been vacant since ill health forced August C. Esenwein's retirement last May.

Defense Dept. is considering modifying Armed Services Procurement Regulations to encourage defense contractors to study the probable effects of any future disarmament agreement. Such studies would be made allowable items of expense on defense contracts.

President Views Defense

President Kennedy has indicated the Fiscal 1964 Defense Dept. budget request will be about $52 billion, that it will not provide for a large B-70 or RS-70/program, that Nike Zeus again will not be put into production and that only Congress can save Skybolt (see p. 20).

The President evidently feels that U. S. weaponry has reached a plateau of achievement high enough to warrant a long look before any large new programs are begun. Dr. Harold Brown, director of defense research and engineering, is a leading exponent of this view and has expressed it publicly in connection with Nike Zeus and the RS-70. In a television interview on Dec. 16, the President cited the nuclear deterrent already available to the U. S., and said military spending would rise from $52 billion to $65 billion a year "if we didn't tighten up as much as we can." He said specifically that "there is no sense going ahead [with Nike Zeus] until that system is perfected," and said he did not believe Russia has developed an anti-missile missile that can handle the problems of decoys and missiles in great numbers.

Navy Capt. William Ditch is leading contender to replace Army Col. Earl G. Peacock as technical consultant to the House space committee. Col. Peacock becomes Los Angeles District Engineer. **—Washington Staff**

Mariner Success Marred by Data Dispute

Venus fly-by produces high-quality telemetry but argument arises over method for releasing results.

By Edward H. Kolcum

Washington—Jet Propulsion Laboratory scientists are quickly analyzing data on the surface temperature and atmospheric characteristics of the planet Venus, which were obtained by Mariner 2, but how and when the highly significant information will be made public was the subject late last week of a fundamental disagreement within the National Aeronautics and Space Administration.

Mariner 2 flew past Venus Dec. 14, reaching a closest approach point of 21,594 mi.—within 400 mi. of the predicted miss distance—at 2:59:28 p.m. EST. Despite a number of potential failures right up to time of the closest pass, the payload made three complete radiometer scans of the planet and returned 42 min. of what was called exceptionally high-quality telemetry data.

This data is the heart of the Mariner 2 mission objective, because it contains the first close measurements of the environment surrounding the planet and the temperature of the atmosphere and surface.

Although some of the quick-look analyses of the Venusian magnetic and radiation fields had been completed a few days after the fly-by, the first official report will not be made until Dec. 26 at the annual American Assn. for the Advancement of Science meeting in Philadelphia. It will be brought up to date Dec. 27 and 28 at an American Geophysical Union meeting at Stanford University in Palo Alto, Calif.

Most significant part of the planetary information—radiometer data on the Venusian surface temperature—is expected to be released at a press conference next week in Washington.

This unusual method of releasing information, rather than making it available to the public as quickly as the findings are made, is a compromise between scientists and public information officials in NASA.

The scientific position is that top experimenters will not be attracted to NASA projects if the agency does not follow what scientists consider the historic ground rules. In essence, these rules imply that an experimenter does not comment publicly on his experiment until the results have been published in a reputable scientific journal. The reasoning is that publication in such a journal reduces rash claims, eliminates charges by other scientists of publicity-seeking, and preserves professional dignity.

The opposing view, which has gained favor among the younger experimenters as the space program has grown, is that scientific findings are the results of expensive, tax-supported projects and should not be confined to the limited readership of scientific journals, which often have lead times of as much as six months between submission of an article and publication.

Compromise which has been reached within NASA is that acceptance of an article by a scientific journal now constitutes publication, and the experimenter is free to talk about his findings at the time of acceptance—even though the article may not appear for some time. The compromise was reached by Dr. Homer E. Newell, NASA space sciences director; Dr. John F. Clark, his associate director and chief scientist on one side, and Dr. George L. Simpson, Jr., assistant administrator for public affairs, on the other.

Dispute came to a head because of the unusual public interest in Mariner 2 accomplishments, which some feel are the most significant to date in the space program. A few weeks before the Venus encounter, Dr. Newell wrote to each experimenter and asked that he not comment on his findings until agreement is reached on their meaning.

Despite the administrative disagreements, Mariner 2 succeeded in its mission by surviving rising heat loads which exceeded battery design limits, two failures of the electronic programmer to start the scanning experiments, and an indication that the fast scanner was inoperative. Programmer was eventually turned on by ground command, and the indication that the fast scanner was out proved to be false.

The payload is still in danger of exploding because the temperature of the sealed liquid battery was rising last week as Mariner neared the closest point to the sun. This point, called the perihelion, will be reached Dec. 27 when Mariner 2 will be 65,505,935 mi. from the sun. Aphelion, or most distant point from the sun, will occur June 18, 1963, and will be 113,813,087 mi. Maximum distance from the earth will occur Mar. 30, 1963 at a distance of 98,063,599 mi. Next closest approach to the earth will come Sept. 27, 1963, at a distance of 25,765,717 mi. The payload revolves around the sun every 345.9 days.

Goddard to Improve Satellite Specifications

Washington—Goddard Space Flight Center expects to award study contracts for new satellite programs so it can identify critical technical problem areas and thus prepare more detailed and realistic specifications for subsequent hardware procurement.

The new policy is similar to the Defense Dept.'s recently adopted practice of first awarding program definition phase contracts. This was disclosed by Eugene W. Wasielewski, associate director of the National Aeronautics and Space Administration's Goddard facility.

Wasielewski said he hopes that the more detailed and better defined specifications will enable some companies to decide that they do not have the required capability, thereby sparing themselves the cost and effort of making a proposal.

He noted that rocket boosters and guidance had enjoyed a major increase in reliability since 1958, when only 30% of the satellites launched went into orbit, whereas this year the percentage was up to 75%.

In launches of Goddard payloads in 1961, five out of seven were successful, while this year all 11 attempts have achieved orbit.

But there has not been as great an improvement in the reliability of spacecraft payloads, Wasielewski said. "Where we had lifetimes of two to three months not so long ago, we seem to be reaching a level of four to five months and higher in 1962," he said.

He cited Tiros 4's lifetime of nearly five months and Telstar's life of about four months.

"But it is obvious that there is much to be done if we are to provide the kind of lifetime which will be required in some of the satellites which are presently being designed," he said.

Successive Failures Precipitate JPL Shakeup

Pasadena, Calif.—Jet Propulsion Laboratory, manager of National Aeronautics and Space Administration's unmanned lunar and planetary programs, has undergone a far-reaching shakeup in the wake of five successive lunar spacecraft failures and in anticipation of criticisms of its management by NASA's in-house review of the Ranger project (AW Dec. 10, p. 25).

As a consequence of the reorganization, the lunar program director, Cliff I. Cummings, and the manager of the Ranger project, James D. Burke, will be reassigned to other posts within JPL.

Combined lunar and planetary projects office has been set up under the direction of R. J. Parks, who formerly headed the planetary program office. This new office will report directly to Dr. William H. Pickering, director of the laboratory, as did the lunar and planetary program offices which it replaces. As former planetary program director, Parks had over-all charge of Mariner 2, JPL's single successful spacecraft mission since it became a NASA contractor in 1958.

Reporting to Parks will be each of the spacecraft project managers. They are:

- Ranger—Harris M. "Bud" Schurmeier, who moves up from the systems division to the Ranger position vacated by Burke. Replacing Schurmeier as chief of the systems division will be Dr. Clarence Gates, former chief of the systems analysis section of that division.
- Surveyor—W. E. Giberson, who continues in the position held prior to the reorganization.
- Mariner (Atlas-Agena)—J. N. James, who has been managing the Mariner R spacecraft under Parks.
- Voyager and advanced development projects—P. N. Haurlan, who continues in this position.

Cummings has been temporarily reassigned to Dr. Pickering's office with a special assignment to assist Parks in the formation of the combined lunar and planetary office. Burke will be a special assistant to Schurmeier.

Changes reportedly were the results of recommendations made by a special JPL review committee which conducted its own review independent of NASA's Kelley Committee (AW Oct. 29, p. 38) which conducted the Ranger investigation.

JPL's telecommunications division also is being reorganized in a move unrelated to the lunar and planetary project shakeups. Responsibilities of the various sections in the division will be redivided among them, and a number of personnel changes are expected. L. Randolph, who had reported to the chief of the communication system development section, probably will head one of the revamped sections.

There have been criticisms both within NASA and in industry of certain aspects of the management of the division's Deep Space Instrumentation Facility, together with the division's handling of recent procurements.

Telecommunication changes are interpreted partly as a move to avert recurrences of these criticisms.

Every day that Mariner 2 continues to fly, it establishes a new space communications record. If the probe survives, it has been estimated that communications will continue for another three months, which will place it more than 95 million mi. from earth.

Data Reduction

Data reduction is continuing on the interplanetary experiments, which have been completed and their preliminary results reported. These experiments consist of a magnetometer, high energy radiation experiment, solar plasma detector and cosmic dust detector (AW Oct. 15, p. 30).

Microwave radiometer experiments scanned electromagnetic radiation at 13.5 and 19 mm. wavelengths. The lower value is at the water absorption band, and the higher was designed to penetrate the Venusian atmosphere to determine why emissions from the planet are as high as 615F. The theories are that the surface of the planet is that hot, or that the atmosphere is that hot because of a greenhouse effect.

Companion infrared radiometer, operating at 8-9 and 10-10.9 microns, looked at the Venus cloud cover to try to find breaks in this cover.

AW&ST Schedule

Aviation Week & Space Technology will publish its next issue Jan. 7. The current issue is the fourth one this month. The Dec. 31 issue, which would have been the fifth in December, will not be published.

Quality Control, Design Criticized By Ranger Program Investigators

Washington—Ranger unmanned lunar landing spacecraft program has been criticized for its quality control, engineering design and test procedures in a report by a board of inquiry convened after the fifth successive failure in the program.

Major results of the board's findings are a shakeup in the top program management at Jet Propulsion Laboratory (see box), an intensified checkout procedure and removal of Ranger 6 from the flight schedule. Ranger 6 spacecraft, which had been scheduled for launch early next year, will be used as a general product improvement model in an effort to correct the shortcomings which the payload has experienced. Modifications developed in the Ranger 6 ground program will be made to Rangers 7, 8 and 9 at the expense of several months delay in the flight program.

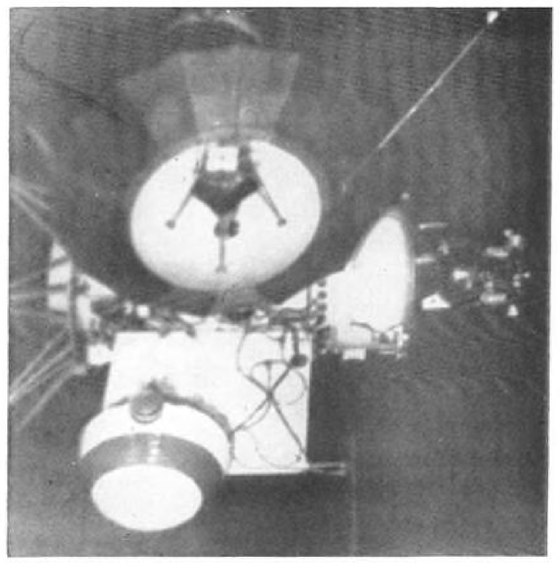
The inquiry board (AW Oct. 29, p. 38), submitted a final report on Dec. 4. In addition to the general conclusions on quality and design, the report questioned the desirability of meeting flight schedules before the system was considered fully flight ready.

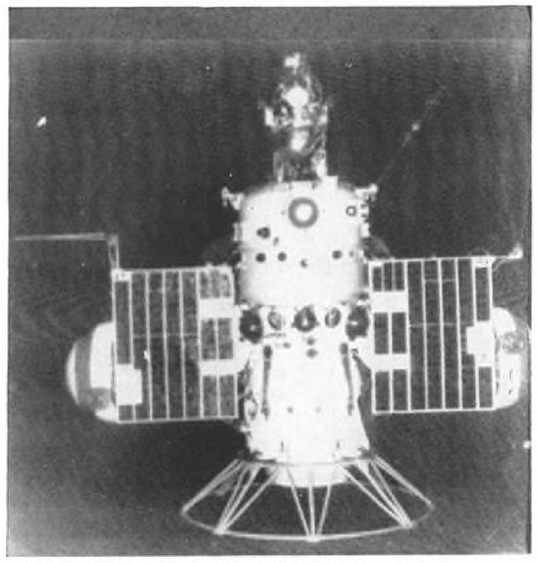
Both JPL and NASA were under heavy pressure to meet launch schedules because of heavy competition for launch pad time at Cape Canaveral, and because spacecraft are being delivered at a regular pace. There is only one pad available for Ranger launches. Argument for maintaining the schedule is that NASA has always learned something from launches, even from failures. The fully-successful Mariner 2 payload is based on the Ranger concept and contains some components developed for Ranger, the agency pointed out.

Much of the NASA report is secret because it contains design data on the Atlas and Agena launch vehicle stages. The launch vehicle was generally absolved in the report, and criticism was leveled at management practices which have contributed to spacecraft unreliability.

Dr. Homer E. Newell, NASA space sciences director, said the next step for Ranger will be an extensive, combined design review and test program. Ranger 7 flight probably will not be scheduled until the review is completed. Ranger program has become a critical part of Apollo.

Inquiry board was headed by Dr. Albert Kelley, a Navy commander on detail to NASA, who is a guidance and control expert. The board consisted of James Koppenhaver of NASA headquarters, Herman Lagow of Goddard Space Flight Center, John Foster of Ames Research Center, Frank Smith of Langley Research Center, F. J. Bailey and Dr. Arthur Rudolph of Manned Spacecraft Center and John Hornbeck of Bellcom.





SOVIETS RELEASED these photos purporting to be Mars interplanetary station. Probe was interrogated 37 times during first month.

Extensive Information Returned By Mars Probe, Russians Claim

Moscow—Soviet Mars probe was interrogated 37 times during the first month of its flight and returned considerable data on the interplanetary environment, according to the Russian newspaper Pravda.

The Pravda article furnished the first details of the spacecraft configuration, but gave no indication of when the critical midcourse maneuver will be attempted to bring the probe close to the planet Mars. Present flight path will cause the payload to miss the planet by 120,000 mi., according to Pravda.

There is a belief in the U. S. that Russia already attempted the midcourse maneuver and failed because the maneuver has not been announced, even though Mars 1 had been in flight 51 days on Dec. 21. Midcourse correction to the U. S. Mariner 2 Venus probe was accomplished nine days after launch. Normally, the longer the delay, the more difficult the maneuver becomes.

Soviet report on the payloads says it has two compartments, one called an orbital compartment containing guidance and on-board propulsion, and the other a planetary compartment containing scientific instruments, which are to be activated as the probe approaches Mars.

Mars 1 was said to weigh 1,966 lb. with maximum dimensions of 160 in. and 132 in. Cylindrical orbital compartment has a 44-in. diameter. Scientific instruments were said to be a phototelevision device to obtain video pictures of the Martian surface; spectroreflectometer to detect organic cover of the planet surface; spectrograph to determine atmospheric constituents; magnetometers and radiation detectors and cosmic dust detectors.

Pravda said the orientation and thermal control systems are functioning properly, and that a backup ground command orientation system is available if the spacecraft fails to maintain its designed attitude. The probe was interrogated every two days through Dec. 13, and this period is now every five days. As the probe continues its flight, the interval between interrogation will be increased to 15 days. Flight time is 210 days, which means May 29, 1963, will be the date of closest approach.

During its flight, according to Pravda, Mars 1 has measured charged particles to distances of 5 million mi. from earth. It recorded an exceptionally intensive stream of solar particles Nov. 30 which reached a level of 600 million particles per sq. cm. per second.

The probe has discovered that since the 1959 Soviet flights, background space radiation has increased 50-70%, the report said. Magnetic field fluctuations have been measured ranging from 4-12 gammas, and the probe has noted a decrease in the amount of cosmic dust the farther away from earth it travels.

Nuclear Arms Restraint Techniques Outlined

Ann Arbor, Mich.—Unilateral policies and procedures to assure "restraint" in the use of nuclear weapons by the U. S. were outlined here last week at the International Arms Control Symposium by John T. McNaughton, counsel for Defense Dept.

These techniques, to be exercised in the absence of negotiated arms control agreements, fall into "administrative" and "physical restraints," McNaughton said, citing:

- Administrative—Requirement for presidential authority to use nuclear weapons, two-man control by carefully screened personnel over areas where such arms are handled, and Strategic Air Command's positive control procedure, which requires "highest authority" before nuclear-armed aircraft can be ordered into enemy territory. The SAC procedure cannot be circumvented by mechanical failure, McNaughton said.
- Physical—Restraints on accidental or unauthorized use of nuclear weapons include elaborate codes, keys, electrical impulses and two-man manual weapon-arming operation.

Earlier in the meeting, Victor Karpov, first secretary of the Soviet Embassy, said the Soviet Union and U. S. are still in fundamental disagreement over whether disarmament should take place with or without inspection. Karpov said U. S. insistence upon on-site inspection in itself "makes us suspicious."

Karpov referred to "certain interventions" as reasons for Soviet opposition to on-site inspection.

Redeye Missile Undergoes Extensive Testing

Radio-guided P4Y drone aircraft was shot down late last month off the Southern California coast by an Army/Marine Corps shoulder-fired Redeye air defense missile, fired from a bazooka-type launcher on San Clemente Island.

Lightweight, infrared-guided missile, undergoing live tests, struck the drone bomber on an outboard engine, sending it hurtling into the Pacific.

Incident was a signal success in a several months-long test program plagued with troubles, which at one point this fall threatened the program with severe changes. General Dynamics/Pomona is the prime missile contractor.

San Clemente success was partially repeated again on Dec. 14 at Naval Ordnance Test Station (NOTS), China Lake, Calif., when a Redeye scored a direct hit on a Navy/Grumman F9F single jet drone.

Lengthy series of tests have been in progress during recent months at both NOTS and at San Clemente island. The tests are being conducted by Army, Marine and Navy personnel.

Redeye is being fired from the ground against a series of targets including:

- Beech Aircraft Corp. KD2B propeller driven drones.
- Bell OH-13E drone helicopters.
- Convair P4Y drone bombers and Grumman F9F drone fighters.

Reportedly a large number of Redeye missiles, possibly over a dozen, have failed to find their targets, apparently in many cases because of guidance difficulties. The missile, which has a Philco infrared seeker head, is intended to home on heat generated by the target's engines.

Reports indicate that the missile has been unable to lock onto the target heat source before it passes too close to the target to permit control changes.

Initially, plans called for attaching flares to the Beech KD2B drones at China Lake but with test failures this procedure gave way to the use of high-intensity light sources, which provide a hotter, more intense source of target heat for the missile. The heat generated by the bomber and jet drone apparently is sufficient for homing purposes, the recent successful San Clemente and NOTS tests would indicate.

Changes are being made in both the primary and backup Redeye guidance system to correct for difficulties revealed in flight tests. In addition, General Dynamics is developing an alternate guidance system which will have its first flight test early next year.

In a typical firing exercise, two drones are employed with the first in target position while the second is prepared for tests. In the Dec. 14 tests, one Redeye fired at a drone went out of control within seconds after its launching. This misfiring was followed by the successful strike against the F9F.

Norstad Is Under Consideration For Post With Comsat Corporation

Washington—Gen. Lauris Norstad, supreme commander of allied forces in Europe, was under active consideration last week for appointment as chief executive officer of the communications satellite corporation now being established by 13 incorporators named by the President.

Opposition is strong to a military man as director of a project in which the U. S. is urging worldwide cooperation and participation.

Gen. Norstad, who will retire from his SHAPE post Jan. 2, made this comment in Paris:

"My interest in the space communications project is that of an individual citizen toward an effort of great national and international interest.

"However, in making my plans for the future I am not considering any personal association with the corporation."

At a closed-door meeting of the incorporators Dec. 10, a list of 50 proposed appointees to head the new corporation was reduced to Gen. Norstad and eleven others, AVIATION WEEK & SPACE TECHNOLOGY learned. Strong opposition to a military man was voiced by some of the incorporators at the meeting.

Philip L. Graham, chairman of the incorporators, said last week that it will be "several weeks" before a final selection is made.

Sen. Wayne Morse (D.-Ore.) accused Graham of "pulling shenanigans to force his choice of Norstad" upon the incorporating board. He said his charge was based on information given to him by the board membership. Graham is president of the Washington Post Co. and board chairman of Newsweek magazine.

Denouncing any military appointment, Morse challenged Graham "to release to the public accurate minutes, or better still an unexpurgated verbatim transcript of the discussion" on Gen. Norstad.

"That meeting was no tea party, and the public interest of all the American people was involved," the Oregon senator declared.

Incorporators last week hoped to complete action on articles of incorporation at meetings scheduled for Dec. 21 and Jan. 4.

When the corporation is formed, the incorporators will serve as a board of directors.

The next step, after the appointment of a chief executive officer, will be to develop a management organization for the company.

Federal Communications Commission last week invited communications common carriers to file applications for authorization to invest in the new company, starting Jan. 2. FCC set a 20-day period for replies to the applications by interested parties, and a 10-day period for replies to these replies by the applicants. After the 30-day period, FCC will process the authorizations as rapidly as possible. This will pave the way for companies to move forward with investment plans, after the capital structure of the communications satellite company has been determined by the incorporators within the legal framework.

The law authorizing the company earmarks 50% of the stock for purchase by communications common carriers and 50% for public offering, and sets a maximum price of $100 per share of stock.

Project Trump Awards

Los Angeles—Payload contractors for the Air Force's target radiation measurement program (Trump), which is to secure data on the infrared and ultraviolet energy emitted by ICBMs and IRBMs launched from Cape Canaveral, were selected recently.

Minneapolis-Honeywell will provide infrared radiometers under a $381,000 contract from the Air Proving Ground Center at Eglin AFB.

Westinghouse Electric will supply an ultraviolet spin photometer under a $175,000 contract.

Third contract was awarded to Electro Mechanical Research for sensing devices. A final award, this one for a rocket stabilization system, is still pending.

Project Trump (AW Apr. 2, p. 63) is an Air Force Space Systems Division-Aerospace Corp. effort to obtain background information relating to missile radiation by measurements made from rocket probes.

The information is expected to help discriminate missile launchings from background radiation.

Polaris May Replace Skybolt for Britain

President Kennedy and Prime Minister Harold Macmillan appeared close to an agreement late last week under which the U.S. would provide Britain with the submarine-launched Navy-Lockheed Polaris IRBM as a replacement for the Douglas air-to-ground Skybolt.

British sources at the Kennedy-Macmillan meeting in Nassau said President Kennedy and U.S. Defense Secretary Robert S. McNamara offered Britain an alternative to Skybolt after Macmillan insisted on an independent deterrent capability.

However, British sources said Macmillan agreed that if Polaris is made available to the Royal Navy, submarines equipped with the nuclear-tipped two-stage solid rocket eventually will be integrated into NATO-controlled forces or at least placed under some kind of multi-lateral European control.

Britain does not have a submarine capable of launching the Polaris, but is building nuclear submarines which, it is understood, could be modified to handle the missile. It also was suggested at the meeting that Polaris could be launched from surface ships.

Prospects for continued development of Skybolt would be damaged immensely by a decision to arm Britain with Polaris, although members and leaders of important congressional military committees said they would fight for continuation of Skybolt to maintain —at least for a few years—the role of the manned bomber as a recallable deterrent force.

Macmillan was expected to present the Polaris offer to his cabinet and the British Parliament at an early date.

Skybolt, the weapon in which the British had placed their hopes for a nuclear deterrent, is a 38.5-ft., two-stage solid rocket intended to carry a warhead 1,000 mi. It was to be launched from the Boeing B-52F, G and H, and the British Avro Vulcan. The USAF-North American Hound Dog air-to-ground missile is now carried on B-52Gs. It was planned to shift the Hound Dog to the B-52E as the Skybolt became operational.

The British canceled their Blue Streak and Blue Water surface-to-surface missiles on the strength of the U.S. agreement to provide Britain with the Skybolt. Since the Royal Air Force is now phasing out its Thor IRBMs, cancellation of Skybolt would have left Britain with only its 100-mi. range Blue Steel air-to-ground missile.

U.S. decision to cancel Skybolt began to take shape several weeks ago and was first disclosed by AVIATION WEEK & SPACE TECHNOLOGY on Nov. 26 (p. 27).

Macmillan took a strong stand at Nassau for an independent deterrent. President Kennedy and Defense Secretary Robert S. McNamara sought to convince the British that their interests would be served as well by a NATO-controlled long-range deterrent capability.

In deciding the fate of Skybolt, President Kennedy was faced with a number of diffuse considerations:

- **Technical problems**—Accuracy of a ballistic missile depends on knowing the precise point from which it is launched. Precisely determining the position of launch from a fast-moving B-52 platform is being cited by Administration as beyond the state of the art. Many technical experts from the Air Force, Douglas and the British teams associated with Skybolt disagree.
- **Cost**—Original USAF-Douglas development cost estimate for Skybolt was $214 million, but this figure was never approved by Defense Dept. Current development cost estimate is $492.6 million to bring the missile to operational status. Cost of the over-all program, including production of 1,077 missiles, is now estimated at $2.3 billion but technical monitors say $2.8 billion is a more realistic figure.
- **Schedules**—Original operational date was October, 1964. In December, 1960, this was revised to spring of 1965. Competing weapons systems are coming along at such a fast pace that even small slippages are prejudicial to Skybolt.
- **Manned bombers**—With Skybolt, useful life of the B-52 and Vulcan would be extended to about 1970. Without Skybolt, the manned bomber will rapidly become obsolete.
- **Foreign policy**—The Administration has indicated that it wants to limit as much as possible the number of nations having a nuclear strike capability.
- **National economy**—Kennedy Administration is acutely aware that cancelation of the Skybolt program means loss of payrolls and jobs in an economy whose health is vitally affected by defense spending.

All of these points were touched upon, debated and amplified in statements by the President, congressional leaders and editorial comment on both sides of the Atlantic. In a television interview last week, the President clearly indicated that the Administration had made up its mind to drop Skybolt from the Fiscal 1964 defense budget requests.

". . . When we are talking about spending this $2.5 billion [for development and production of Skybolt]," the President said, "we don't think we are going to get $2.5 billion worth of national security. . . .

"We are talking about $2.5 billion to build a weapon to hang on our B-52s, when we already have billions invested in Polaris and Minuteman, and we are talking about developing now Titan 3 and other missiles. There is just a limit to how much we need, as well as how much we can afford to have a successful deterrent.

"I would say when we start to talk about the megatonnage we could bring into a nuclear war, we are talking about annihilation. How many times do you have to hit a target with nuclear weapons?" In response to a question on a Douglas advertisement for Skybolt in a national magazine, the President brought out the economic aspects of the Skybolt controversy.

". . . I think it [the ad] was an attempt to influence our decision," he said. "I see nothing wrong with that . . . Skybolt is very essential to the future of the Douglas Co. There are thousands of jobs involved."

The most formidable opposition to the Administration viewpoint was expressed in the Senate Armed Forces Committee. Chairman Richard B. Russell (D.-Ga.) said he would ask for a committee investigation, and Sen. Stuart Symington (D.-Mo.), a committee member, forecast that the battle over Skybolt in the forthcoming session of Congress "will be a great deal bigger than the B-70."

Sen. Symington, who was Air Force secretary during the Truman Administration, fought hard for the B-70. He said he will conduct a determined campaign to continue Skybolt—even suggesting that Skybolt proponents may vote cuts in civilian space projects and other Administration-backed programs if the executive branch refuses to spend funds appropriated for Skybolt.

Sen. Symington said abandonment of Skybolt "is the end of the manned bomber. . . ." and the end of the Air Force. "I just don't see the future of the Air Force if Skybolt is canceled."

Other grounds on which he objected to the Administration viewpoint were:

- **Elimination of manned bombers** equipped with nuclear bombs or rockets carrying nuclear warheads takes away some of the "options" Defense Secretary McNamara has said the U.S. needs to maintain a tactical war capability.
- **Reliance on ICBMs and IRBMs** increases the emphasis on pushbutton warfare and consequently increases the escalation danger in a nuclear war.

Sen. Willis Robertson (D.-Va.), who is to become chairman of the military appropriations subcommittee of the Senate Military Appropriations Committee, lined up with Symington. He urged continuation of development with the $362.7 million earmarked for it in the current Defense budget, and indicated he will question the Joint Chiefs of Staff closely on the need for Skybolt when they appear before his subcommittee in January.

British editorial comment continued to reflect that nation's bitter disappointment at the prospect of losing the nuclear strike capability Skybolt would give the Vulcan bomber. British editorials and cartoons scorned alternatives suggested by the Administration—arming the Vulcan with the shorter-range USAF-North American Hound Dog or launching of Polarises from ships.

Opinion opposite that of the government and popular press was expressed by the Economist, which advised that "Britain's efforts will now be better directed to contributing to a total, balanced deterrent within the alliance in terms of the likely strategic needs of 1970—not on twisting the Americans' arms for face-savers, flag-wavers and evanescent expedients."

AAD-70 Competition

Washington—Mobile Army air defense system for field use in the period beginning around 1970, known as AAD-70, is planned as a successor to the field army ballistic missile defense system (FABMIDS), which never got beyond the contractor selection stage. Requests for industry proposals for studies are expected to be issued within several months.

Present plans call for selection of several contractors to perform program definition studies. In original FABMIDS competition, General Electric's proposal was selected, but Army and Defense Dept. feared program costs would far overrun available funds. New AAD-70 is expected to call for less sophisticated design approach.

Pioneer Shifted to Ames

Washington—Management of the Pioneer space probe series will be shifted from Goddard Space Flight Center, Greenbelt, Md., to Ames Research Center, Moffet Field, Calif. Relatively simple spin-stabilized interplanetary measurement probes (IMPs) will be flown on Thor-Delta vehicles as the next part of the series.

One purpose of the program is to bolster NASA's ratio of successes. Compared with attitude-controlled spacecraft such as Ranger, spin-stabilized spacecraft have a high probability of success. NASA feels it needs successful deep space flights to balance failures in the high-risk Ranger and Surveyor lunar landing flights.

Crisis Over Skybolt Stirs Interest In TSR-2 and Blue Steel Mark 2

By Herbert J. Coleman

London—British subcontractors in the British Aircraft Corp. TSR-2 strike-reconnaissance fighter program have been told quietly to accelerate delivery of components, partly because of the crisis over delivery of the USAF-Douglas Skybolt air-launched ballistic missile to the Royal Air Force.

Uncertainty over Skybolt's future also has renewed interest in the Mark 2 version of Blue Steel—the RAF's 150-mi. range standoff bomb—although the manufacturer, Avro, has not yet been given any go-ahead or funding. The design is now four years old and would stretch the missile's range to 800 mi., using ramjet engines.

Meanwhile, Defense Minister Peter Thorneycroft last week faced an angry Parliament and, in a statement interrupted by jeers and laughter, said the British government had known from the outset that Skybolt posed a formidable development problem.

Thorneycroft said that last September, when he visited Defense Secretary McNamara in Washington, he was assured that Skybolt would be delivered to the RAF. It was not until November, he said that McNamara informed him that the future of the weapon was in question.

The defense minister confirmed that discussions of an alternative nuclear weapon included the possibility of Polaris submarine-launched missiles for the Royal Navy, but he stressed that no decisions had been made either on Skybolt or the alternatives.

Response from the opposition Labor Party was bitter. The party's deputy leader George Brown, who recently visited the Pentagon, charged:

"For the first time the minister has admitted today what his predecessors and other service ministers have persistently denied. That from the outset the government knew, as the opposition knew, that this [Skybolt] was no more than a gamble, with great difficulties in the way of getting it."

Brown questioned the efficiency and reliability of Skybolt, even if development is continued and asked: "Have we not had enough experience of equipping British forces with second and third rate weapons before now. . .?"

Parliamentary reaction also reflected widespread British resentment over U.S. handling of the Skybolt cancellation, summed up by Emery Hughes, the Labor member who submitted the retaliatory bill to cancel the Holy Loch Polaris base agreement (AW Dec. 17, p. 26). Hughes said:

"It is very humiliating to see the Minister of Defense and the Prime Minister going cap-in-hand and crawling to the Americans for something which is not in use and would be exorbitantly expensive to the British people."

Others referred to the humiliation Britain faces because of Skybolt and said it directly arises from the famed White Paper of 1957, prepared by then Defense Minister Duncan Sandys, which committed Britain to missiles rather than manned bombers. Since then the two main weapons, Blue Streak and the medium-range Blue Water have been canceled.

Intensity of the British desire to remain a strong member of the Western nuclear club was demonstrated later when 100 Conservative party members supported a motion in the House of Commons, emphasizing Britain's determination to retain her own nuclear deterrent within the weapon alliance.

One of the signers was Harold Watkinson, former defense minister who negotiated the Skybolt agreement.

Saturn Crawler Bids

Twenty-two firms were invited to bid last week on the crawler-transporter to be used in moving the Saturn C-5 launch vehicle and its Apollo spacecraft from the assembly building to the launch site at Cape Canaveral, Fla.

Pre-proposal briefing was given by the National Aeronautics and Space Administration's Launch Operations Center at Cape Canaveral. Tracked crawler (AW July 2, p. 135), driven by four pairs of steel-link treads each about 40 ft. long and 20 ft. wide, must be capable of moving the estimated 8 million lb. weight of the launch table and the empty launch vehicle at a speed of 1 mph. and climbing a 5% grade.

Hydraulic jacks, 90 ft. apart, will raise six feet to lift the launch table clear of the ground for movement and must be able to sustain a normal loading of 3 million pounds each for extended time periods and peak loads of 4 million pounds for short periods.

Saturn-Apollo will be launched directly from the table, which is expected to measure about 150 ft. long by 130 ft. wide.

Bids for the crawler-transporter, including the launch table and umbilical tower, are due Jan. 15, 1963, and a contract is expected to be awarded by Mar. 1.

Boeing, IAM Await Advisory Unit Report

By Katherine Johnsen

Washington—Labor and management at Boeing Co. are awaiting a report by a three-man presidential advisory board, due by Jan. 5, as the next major development in a critical situation.

During six months of negotiations, the company and the International Assn. of Machinists have failed to even approach agreement on any major issue —union shop, wages, or other benefits. The union shop is the main obstacle. Settlement of this issue would probably pave the way for agreement on other issues.

To avert a strike in mid-September when the last labor-management contract expired, the President appointed the Boeing Aerospace Board, headed by Saul Wallen, Boston lawyer. The two other members are Lewis Gill, private arbitrator, and Patrick Fisher, private arbitrator and lawyer.

The latest evidence of deteriorating relations between Boeing and IAM was the company's repudiation of an election on the union shop held at Boeing's Seattle facilities. The election included workers detailed to the Michoud, La., booster assembly plant of National Aeronautics and Space Administration. The result, announced by National Labor Relations Board Dec. 10, showed approximately 74% of the 30,128 workers involved favored a union shop.

Pre-election Campaigning

Boeing management declared the election invalid because in pre-election campaigning, the company said, union leaders interjected wages, pensions, and other issues and confused workers as to exactly what they were voting on.

The union countered that Boeing management conducted an equally aggressive campaign to induce workers to vote against union shop.

The election was requested by the Wallen board for guidance in making its report to the President. In reluctantly agreeing to the request, Boeing emphasized the election result would not be binding on either labor or management. The union agreed to postpone possible strike action until Jan. 15.

Following the election, Boeing management stated:

"Boeing does not see how the Wallen board can accept the vote as an indication that the employes want a union shop, since the board's clearly-stated purpose in calling for the poll was distorted by the union.

"The board had asked for an expression on the single question: 'Do you want a union shop?' Apparently concerned that employe sentiment on this simple question would be negative, the union interjected the issues of wages, pensions, and other benefits into the poll.

"In its newspaper, in advertisements and on the radio the union went to such extremes as indicating that every employe would receive an increase of $500 a year if he voted for the union shop. It thus sought to convince employes that they were voting for higher wages and other benefits, rather than on the simple issue of the union shop. . . ."

John Sullivan, president of IAM's Seattle district, acknowledged an active union pre-election campaign, and explained:

"The company campaigned against the union shop because it wanted a weak union to deal with. We campaigned for the union shop because we know it will strengthen the union's ability to negotiate better wages and working conditions."

Workers at Boeing's Vertol Division at Morton, Pa., organized by the United Auto Workers, also voted 73% in favor of a union shop.

Taylor Board

The Wallen board appears to be under some compulsion to follow the solution to the union shop issue that was recommended by the Taylor board, appointed by the President to advise on aerospace disputes in California (AW Nov. 26, p. 36). The Taylor board recommended the issue be decided by a vote of workers, with a two-thirds majority required to establish the union shop.

The Wallen board could then recommend on the alternatives: that a valid election showed more than two-thirds in favor of a union shop, and therefore it should be established; or, the Boeing election, as the company maintains, was invalid, and therefore union shop should be decided by another election.

This Taylor board proposal was accepted by IAM and UAW unions and three California firms: North American Aviation, Ryan Aeronautical Co., and the Convair Division of General Dynamics Corp. The unions failed to win the necessary two-thirds majority at all three firms.

Negotiations between IAM and Lockheed Aircraft Corp., which has adamantly refused to accept a decision by election on union shop, continued stalemated last week. The President invoked the 80-day no-strike provisions of the Taft-Hartley Law Dec. 3 after Lockheed was confronted with strike action (AW Dec. 10, p. 29).

In a letter to Rep. Gerald Ford (R.-Mich.) last week, Defense Dept. denied reports that it was threatening Lockheed with loss of current and future business if it did not accept settlement of the union shop issue by vote. Ford, ranking minority member of House appropriations subcommittee on the armed services, had asked for clarification of the reports.

Thomas D. Morris, assistant secretary of defense for installations and logistics, did acknowledge to Ford that the Defense Dept. would make "necessary preparations" to assure against production losses in vital national defense projects from a strike. The injunction issued under Taft-Hartley assures Lockheed against a strike at least until the 80 days runs out Feb. 21.

Continued Production

This policy, Morris said, "represents what any responsible and prudent customer would do when faced with the possibility of an impact upon his supplier's capacity to produce his requirements . . . One of the factors to be considered as a customer and in the national interest is whether or not alternate means can be utilized to assure continued production. . . ."

Morris added: "I know of no threats to cancel military procurement contracts or of any contracts which have been canceled with the Lockheed Aircraft Corp. Likewise, this concern [Lockheed] has not been warned it will be barred from future competition on military procurement awards if it does not capitulate in this labor-management dispute."

Ford said that he was not completely satisfied with Morris' reply and would pursue the matter during hearings on the Fiscal 1964 defense budget before his subcommittee early next year.

French Pledge Support Of Rallye Program

Paris—French government has intervened in the bankruptcy of Morane-Saulnier and sources say final decision on future of the aircraft builder will be made by Jan. 7 (AW Nov. 19, p. 40).

Defense Minister Pierre Messmer currently is discussing various solutions with interested parties. It is understood both French and foreign companies have indicated an interest in taking over Morane-Saulnier. Government and French aircraft industry association states that whatever solution is decided upon, all orders on the books for company's Rallye sportsplane will be honored. After-sales service also will be assured.

MA-9 Flight May Last 34 hr.

Washington—Mercury Atlas-9 flight of Maj. Gordon Cooper will last nearly 34 hr. and between 21 and 22 orbits if studies now under way by the National Aeronautics and Space Administration indicate such a flight plan is feasible.

If approved, the flight plan will be a significant expansion of the Mercury system limit, which had been considered to be 18 orbits. NASA is not worried about reaction control fuel consumption on the flight, since Cdr. Walter M. Schirra proved on his MA-8 mission that drifting flight is not difficult (AW Oct. 8, p. 26). The analyses being made by the agency concern consumables such as environmental oxygen, lithium hydroxide filters and on-board battery power.

Cdr. Schirra's six-orbit flight is the longest so far in the Mercury program. It is expected that Maj. Cooper's MA-9 mission in April will be the last in the Mercury schedule if it goes according to plan. Manned Gemini flight with a two-pilot crew is scheduled in early 1964.

Soviet Maj. Andrian Nikolayev flew 64 orbits in approximately 95 hr. as pilot of the Soviet Vostok 3 spacecraft and he holds the world's record for sustained orbital flight. A 48-orbit, 72-hr. mission was flown by Lt. Col. Pavel Popovich in Vostok 4.

Explorer 16 Satellite Provides Excellent Micrometeoroid Data

Washington—Explorer 16 micrometeoroid satellite was being interrogated successfully on each orbit last week and is expected to furnish more data on the hazards of cosmic dust than all prior satellites which have made such measurements.

The satellite was launched at 9:33 a.m. EST Dec. 16 from Wallops Island, Va., as the payload of the tenth Scout vehicle. Its orbital elements are: apogee, 733 mi.; perigee, 466 mi.; period, 104.4 min., and inclination to the equator, 52.01 deg.

Previous Attempts

By late this week, the 222.2-lb. Explorer 16 appeared to have the best opportunity to date to obtain critical design point data on the frequency and velocity of micrometeoroids. Two previous attempts to launch similar payloads in the S-55 series were relatively unsuccessful. S-55 failed on June 30, 1961, when the Scout third stage Antares motor failed to ignite. S-55A, launched Aug. 25, 1961, remained in orbit only three days as Explorer 13.

Other payloads which have counted and measured the velocities of cosmic dust (AW Oct. 22, p. 54) have been Explorers 1, 3 and 8; Vanguard 3; Midas 2; Samos 2; Luniks 1 and 2 and Sputnik 8.

The cylindrical satellite, 24 in. dia. and 76 in. long, is conducting its measurements with these five types of detectors:

• **Beryllium-copper** pressurized half-cylinders, ranging in thickness from 0.001 to 0.005 in. and filled with helium gas. The 160 cells give the payload its nickname—the beer-can satellite— because they look like tin cans. This system was designed by National Aeronautics and Space Administration's Langley Research Center, which also acts as manager for the project. Measurements are made by determining the pressure losses when the cells are punctured.

• **Foil gages,** developed by Lewis Research Center. If a micrometeoroid punctures any of the 60 foil detectors, a change in resistance level occurs.

• **Wire grids,** consisting of 46 cards wound with copper wire. Experiment was devised by Goddard Space Flight Center. It works on the same principle as the foil gage experiment.

• **Cadmium sulfide cells,** also developed by Goddard. The cells are covered with quarter-mil Mylar coated with evaporated aluminum on both sides. Particles which penetrate the Mylar allow light to focus on the cells, changing the resistance.

• **Crystal transducers,** mounted on sounding boards to detect three distinct impact velocity levels. This experiment also was devised by Langley Research Center.

Minitrack Stations

By early last week, the satellite had been interrogated 13 times by Minitrack ground stations, and it had responded with data each time. Data reduction is being performed at Langley, and analyses and evaluation will be done by the individual experimenters.

The satellite also contains five groups of solar cells to determine protection needed for these cells. One group is unprotected, three groups are protected by 6-mil glass slides, and the fifth group of solar cells is protected by a ⅛-in. quartz window.

Defense Is Pushing Random-Orbit Satellite

Los Angeles—Dept. of Defense Research and Engineering probably will approve only the random-orbit, medium-altitude, communication satellite system for development. The synchronous-orbit system will be supported only as a low-priority study, perhaps for as long as one year. Sufficient funds are not available to start both programs as parallel development efforts.

In the random-orbit satellite program:

• **Air Force Systems Command's** Space Systems Division, under its 369 directorate, will issue a single request to industry for a quotation to cover the complete satellite package. (Synchronous-orbit communications study will be managed by SSD's 814 directorate.)

• **Army's Satellite Communications** Agency, will issue a single request for a quotation to cover the ground communications system for the random-orbit satellite.

As many as four to eight satellites may be boosted in a single launch by an Atlas/Agena D combination. Satellite weight may be specified somewhere between 50-150 lb. Orbital altitude may vary between 5,000-12,000 naut. mi.

Industry companies watching the impending competition for the random-orbit satellite responsibility include RCA, Bendix, Philco, Space Technology Laboratories, General Dynamics/Astronautics, Hughes and Bell Labs.

Bell's position with regard to the competition is uncertain in view of its relation to the Telstar program, results of which it is now discussing with DOD.

Hughes final decision also is uncertain now, because it may want to concentrate solely on the synchronous-orbit satellite effort in view of its present work for National Aeronautics and Space Administration on its Syncom program, which is purely a development effort. Currently, Hughes has an effort under way for NASA future consideration—Syncom 2—a 500-lb. communications satellite (AW Aug. 20, p. 80) of greater sophistication than the basic Syncom satellite.

French Space Budget

Paris—French 1963 budget contains $900 million for research and development, of which $32 million is earmarked for space research compared with $17 million in 1962. About $13 million of the $32 million will be used to finance French participation in European space projects and $1.2 million for French and NASA programs. Development of the Diamant missile, which is scheduled to orbit the first French satellite in 1965, has been allocated $4.2 million.

Slim Hope Remains for Success of Relay

By George Alexander

Cape Canaveral—Space agency officials maintained a slim hope late last week that power might eventually build up in the Relay 1 spacecraft to the point where communications experiments will be possible, but only tests of the telemetry system had been conducted through Dec. 21.

Disappointing operation of the payload followed another extremely precise launching by a Thor Delta vehicle which placed the communication satellite into an orbit ranging from 819.64 mi. to 4,612.18 mi. in a period of 3 hr. 5.09 min. Planned orbit was 700-4,500 mi. with a period of 3 hr. 4 min.

Abnormal power drain apparently occurred early Dec. 14 between the fifth and sixth orbits. On the fifth orbit, Relay exchanged signals with the National Aeronautics and Space Administration's test station at Nutley, N. J., but the on-board voltage was too low on the sixth orbit to activate one of the two transponders necessary to conduct planned communications experiments.

The power remained low throughout the first week, and NASA was attempting to determine the cause of the failure through analysis of telemetry data.

The 172-lb. Relay satellite, built for NASA by Radio Corp. of America, was successfully launched into orbit by the three-stage Thor Delta vehicle at 6:30 p.m. EST Dec. 13. The Douglas-built vehicle missed the scheduled launch time by only 1 sec., and now has a record of successfully orbiting 14 consecutive payloads after an initial failure.

Plans had called for Relay to transmit television, two-way telephone, teletype and other data experiments between the American Telephone and Telegraph Co.'s Andover, Me., ground station and the British General Post Office station at Goonhilly Downs, and the French National Center for Telecommunications Studies installation at Pluemeur-Bodou.

The two-way telephone, teletype and data experiments were to have been transmitted between the International Telephone & Telegraph Co.'s Nutley, N. J., station and the Brazilian station at Rio de Janiero, operated by Radio Internacional de Brazil. One-way voice and teletype transmissions were to have been conducted by U. S. and Brazilian stations to the Italian station at Fucino, operated by Telespazio. Italian station had the capability to receive, but not to transmit.

Visibility between stations was estimated to have been between 15 and 50 min. for each of the satellite's three daily passes. Orbital inclination of Relay was 47 deg., so the satellite does not always pass within range of the countries participating in the program. Relay was equipped with two identical transponders to ensure mission reliability.

The satellite was to receive wideband (television) signals from ground stations at 1,727 mc. and repeated by one of the transponders selected by the ground station at 4,170 mc. Narrow-band telephone, teletype and data transmissions were to have been on frequencies of 1,726.6 mc. (station-to-satellite) and 4,165 mc. (satellite-to-station) when the spacecraft was passing overhead in a west-east or north-south direction; 1,723.3 mc. (station-to-satellite) and 4,175 mc. (satellite-to-station) when passing in an east-west or south-north direction.

Narrow-band transmissions could accommodate either 12 two-way or 300 one-way telephone channels. Relay also carried two command receivers (approximately 148 mc.), two command decoders, two telemetry transmitters (136 mc.) one telemetry encoder and one command control unit. Tracking beacon was to have operated continuously at 4,080 mc.

Temperature control of the satellite was maintained by a series of aluminized Mylar shutters across the broad end of the spacecraft. Shutters were activated by a bellows-type piston filled with liquid sulphur dioxides. Heat rise causes the liquid to expand and drive the shutters open. Designed temperature environment was 40F to 80F.

Scientific experiments carried were:

- **Solar cell damage.** Of the 8,215 cells covering the spacecraft, 30 were set aside for this experiment. Nine were of the N-on-P variety, nine were P-on-N, and three were of gallium arsenide. Shielding varied from none to quartz plates ranging in thickness from 30 to 60 mils.
- **Diodes.** Six diodes were to be exposed to solar radiation damage, along with the cells. Thermistors connected to the diodes were to indicate temperature rise of the units and from this data, damage could be inferred.
- **Radiation monitor.** This device, built by Bell Telephone Laboratories and State University of Iowa, was installed in a clover leaf-like aperture in the side of the spacecraft and was to sample protons between 35 and 300 mev., 1 and 8.1 mev. and 15 and 60 mev.; and electrons between 0.5 and 1.2 mev.

The BTL part of the unit was to sample electrons between 0.25 and 1.0 mev. and protons between 2.25 and 25 mev.

Relay was the first payload to be launched by the improved Delta vehicle (AW July 2, p. 132). Second stage length was increased by 36 in., adding about 1,300 lb. propellant capacity to the unit. Coupled with the uprating of the first stage engine from 150,000 lb. to 172,000 lb. thrust (starting with Delta 13), payload capability of the vehicle has been increased from 500 lb. to 800 lb. in a 300-mi.-high earth orbit.



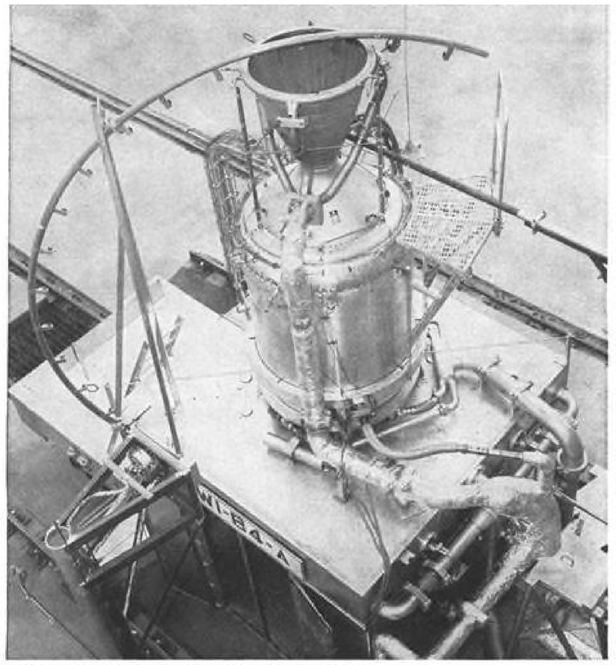
ANTENNA FOR RELAY, built at Mojave, Calif., by Philco Corp. for NASA is mounted on X-Y mount and provides wideband communications transmission and reception capability. Structure is 55 ft. high, 28 ft. across at the base and 40 ft. across the dish. Total weight is 157 tons.

Relay 3 Solar Cells

Washington—Radio Corp. of America has received an $800,000 contract from the National Aeronautics and Space Administration to provide N-on-P solar cells for Relay 3, and for Relay 2 if the next satellite can be retrofitted in time to meet its scheduled March, 1963 launch date. Relay 3 is scheduled for a mid-1963 launch.

Relay 1 was fitted with P-on-N solar cells, but NASA said analysis of Relay telemetry data to date indicates that the failure was caused by a short circuit in the voltage regulator circuit used to maintain steady voltage.





KIWI-B4-A nuclear rocket reactor is shown a few hours prior to firing. The reactor is tested as part of the Project Rover program.

Construction of Nerva Test Stand Delayed

By C. M. Plattner

Jackass Flats, Nev.—Construction of the test stand for the Nerva nuclear engine in National Aeronautics and Space Administration's Project Rover will not be completed until the spring of 1964, about 15 months later than a target date established this year (AW Feb. 26, p. 65).

First test firing of Nerva (nuclear engine for rocket vehicle application) is scheduled for late 1964.

Work on Engine Test Stand No. 1 at the Nuclear Rocket Development Station, which will be used for the first Nerva ground tests, will be complete except for instrumentation, shielding and exhaust system by March. But problems such as heat transfer and high velocities in exhaust ducting have slowed development of key phases of the test stand installation.

Other problems encountered in the Kiwi solid-core reactor testing program of Project Rover, designed to develop a liquid hydrogen-nuclear rocket engine for space applications, include:

- **Lubrication of bearings** at liquid hydrogen temperatures (−423F) in a radiation field.
- **Finding materials suitable** for a pressure vessel which will maintain strength at cryogenic temperatures in radiative fields.
- **Flow problems from vibration,** which causes sloshing, flow oscillation and moving of the liquid fuel level.
- **Radiation problem** necessitating remote handling and testing, requiring development of new equipment and control techniques.

Demonstration that a reactor core using liquid hydrogen as the propellant could be successfully started was made Sept. 1 with a Kiwi-B1-B test vehicle.

On Nov. 30 a test run of Kiwi-B4-A lasted 260 sec. before it was shut down when flashes were observed in the exhaust flame. Test monitoring instruments in the control room showed no sign of irregularity in reactor operation. Probable cause was seal leakage or induced vibration, but final analysis is awaiting disassembly of the reactor core.

Nerva engine is being developed by Aerojet-General Corp. for the Space Nuclear Propulsion Office (SNPO), a joint National Aeronautics and Space Administration-Atomic Energy Commission organization. A hot-bleed-cycle configuration will be used, according to Aerojet officials. This type of cycle refers to a technique for venting hydrogen gas to drive a turbine, which in turn, drives a liquid-hydrogen pump.

Relatively cool gaseous hydrogen, which has been warmed slightly by circulation through the jacket of the exhaust nozzle, will be mixed with hot hydrogen gas tapped from the throat of the nozzle to drive the turbine connected to the liquid-hydrogen pump. After passing through the turbine, the gas will be exhausted through swiveled nozzles to provide roll control for the vehicle. Pitch and yaw control will be provided by swiveling the entire engine at a gimbal point between the turbopump and the propellant tank.

To provide thrust for the Nerva engine, the liquid hydrogen from the turbine-driven pump will be circulated through the nozzle jacket to a cylindrical neutron reflector surrounding the reactor core and also through the circular shield on top of the reactor. After passing through the shield, which minimizes radiation to the control area, the hydrogen gas passes through the reactor core, where it is heated and accelerated through the exhaust nozzle.

Next step in the Rover project will be development of Rift (reactor-in-flight-test) rocket stage employing the Nerva engine for propulsion. NASA has planned Rift as the third stage of the Saturn C-5.

First nuclear rocket-powered flights could be in 1968 if funding shortage does not slow the program (AW Dec. 17, p. 28).

Program calls for 10 Rift stages to be built. First two stages built will not be flight hardware and will be tested at the Nuclear Rocket Development Station here. Next three stages will be flight configurations and will also be used in the static test program at the station.

Last four Rift stages will be flight-tested from Atlantic Missile Range from Launch Complex 39, which also will be used to fire the Saturn C-5. Rift launch vehicle will consist of Saturn S-1C, an S-2, and S-2 dummy stage and Rift stage powered by Nerva engine.

House Unit Urges That NASA Assume Large Solids Program

By George C. Wilson

Washington—Special House space subcommittee has recommended that National Aeronautics and Space Administration consider taking over the large solid propulsion development program from the Defense Dept. to ensure that civilian space requirements for the boosters are met.

This recommendation is contained in a report on large solid propellant boosters prepared by the special propulsion subcommittee of the House space committee. Rep. David S. King (D.-Utah), who was defeated in November in his Senate bid, is subcommittee chairman.

The report contains the first analyses of the Defense Dept.-NASA agreement to conduct a large solid motor program which is expected to cost $149 million through June, 1967, and result in eight demonstration firings.

The agreement concludes that solids cannot compete with liquids as the propulsion system for the Nova launch vehicle, and consequently restricts the program to a generalized state-of-the-art approach. The two agencies considered four alternatives (AW Dec. 17, p. 31), the most expensive of which would have cost $298 million and would have allowed solids to compete with liquids as the Nova system through June, 1965, when one of the two concepts would be selected. However, the agreement effectively cancels the large solid program as a parallel or backup to liquids. Subcommittee study of the program concludes that the cancellation is justified if there is no military need for large solid boosters, and if NASA is convinced that solids cannot compete with liquids in Nova. But, the subcommittee said if money alone dictated the decision, it should be re-examined.

The subcommittee also decried the manpower and time required to reach an agreement, and the long delay "in starting even the most basic development program."

Defense Dept.'s large solid development plan calls for spending the $149 million this way:

- **Fiscal 1963**—$10.9 million for two firings of half-length 260-in. motors; $2.8 million for three firings of subdiameter but full-length motors of short burning time to simulate the ignition of 260-in. motors; $12 million for advanced large solid technology.
- **Fiscal 1964**—$8 million for two firings of half-length 260-in. motors; $13.5 million for one firing of a half-length 260-in. motor of flight weight; $800,000 for an additional three firings of the sub-diameter, full-length motors; $12 million for advanced technology.
- **Fiscal 1965**—$30 million for two firings of full-length 260-in. motors at a waterside facility; $12 million for advanced technology.
- **Fiscal 1966**—$35 million for an additional two firings of the full-length 260-in. motors at waterside facilities, and $12 million for advanced technology.

The $65 million for the firings of the full-length 260-in. motors evidently covers the cost of crude waterside facilities. Several aerospace contractors are moving to obtain land in Georgia and Florida along the Gulf Coast in hopes of improving their chances of obtaining large solid contracts.

Under the selected plan, Defense Dept. would not commit itself to a single contractor until late 1964, and could use three main contractors until then on the large solid program. "The major part of this program," Defense Dept. said, "is oriented toward answering critical feasibility questions through a few demonstrations of the 260-in. diameter monolithic motor on a time scale not related to a flight schedule of any particular vehicle." Defense Dept. noted that work would also be done on the technology related to 156-in. segmented motors.

Defense Dept. told the subcommittee that the "principal deficiencies" of the selected plan were its slow pace and limited number of tests, while its "principal virtue" was contractor competition in the early phase.

Defense Dept. said that the selected plan would result in a late demonstration of motor feasibility.

The other three proposals—called alternatives 2, 3 and 4—would cost from $144 million to $298 million. Alternative 2 and 3 both would cost $144 million and be tied to the Nova schedule. Principal deficiencies of these two plans, according to Defense Dept. were the commitment to one contractor rather than three and the limited number of tests. Alternatives 2 and 3 would be only feasibility demonstrations.

Alternative 4 would cost $298 million but would be a development as well as a feasibility program for large solid motors. Principal deficiencies, Defense Dept. told the subcommittee, were its high cost, commitment to one contractor and the fact that it would require a decision in Fiscal 1964 to use large solids for Nova.

Navy Wants 4 Transits in Orbit

Launches of operational Navy Transit navigation satellites are scheduled to take place every 30 to 60 days from now on until four successful vehicles have been placed in polar orbits roughly 90 deg. apart.

The Navy wants all four in orbit before the end of 1963. After that, two replenishment launches per year are planned.

This schedule for an operational system that will enable Navy ships and submarines to determine positions within a tenth of a mile was revealed after Transit 5-A was launched at 8:25 p.m. EST on Dec. 18 from Pt. Arguello, Calif. The satellite became silent after only one day of operation.

The 135-lb. payload was successfully placed into a near circular orbit by a four-stage Chance Vought Scout solid-propellant rocket. This was the first use of Scout to launch a Transit. Earlier launches used Douglas Thor-Ables and Thor-Ablestars. Countdown and launch were conducted by an Air Force crew.

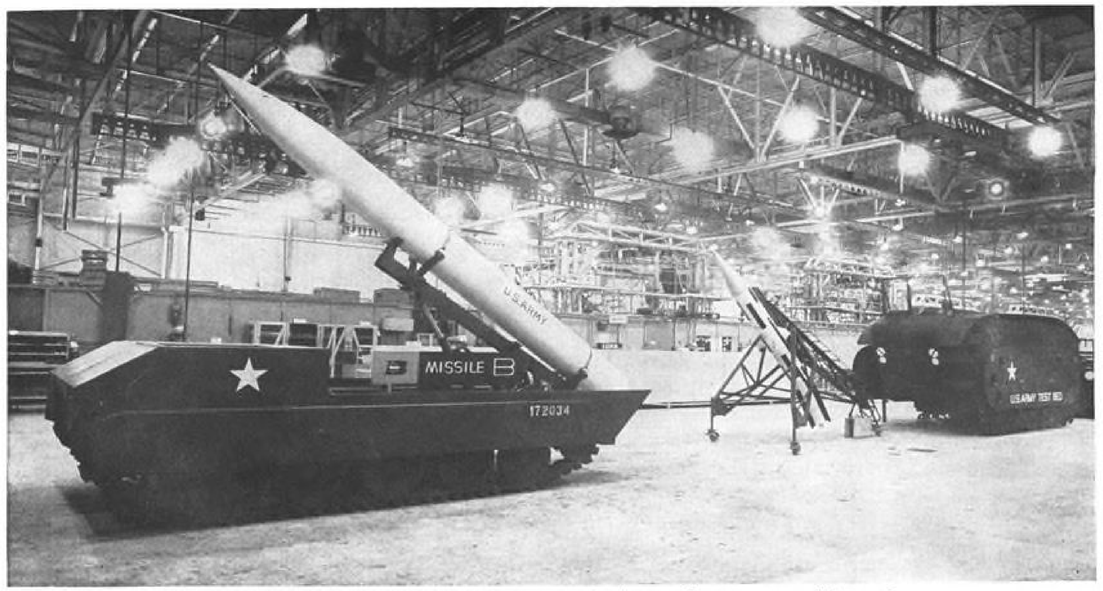
Dr. Richard B. Kershner, supervisor of the Space Development Program of the Johns Hopkins University Applied Physics Laboratory, said the command receiver would not accept instructions from ground control stations. This prevented turning on the memory system for storing orbital data, and deployment of the boom-spring-weight gravity gradient stabilization system.

The Applied Physics Laboratory is technical director for development of the satellite payload and the navigation system.

Efforts were under way late last week to determine the cause of failure. Applied Physics Laboratory spokesmen say they have enough telemetry to find the trouble. Doppler ranging system and telemetry transmissions operated initially, but the command receiver did not function.

The payload is in an orbit with a 375 naut. mi. perigee and 395 naut. mi. apogee. Eccentricity of the orbit is .0025, which Kershner considers as nearly circular as necessary for the mission. Transit 5-A was launched on an inclination of 90.7 deg. to the equator, which places it in a slightly retrograde orbit. Period is 99.06 min.

One other Type 5 satellite is scheduled for the next launch. It will be followed by the operational models. The Model 5 is 200 lb. lighter than the heaviest test vehicle, Transit 3-B. The weight saving was accomplished by using a lightweight shell of glass fiber and honeycomb plastic and housing electronic components and systems in high-density packages encapsulated in plastic foam.



First Photo Shows Mockup of Army's Lance Missile

First photo of the mockup of Army's Lance battlefield missile (formerly called Missile B) shows the division-support weapon system on its mobile field launcher. Chance Vought Corp., of Dallas, a division of Ling-Temco-Vought, is prime contractor, with Army Missile Command as program manager. Lance is designed as a highly mobile weapon with conventional and nuclear warhead capability. It is the first Army missile to use storable liquid propellant. Behind Lance is a mockup of Project Fire, a battlefield missile developed a few years ago by Chance Vought as a private venture. The Fire program was dropped after a few firings.

Management of Anna Returned to NASA

Washington—Project Anna geodetic satellite program management was transferred from Defense Dept. to the National Aeronautics and Space Administration last week in compliance with congressional recommendations that the civilian space agency should conduct the program on an unclassified basis.

Transfer of the project to NASA completes the full management loop for the satellite (AW Aug. 13, p. 33). NASA managed Anna from the time the agency was established in October, 1958, until August, 1960, when it gave the program to the Defense Dept.—because the space agency would not agree to participate in a classified project.

Defense Dept. had successfully argued that the military requirements of satellite geodesy were overriding, and the program should be classified because of a belief that data obtained would help Soviet Russia in targeting analyses. This belief was changed last April when Defense Dept. concluded adequate geodetic information for military needs already is available.

Only successful satellite in the program was Anna 1B, which was launched Oct. 31 with the Navy as executive manager. Defense Dept. will continue to track and obtain data from this payload, which, until Feb. 1, 1963, will be used for calibration, using flashing light, radio ranging and Doppler techniques.

NASA is expected to change both the concept and the name of the geodetic satellite project. The name is an acronym for Army, Navy, NASA and Air Force.

News Digest

LOT Vickers Viscount turboprop transport crashed at Warsaw airport last week during an approach. All 33 persons aboard were killed. Plane was one of three Viscounts purchased by the Polish carrier. LOT is the only communist bloc airline to buy British-built aircraft.

Space Agency has set Jan. 28 for a final hearing on its proposed new regulation on title rights to new inventions. At earlier hearings (AW Dec. 17, p. 30), Aerospace Industries Assn. and Electronic Industries Assn. opposed the proposal, which would ban title waivers by NASA in fields developed predominantly through government sponsorship. Sen. Russell Long (D.-La.) has announced that hearings on the NASA proposal will be held early in the new congressional session by the Senate Small Business Monopoly Subcommittee, which he heads.

NASA Pilot Milton Thompson escaped injury Dec. 20 when he ejected from a Lockheed F-104 while on a weather reconnaissance flight in advance of an X-15 mission.

First Kaman UH-2A (HU2K-1) Seasprite utility helicopter was delivered to an operational Navy squadron last week at Bloomfield, Conn. UH-2A will be flown by Utility Helicopter Squadron 2 at Lakehurst NAS, N. J.

British Executive Air Services, a subsidiary of Pressed Steel Co., will manufacture the Brantly B-2 helicopter in England under license from Brantly Helicopter Corp., Frederick, Okla.

Soviet Union is offering to provide India with a plant to produce the Mi-4 helicopter, and Indian acceptance of such an agreement is likely. Some delay in delivery of Soviet MiG-21 fighters promised to India earlier this month has been reported in parliament by K. Raghuramaiah, Indian minister of defense production.

Sir Gerald D'Erlanger, 56, former chairman of British European Airways and later chairman of British Overseas Airways Corp. died Dec. 15. He commanded the Royal Air Force military ferry service, Air Transport Auxiliary, during World War 2.

New Local Carrier Aircraft Drive Begins

ALTA group studies proposals for inexpensive, short-haul transport; Bede BD-7 design appears favored.

By L. L. Doty

Washington—Assn. of Local Transport Airlines last week launched a drive for early procurement of a short-haul, low-cost transport aircraft which many local service airline officials believe is essential to the survival of their industry.

Although the local service group is still divided over the exact need for such an aircraft and the specific role local carriers should play in the nation's air transport system, it appears likely that the industry will soon take firm action toward adopting an airplane that, for the first time, would be uniformly designed for local service requirements.

The drive is headed by Leslie O. Barnes, president of Allegheny Airlines and chairman of the ALTA low-cost plane design committee. Earlier this month, Barnes invited engine and aircraft manufacturers to meet here with local service officials to discuss production of an aircraft that would serve low traffic-density routes at minimum operating costs.

Last week, Barnes named an advisory group to study proposals brought forth during the discussions and make recommendations to the design committee. The committee, in turn, will prepare a draft recommendation from the advisory group's findings and submit the final paper to ALTA membership for action.

The advisory group consists of: R. Dickson Speas, airline engineering and operational consultant, William Littlewood, American Airlines vice president of equipment research and Dr. Joseph J. Cornish, a specialist in the field of boundary layer control at Mississippi State University. Melvin Gough of the Federal Aviation Agency will be available to the group for consultation.

These are the chief contenders for the ALTA choice:

• **French-built Henry Potez 840** transport, powered by four Turbomeca Astazou turboprop engines. Plane is being sold in the U. S. by Turbo-Flight, Inc. of Chicago. It will carry between 16 and 24 passengers.

• **French Max Holste MH.260** Super Broussard light transport, powered by two Bastan 4 turboprop engines. It will carry between 20 and 30 passengers.

• **U. S.-built Bede BD-7** transport, powered by two General Electric T-58 turboprop engines driving a single shrouded aft-mounted propeller. Plane will be equipped with boundary layer control, and will carry between 15 and 24 passengers.

Although these aircraft and any other contenders will undergo objective study by the advisory group, it appeared evident during the meeting between the carriers and the manufacturers that the BD-7 came closest to meeting the carriers' desires.

In his presentation, Barnes said the industry was seeking an aircraft that could operate at less than two cents a seat mile, over stage lengths not to exceed 100 mi., and carry about 20 passengers at an operating cost of less than 40 cents a plane mile.

He said that he did not feel that STOL characteristics were necessary, but he called for approach speeds of between 35-40 mph. He said pressurization of the cabin is desirable but not "an absolute must." He did insist that the plane be equipped with adequate heating and air conditioning systems.

James Bede, vice president of Bede Aircraft, Inc., said that for 100-mi. stage lengths, cruising at altitudes of 15,000 ft. airplane cost per mile of the BD-7 will be 36.64 cents. The aircraft will cost about $500,000, he said.

He said that maximum gross weight of the airplane will be 12,500 lb. and its useful load will be about 110% of its empty weight. It will carry a relatively small amount of fuel in proportion to its passenger capacity, he said. He added:

"Our projections are that gross conditions will permit 24 people and a sufficient amount of fuel to fly three 100-mi. segments with a 45 min. reserve at 10,000 ft. remaining at the end."

Bede said he will recommend an approach speed of 65 to 70 mph. and a touchdown and take-off speed of 50-55 mph. He added that the aircraft can clear a 50-ft. obstacle in less than 500-ft., at full gross weight, on a 100 deg. temperature day. He said if half the power is lost, only 36% of the static thrust is lost, and therefore, acceleration and angle of climb is "still outstanding."

Bede said his firm's experience with boundary layer control (BLC) used on an experimental model now flying with reciprocating engine power, has demonstrated that BLC requires a relatively small amount of power and does not induce unusual pitching moments. He said that it does not add a large amount of energy to the wing, which could produce instability. Instead, he said, it extends lift curve slope, permitting wing to operate at an extended region over that of conventional wings.

Don Payton, president of Turbo-Flight, said that Potez 840 costs have been placed at 40 cents per plane mile at 80-mi. stage lengths, at a cruise speed of 250 mph. He said the plane accelerates in 15 sec. and in 1,500-ft. to its rotation speed of 80 kt. Climb speed, he said, is 100 kt., approach speed is 90 kt. and touchdown speed is 65 kt. He also said that the "very small nacelles with the combination of the four propellers over a high performance wing . . . does produce a laminar flow effect."

Pierre Lecointe of Nord Aviation said the Super Broussard operating costs have been set at two cents a seat mile on stages of 80-mi. average, with a plane utilization of 2,500 hr. per year. Operating costs per plane mile are 56 cents on 100-mi. stage lengths, Lecointe said.

Citing the need for the short-haul aircraft, Barnes said many cities are in danger of losing air service unless such a plane is brought into scheduled operation. "If you applied use-it-or-lose-it in Oklahoma alone, only two cities in all Oklahoma would still retain air service: Tulsa and Oklahoma City," he said.

Barnes said the first level of service for local service carriers was in operating schedules to small intermediate cities on routes feeding into connecting terminal hubs. He noted that the industry had never adequately fulfilled this service because "we have not had the airplane to do this."

He said that local service airlines which he termed "second level," were now moving into regional operations, or service in the short-haul high traffic density markets which have been vacated by the trunk carriers. He said he felt that there is no resistance to local service carriers entering this field, but stressed that local service carriers cannot afford to allow a "progressive erosion of the original purpose for which local service carriers were conceived."

Boyd Warns Mohawk On BAC 111 Order

Washington—Civil Aeronautics Board Chairman Alan S. Boyd warned Mohawk Airlines last week that CAB would not subsidize costs involved in the airline's purchase and operation of four BAC 111 jet transports and suggested the carrier reexamine its equipment program.

In a letter to Mohawk President Robert E. Peach, Boyd said that the plan to introduce the large planes into scheduled service is "fraught with substantial risks, particularly in the light of the low average load factor of the local carriers." He noted that Mohawk's load factor is currently at 48%, compared with the 58% it reported before it acquired its fleet of modern equipment—Convair 440 transports. Boyd added:

"Under these circumstances, it is our present belief that a program for acquisition of large type aircraft such as the BAC 111 is, at least, premature."

Boyd said the need for such aircraft in local service areas has not been demonstrated. Such equipment can lead to a substantial increase in subsidy need or "an impaired ability to meet other local service needs," he said.

Boyd explained that a binding decision can be made only after a full investigation, and that the letter only warned that the operation of the BAC 111 will not be subsidized.

Peach said last week that prior to the Boyd letter, he had made it clear to the CAB that the purchase of the four BAC 111s was planned on the assumption that the aircraft would not be subsidized by the government. He said cost and traffic studies conducted by Mohawk indicated that the airplanes would prove profitable and self-sustaining on routes for which they were earmarked. Earlier, Mohawk had said it must offer jet service on its high-density routes to stay competitive.

Constellation Crash

Washington—Loss of an AN-175-21 nickel steel bolt from the parallelogram linkage of the elevator boost system was the probable cause of the crash of a TWA Lockheed 049 Constellation at Chicago on Sept. 1, 1961, the CAB said last week. All 78 persons aboard died in the crash at Midway Airport. The Board said that the manner in which the bolt was lost is a "matter of conjecture."

Pan Am, TWA File Merger Plan; Hughes' Interest Reduced to 29%

New York—Year-long negotiations between Pan American World Airways and Trans World Airlines culminated last week in formal approval of a merger agreement by their boards of directors and filing of the plan with the Civil Aeronautics Board.

New company would be called Pan Am World Airlines, Inc. Juan T. Trippe, current Pan Am president, would become chairman of the board and Charles C. Tillinghast, Jr., head of TWA, would be president.

Under the merger plan, TWA stockholders will receive one share of stock in the new operating company for each share of TWA they now hold. Pan American World Airways would become a holding company, and would receive from the new operating company—Pan Am World Airways—1.7 shares for each currently outstanding TWA share.

The holding company would thus have 11,346,063 shares. Adding to this TWA's 6,674,155 shares, the total outstanding stock of the operating company would be 18,020,218 shares.

Under this exchange, the percentage ownership by Howard R. Hughes, who now holds 78.2% of TWA's stock, would be reduced to approximately 29% of the new corporation. This plan for dealing with Hughes' stock was first revealed by AVIATION WEEK & SPACE TECHNOLOGY (May 28, p. 38).

Merged corporation would have a 26-man board, with the selection ratio subject to further agreement. However, the merger plan calls for 15 to be chosen by Pan American and 11 by TWA if no other agreement can be reached by the closing date.

Merger is conditional on approval by the CAB, President Kennedy, the companies' stockholders and the Internal Revenue Service. IRS is involved primarily because the new corporation wants the tax credits available through TWA's operating losses.

Another condition of the agreement is settlement of the current litigation between TWA and the Hughes Tool Co. Pan Am reserves the right to reopen the agreement prior to the closing date if settlement of the litigation results, or could result, in a change of TWA's capital stock. TWA may also reopen the deal if it involves a change of $10,000,000 or more in its stock value.

One aim in moving ahead with the merger may be to force Hughes to commit himself on it one way or another. Hughes transferred control of his stock to a voting trusteeship in 1960 to obtain $165 million in financing for TWA, and the trustees have the power to vote the stock in a merger. Even so, Hughes could still fight the merger in the courts by contending that the trustees failed to protect his interests properly.

Those currently controlling TWA, however, see in the merger relief from many of the problems the carrier faces. One special trouble area is TWA's domestic division, where TWA is crippled by lack of aircraft in competing with its two main rivals, American and United.

TWA currently has 70 jets, including five 707-320Cs being obtained on lease from Boeing. But 17 of these, counting the new aircraft, will be devoted almost exclusively to international operations.

With these it must compete against American's 60 and United's 87 jets.

Hope of closing this gap with future aircraft orders is dimmed by TWA's ordering only 10 Boeing 727s as opposed to American's purchase of 40 and United's of 25. TWA did place a $100,000,000 order in 1961 for 20 Sud Caravelles, which would have given it a boost in the high-density markets east of the Mississippi. But the order was canceled following failure to complete financing arrangements.

Lack of aircraft has seen TWA's position eroded in certain key markets, such as Los Angeles, San Francisco and Cincinnati. In October this year, seeking to relieve aircraft for markets where competition wasn't so severe, TWA reduced its transcontinental nonstop frequencies from New York to Los Angeles to three daily, and New York to San Francisco to two, a drop of one schedule to each point.

In its totally international operation, Pan Am uses 58 jets, both DC-8s and Boeing 707s, plus 40 piston aircraft. Merger with TWA would provide a total of 138 jets and 122 piston aircraft, plus a 37-plane cargo fleet that would include three Boeing 707-320Cs now on order by Pan Am.

Comparing the two carriers financial results in the first 10 months this year, Pan Am had revenues of $424,250,000 and a net income of $10,240,000 after taxes. TWA, with $335,351,000 in revenues, reported an after tax loss of $6,764,000.

Merger with TWA would also satisfy Pan Am's historical ambition to enter the U. S. domestic market, making it a truly round the world airline. It cannot today sell tickets for travel between any two points in the continental U. S. Also, in teaming with its primary North Atlantic competitor, Pan Am would gain service rights overseas into Geneva, Zurich, Milan, Madrid, Athens, Tel Aviv, Cairo, Dhahran and Bombay.

Summer Atlantic Traffic Topped Million

By James R. Ashlock

New York—North Atlantic traffic on scheduled carriers topped the million mark for the first time during this year's peak four-month summer travel period, and off-season increases have been such that volumes for the full 12 months should be up approximately 19%.

June through September showed 1,123,578 persons traveling between the U. S., Canada and Europe, a 22.4% rise over the 917,754 reported for that period last year (AW Nov. 13, 1961, p. 42).

Carriers reported 2,010,000 passengers in the first 10 months of this year for a 19.5% increase. Continued increases through November and December by major carriers, such as Pan American World Airways and Trans World Airlines, should maintain the growth average until year's end.

Pan Am estimates that it will close the year with 448,815 transatlantic passengers, an 11% increase. TWA's volume is expected to total 278,804, or 34.3% over 1961.

Load factors during the June-September period, as reported by 17 IATA airlines, averaged 55.7% compared with 53% in 1961. However, airline officials are more encouraged by the passenger volume increase of 22.4%, being well over the 15.7% rise in capacity, indicating that 1962 may be a turning point toward more equitable balance between bookings and available capacity.

Same four months of 1961 showed a passenger volume increase of only 33,602 in the face of a 409,630 boost in seat capacity.

Available seats from June through September this year totaled 2,016,627, compared with 1,743,085 in the same period last year. Scheduled flights increased to 15,515, or 14.4% more than the 13,562 flown in the same four months of 1961.

First-class load factors remained low this summer compared with those in the economy section. Only five carriers reported eastbound first-class load factors more than 50% during June, the peak eastbound travel month. Of the 32,489 first-class seats offered, only 12,490, or 38.4%, were occupied.

However, economy-class load factor eastbound in June was 75%, with 162,301 of the 216,505 available seats being sold.

Airline officials credit the new group fares, which became effective in May for groups of 25 or more persons, as a major factor in pushing this summer's volume over the million point. They say the 17-day excursion fares, available from October through March, also enjoyed better acceptance this year and helped hold up off-season business.

No carrier specified just what percentage of its transatlantic passengers traveled under group fares, however. Officials stress that with all the special tour programs now available, plus lower-rate military traffic as carried by TWA and Pan Am, breaking out percentages is a monumental bookkeeping task.

"We have tried to pinpoint just how much business was coming from the various programs," one airline spokesman said, "but we've yet to come up with any conclusive figures."

TWA did estimate an 84% increase this year in the number of its passengers traveling under package tour arrangements, but did not break this down into specific programs. Based on these figures, TWA officials said they will concentrate more sales attention in 1963 on major tour operators.

Another development this year is the airlines' growing hesitancy to rely on advance bookings in forecasting upcoming business. Last-minute bookings, an outgrowth of the tremendous capacity increase that came with the jets, has now become an established practice rather than a trend, carrier officials report.

"We now look to the advance bookings on ocean liners as an indication of how the travel picture looks for upcoming weeks," said a spokesman for Lufthansa. "So many air travelers are buying tickets at the last minute that we can't rely on our own advance bookings for an accurate forecast."

Carriers anticipate that 1963 will bring further passenger volume increases. Capacity will also rise slightly, with Pan Am, for example, planning a 11% increase weekly in flight frequencies during the peak season. This summer, Pan Am had 184 jet flights weekly to and from Europe. TWA will also schedule more flights, adding five Boeing 707-320Bs to its present transatlantic fleet of 12 707-320s.

However, the over-all capacity increase will not be so sharp as that which erupted in 1961, and airlines predict that the percentage of passenger growth next year will again exceed the rise in capacity.

Reports by individual carriers:

• **Alitalia**—Passenger volumes for 1962 are 40% above 1961, with load factor improving to 55.5% from 51.5%. It will report a profit on transatlantic operations this year. Spokesmen say 1963 will be a good year, although they expect more moderate passenger increases, probably 15-20%. Alitalia will receive another Douglas DC-8 jet in May, and will add three flights weekly in each direction to the 24 it operated this summer.

• **Pan Am**—Pan Am also sees a 15-20% increase in passenger volumes next year, which would be in excess of the 11% recorded this year. Increased frequencies, plus initiation of new service to Belgrade, Yugoslavia, is expected to bring added business. Pan Am officials say this year's volumes were harmed by strike threats in June, just as the heavy transatlantic movement was getting under way.

• **BOAC**—June-September business rose 20% this year with 153,465 persons carried between the U. S., Canada and Europe. BOAC officials say the group fares have been "definitely favorable," although it would be difficult to analyze their precise impact on the market.

• **TWA**—In the peak four-month season, TWA carried 125,681 transatlantic passengers, a 23.7% increase over 1961. Like Pan Am, TWA blames strike threats with preventing even greater increases. Carrier's revenues on the North Atlantic showed a profit of $10,779,000 in first nine months this year, compared with a $6,001,000 loss in the same period of 1961. TWA is forecasting that its international revenue passenger miles in 1962 will increase 32.5%.

• **SAS**—Traffic increased 18.4% for June through August, and 16% for September through November.

• **Air-India**—Finishing its second full year of transatlantic operations, Air-India reports passenger volumes up approximately 70% on its five flights weekly. It plans no increase in frequencies next year.

• **Irish**—From April through September, Irish International Airlines carried 57,768 passengers, a 53% increase over the same period in 1961. The carrier says its load factor of 67% during this period was the highest among transatlantic airlines. Spokesmen cite growing tourist interest in Ireland as a large factor in traffic growth, claiming a 70% increase in passport applications by Ireland-bound travelers this year. Irish plans no increase next year in the 14 weekly flights operated between New York-Boston and Ireland.

• **KLM**—The Dutch carrier reported a 23% rise in passenger volumes for June through November.

• **Lufthansa**—Business in first 11 months was up approximately 18%. Officials term it a "good year, conservatively speaking."

• **Swissair**—June through November showed a 17% increase in Swissair's transatlantic traffic over the same period last year. Load factor advanced from 55.4 in 1961 to 55.5 this year. The carrier foresees a similar traffic increase for 1963.

Transatlantic Traffic

June-September, 1962

Carrier	Flights	Passengers
Air France	1,187	95,999
Air-India	226	14,421
Alitalia	768	61,652
BOAC	2,200	153,465
Lufthansa	798	65,936
El Al	321	28,997
Iberia	140	7,363
Irish	343	32,374
KLM	1,275	84,773
Pan American	3,466	213,826
Qantas	104	6,009
Sabena	600	45,883
SAS	928	73,863
Swissair	489	37,716
TWA	1,597	125,681
Canadian Pacific	246	19,349
Trans-Canada	807	56,271
TOTALS:	15,515	1,123,578

British Merger Scored

London—Reports that British European Airways will merge with British Overseas Airways Corp. to combine state-owned assets (AW Sept. 10, p. 81) last week were sharply attacked by Lord Douglas of Kirtleside, BEA chairman.

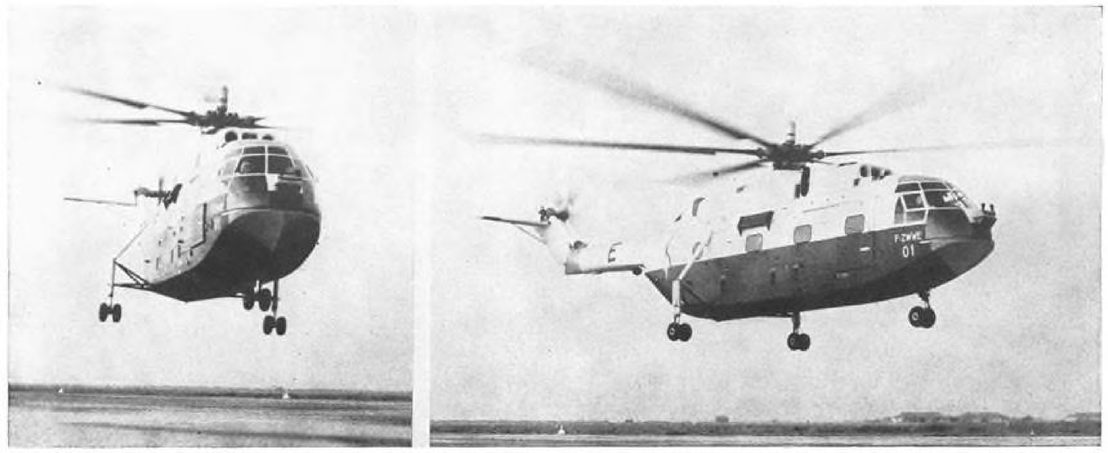
He said suggested merger plans have, in the past, been rejected as inefficient and costly, and claimed that arguments against amalgamation of the two carriers are stronger than ever.

Lord Douglas said: "The differences between short-haul and long-haul air transport are increasing and will continue to increase, particularly with the possible introduction of supersonic aircraft on long-haul services in the 1970s."

Lord Douglas also claimed that suggestions that $5.5 million a year could be saved by a merger are "absurd," and added:

"This desire to dig up the plant of British air transport and examine its roots, which has been going on continuously since air transport first started, must be resisted. It can only lead to frustration and confusion and in the end can do nothing but harm to the British airline industry."

Lord Douglas' term as chairman expires in December, 1963. He has repeatedly fended off questions as to his intentions in regards to retirement or accepting another term.



Super Frelon Shown During First Flight

Sud Aviation's SA 3210 Super Frelon heavy helicopter is shown during recent first flight. Mounting on the nose of the helicopter is a test instrumentation package. The 26-passenger helicopter is powered by the three Turbomeca Turino 3C turbines (AW Dec. 3, p. 31).

Airport Management In Russia Criticized

Moscow—Russian newspaper Sovietskaya Rossiya has criticized management of Moscow's Sheremetyevo Airport for not acting to correct published criticism. The paper charged that Sheremetyevo is dispatching planes with empty seats after telling travelers that all space has been sold.

According to publication, one passenger who had to fly immediately from Moscow to Arkhangelsk was forced to leave his family in the Russian capital because he was told that only one seat was available. During the flight he counted 11 empty seats. He said the next day's Moscow-Arkhangelsk flight had only 30 of 80 seats occupied.

Sheremetyevo Airport officials said they were not responsible for the situation. They admitted that "planes frequently fly empty." But, they explained, "there is a lack of coordination between city ticket offices and the airport reservations center. Seats are reserved but then aren't occupied."

The newspaper also charged that Sheremetyevo's customer comment book had many entries in which passengers complained about flight delays, ticketing confusion and restaurant service.

CAB Probes Wreckage Of Tiger Constellation

Los Angeles—Wreckage of a Flying Tiger Super Constellation 1049H cargo plane which crashed here Dec. 14 is being laid out in a hangar at Lockheed Air Terminal by Civil Aeronautics Board investigators in an attempt to determine why the plane was 380 ft below the glide path at the time of the crash.

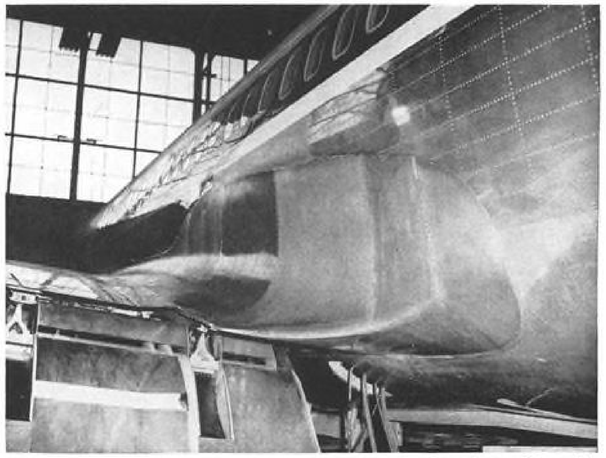
Constellation hit the ground in a left-wing-down attitude 1½ mi. short of Runway 7 in North Hollywood during an ILS approach to Lockheed Air Terminal.

Runway visibility was 1½ mi. due to partial obscuration by fog. Pilot had twice requested and received a current altimeter setting during the approach. Last voice contact was "understand, OK"—the pilot's response to a 2-mi. radar fix given by Burbank tower.

Plane, which crashed 20 sec. later, was on the runway heading, and approach appeared completely normal up to time of impact.

Flight was a regularly scheduled run from Boston to Los Angeles with 40,600 lb. of general cargo aboard.

Eight fatalities included three crewmen, two passengers and three residents of the crash area. Nine houses and three small manufacturing plants were either destroyed or damaged in the crash.





SWISSAIR'S 990 TRANSPORTS were modified by Convair to bring the aircraft up to company-guaranteed performance specifications. Major change included streamlining of engine nacelles. Second modification was to reduce drag by installation of deep fillet along fuselage skin to cover the external wing attachments (left). Krueger flaps had been used on inboard section prior to modification, but, in the change, entire leading edge was replaced (right). Note that suck-in doors have been opened to increase air flow.

Settlement Nears on American, Varig 990s

By William H. Gregory

New York—American Airlines will take delivery by next March of five "optional" Convair 990 jet transports in addition to the 15 it has in service, and Varig Airlines is resuming negotiations for three 990s which it previously has refused to accept.

Sale of an additional Convair 880M last week to the Venezuelan carrier Viasa leaves General Dynamics with two 880Ms and seven 990s built but unsold, General Dynamics President Roger Lewis said last week.

Prospects for sale of the two 880Ms and three of the 990s are good, Lewis said, and sale of the other four 990s is expected. Delta Airlines' decision to buy two more Douglas DC-8s may be a damper, however, since Delta, as an 880 operator, was a possible customer (see p. 34).

The unsold 990s, committed to production on American's original order for 25 and on a Hughes Tool Co. order for 13, later canceled, include two test aircraft that also will be offered for sale.

American will perform the modifications at its Tulsa overhaul base with kits supplied by General Dynamics. When the revised American contract was signed in September, 1961 (AW Sept. 25, 1961, p. 354), it was assumed the work would be done at San Diego, but the contract was left open on that point.

Acceptance of the five additional aircraft was called for by the contract, if the original specifications were met, but the contract terms called for demonstration by a production aircraft. The first production modified version for American is off the line and certification is expected soon, probably by year-end.

American will send the first unmodified 990s to Tulsa in February and work on all 15 will be completed in a year. Kits will provide for modifications to the wing, including leading edge slats, tips and wing fuselage fillets, and to engine thrust reversers.

Indications are that Varig will accept the 990s after a stalemate on delivery of about a year (AW Mar. 19, p. 42). Varig had objected to the short field and high-altitude-airport performance of the unmodified 990, but was impressed by changes in the modified airplane after a South American demonstration tour that ended last week.

Varig believes the modified airplane can now operate successfully out of the 5,500-ft. runway at Congonhas Airport at Sao Paulo, at full gross weights.

Lewis, in his first meeting with the press since becoming president of General Dynamics 10½ months ago, said that the 880/990 line is shut down though the jigs are still there.

Getting the jet transport program in hand following several years of write-offs totaling $450 million before taxes was his first objective on assuming the General Dynamics presidency, Lewis said, and he believes this task is now accomplished. Estimates made for costs of winding up the program will be more than enough to cover the actual costs. These estimates were based on assumptions that the Varig and American airplanes were sold.

Even if these negotiations do not succeed, General Dynamics probably will collect contingency payments on the American airplanes that would offset such a loss. The contingency payments call for increases in prices of the last five airplanes on the basis of any improvements in two major categories, cruise speed and landing distance. In effect, these payments would bring the over-all total for the 20 airplanes near to the original contract price.

General Dynamics has demonstrated the improvements, but American must confirm them on a production airplane before the payments will be made.

During the Cuban crisis, General Dynamics—like all jet transport manufacturers—was asked by the government to quote prices and schedules for delivery of transports as part of mobilization studies. Convair is making studies of possibilities of selling more 880s or 990s off the shelf to help offset the $450-million write-off on the program, Lewis said, but no firm program is in sight. Drop in employment at the San Diego Division—now down to the 6,000 level—was severe, Lewis said, because the 880/990 program was a big user of production manpower. The division still has specialized capabilities, solid military and civil spares business, and there are no plans to merge it with any other division, Lewis said.

"This division has been leaned out, it's been through hard times," Lewis said. "It is shaping up a good, tough, forward-thinking engineering group, which will stay on."

No large part of the TFX bi-service fighter program, for which General Dynamics/Ft. Worth is prime contractor, is scheduled to go to San Diego. Inclusion of Grumman Aircraft Engineering Corp., primarily for naval portions of the program, Lewis said, means that Ft. Worth will be subcontracting more than the 50% regarded as usual for a major program.

Both services are likely to look favorably on any smaller segment of the work that could be placed in the San Diego Division to help keep this operation as part of the mobilization base, he added, but no specific program was revealed.

"Lean" was a word Lewis also applied to the over-all General Dynamics structure. Uncertainty caused by the existence of corporate offices in both New York and San Diego has been resolved by elimination of the San Diego office, Lewis said, and corporate office expenses have been cut by one-third.

Lewis Cautious on SST Program

Government sponsorship of a commercial supersonic transport is not an inescapable requirement, in the opinion of General Dynamics President Roger Lewis, although he takes a cautious view of how soon one might actually be feasible.

"You've seen one company [General Dynamics] take a $450-million licking in a subsonic jet program," Lewis said. "Even so, the government did not have to step into the subsonic jet picture. The real thing about the supersonic transport is that the minute it becomes feasible, that it will operate at lower seat-mile costs, somebody will buy it."

General Dynamics has no plans for any new commercial transport, including a supersonic version, Lewis said, even though he feels the company has an obligation to put to use the experience gained in the B-58 Hustler bomber program.

"It isn't because we wouldn't," Lewis said. "When you're in the airplane business, you're in the airplane business. But we are certainly more cautious now about the profit and loss effect."

Prestige is used as an argument for a U. S. supersonic transport program. But Lewis believes a supersonic transport is a much different problem from launching a Sputnik. A supersonic transport, he said, is not successful unless people are willing to buy tickets, and to attract customers it must have reliability of a much different order. Similarly, the company has no plans for a small jet transport or a cargo version of the 880 or 990. Fundamentally, these would be good cargo airplanes, Lewis said, but it would cost a great deal of money to put in a cargo floor, and even then payloads would be smaller than the Boeing or Douglas cargo transports.

Trunklines Expected to Break Even With 8% Traffic Increase in 1962

Washington—Preliminary estimates of domestic airline activities for 1962 indicate that traffic for the year will increase 8%, compared with 1% in 1961, and that net earnings will be in the break-even area, compared with a $34 million loss last year.

Figures used in the estimates, compiled by the Air Transport Assn., were based upon nine months actual operations and three months estimated. The 8% passenger revenue mile increase for the domestic trunkline industry compares with a 9.5% increase forecast last month by AVIATION WEEK (Nov. 19, p. 41). At that time, AVIATION WEEK predicted a $25-million net profit for the industry during 1962. The ATA has declined to set a fixed net earnings or loss figure, but stated that the trunklines "as a group will just about break even in 1962."

In its estimates, ATA said domestic trunklines will report a total of 31.9 billion revenue passenger miles in 1962, against 29.5 billion flown in 1961. U. S. mail ton miles will show a 10.1% increase, express ton miles, 17.1% and air freight, 25%.

For the consolidated industry—trunklines, local service, international and overseas carriers, helicopter, intra-Hawaiian and intra-Alaskan airlines—revenue passenger miles will show an increase of 10.7%. Number of passengers carried by the group will increase 7.3% over last year.

Air cargo—mail, express and freight—paced the airline growth in 1962. Close to 1.3 billion revenue ton miles of air cargo were hauled in 1962, an 18.7% increase over the 1961 volume.

In a year-end statement, ATA said that during the Cuban crisis, a total of 290 four-engine airline transports were made available to the military services during the 18 days beginning Oct. 23, when the emergency reached its height. Of this total, 30 aircraft were pure jets.

A total of 179 propeller aircraft and 23 turbojet or turbofan transports were actually put into service for the Cuban airlift. According to the ATA, its Military Bureau operated on an "around-the clock" basis to handle aircraft flow from airlines to the armed services.

For the 12-month period ending Nov. 30, the airline industry compiled a passenger fatality rate of 0.28 per 100 million passenger miles, compared with a fatality rate of 0.60 in the same 12 months last year. Fatality rate was 0.31% in Calendar Year 1961.

The ATA report said that as of June 30, there were 173,453 people employed by the airlines, a net increase of 6,699 over 1961. Annual payroll as of the same date was $1.2 billion, an increase of $108 million over the same period a year ago. Average annual wage per employe in the airline industry was $6,971. According to Commerce Dept. figures, average annual earning for full-time employes in all industries was $4,843 in 1961.

On the subject of equipment, ATA said that by June, 1962, the airlines had accepted delivery of 566 turbine-powered aircraft. Of this total, 226 were turboprops and 340 were pure jets. Total of 160 turbine aircraft are now on order for delivery up to 1965.

Total airline fleet of aircraft of all types, including helicopters, at year's end will be about 1,620. Scheduled airlines have invested more than $3.5 billion in turbine-powered aircraft.

Local service carriers will report impressive gains for 1962, according to ATA. The 13 local airlines carried an estimated 7.8 million passengers in regular service during the year, a 21.7% increase over 1961. Passenger revenue miles rose 19.5% and air freight climbed 31%. Local service carriers operated over 51,128 route miles and served 580 cities in 1962.

Internationally, airlines carried 73.7% of all overseas travelers. The ATA said that during the first six months of 1962, 1.6 million travelers flew overseas and 569,111 went by ship.

In this period, 50.2% of all air travelers flew on U. S. flag airlines, although 61.8% of all air travelers were U. S. citizens. On the transatlantic routes, U. S. flag share of all U. S.-Europe air traffic was only 35.1%.

Number of passengers carried on international and overseas U. S. airlines will show an increase of 16%. Revenue passenger miles are expected to show a similar gain. Freight ton miles will rise 17.5% over last year and express ton miles will show a 37% improvement. Total revenue ton miles on all-cargo international flights are expected to rise 30.6% in 1962, compared with 1961, according to the ATA estimates.

Northeast Control

New York—Hughes Tool Co. took formal control of Northeast Airlines last week when the Atlas Corp.'s holdings in the airline were transferred to the tool company.

Holdings include 56% of the common stock and promissory notes of Northeast held by Atlas. Hughes Tool is wholly owned by Howard R. Hughes.

AIRLINE OBSERVER

► Local service airlines flew 138.5 million revenue passenger miles in November, an 18.5% increase over the same month last year. Revenue passenger miles for the first 11 months of the year reached 1.5 billion, an increase of 19.5% over the corresponding period last year. Load factor for the January-November period was 42.4%, compared with 41.7% in the same 1961 period.

► **There were no signs as of late last week that a decision in the U. S.-Tahiti route case was imminent, although it has been five months since the Civil Aeronautics Board gave assurances that it would act with expedition on this portion of the Transpacific Route Case. Issue of whether Pan American World Airways or South Pacific Airlines, which serves Tahiti from Honolulu, should operate the Tahiti-U. S. mainland route has been in question for almost four years. During most of that time, the privately-owned French carrier TAI has served the route on a monopoly basis.**

► Despite their widening political rift, Russia and Communist China this month signed an air freight and mutual services agreement which the parties said "is expected to increase shipments on the nations' respective airlines."

► **New low fares were introduced last week on the Boston-New York-Washington route by Eastern Air Lines and Northeast Airlines after the CAB dismissed complaints filed by each carrier against the other. Northeast alleged that Eastern's fares are "rate-war" rates, and Eastern's complaint alleged that Northeast's rates were not reasonably related to costs. Eastern's fares will apply to off-peak Air-Shuttle flights and are $3 less than standard Air-Shuttle rates, or $10 between New York and Boston and $12.00 between New York and Washington. Northeast's stand-by, no-reservation fares are now $9.52 between Boston and New York, $11.43 between New York and Washington.**

► Shannon Free Airport Development Co. executives are working on a plan to service pure jet cargo freighters, such as the Douglas DC-8F, by making Shannon a cargo feeder-line airport for common market countries. Officials feel such service will be of value in view of immense cargo loads carried by jet freighters, along with duty and customs advantages offered in the free airport zone.

► **Finnair is buying up the majority interest in Kar-Air, privately-owned Finnish airline operating charter business between Finland and southern Europe and a limited domestic service in Finland. The move helps to explain Finnair's recent order for six Caravelle Super B transports powered with Pratt & Whitney JT8D-1 turbofan engines. Finnair presently operates four Mark 3 Caravelles. At the time of the new order, industry sources said Finnair was considering, increasing its charter activity and so required a larger jet fleet.**

► Aeroflot expects to increase traffic to "about 35 million passengers" in 1963, compared with 29-30 million in 1962, 21.8 million in 1961, and 16 million in 1960. The Soviet carrier's 1963 target indicates a slower rate of traffic growth than in 1962, when numerous tariff cuts and promotional fares were found necessary to keep aircraft reasonably filled.

► **Federal agencies concerned with inspection and clearance of air travelers and cargo now will pay rent for the space occupied at international airports. Budget Bureau has notified these agencies that plans for such rentals will be included in their Fiscal 1964 budgets: Immigration and Naturalization Service, Public Health Service, Bureau of Customs and the Plant and Animal Quarantine Service. In the past, airports have borne the costs of the space used by these governmental agencies.**

► Delta Air Lines last week purchased two additional Douglas DC-8 turbofan transports at a cost of $11 million, bringing its DC-8 fleet up to a total of 10. Two of the original eight DC-8s have been converted to turbofan power, using the Pratt & Whitney JT3D forward fan engines. Conversion of the remaining six DC-8s will begin in May, 1963, and be completed in October.

SHORTLINES

► **Aeroflot's** twin-turboprop An-24 transports and twin-turbofan Tu-124 aircraft will be placed in regular service on about 50 Soviet routes in 1963. Both planes began scheduled passenger service in November. With the medium-range Tu124s and An-24s available, Aeroflot expects to carry almost 75% of its passengers in turbine-powered transports in 1963. It says "piston-powered transports will serve only residents of little towns and district centers."

► **British Aircraft Corp.** will equip passenger cabins of its BAC 111 jet transport with a new type of electroluminescent lighting developed by the Sierracin Corp. of California. The new lights, previously used only for cockpit panel lighting, provide a uniform surface of light.

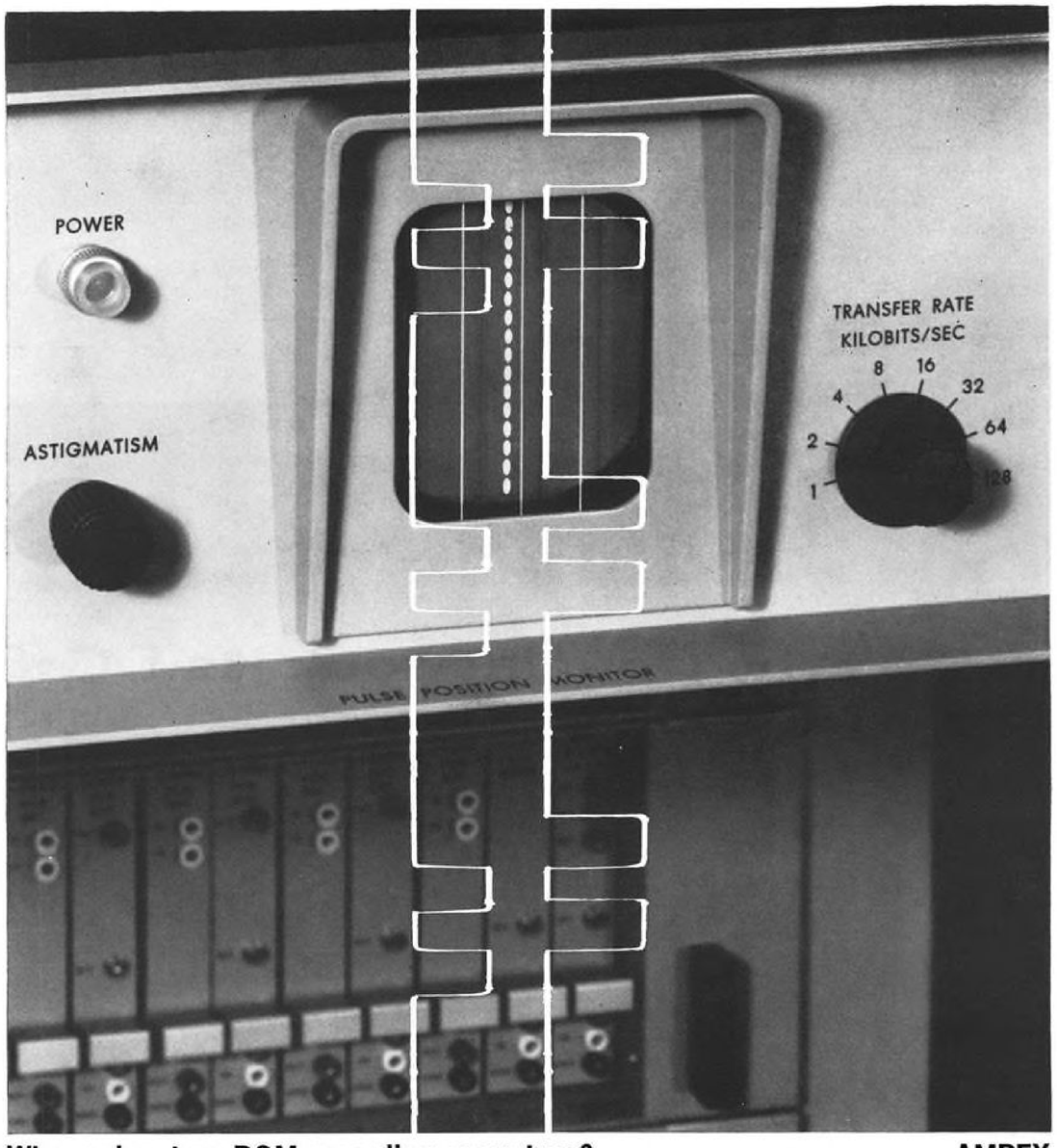
► **Federal Aviation Agency** has withdrawn proposed rules that would have required high performance aircraft in the 6,000- to 12,500-lb. class to meet transport airworthiness standards. Because of comments received from the aviation industry, FAA concluded that the proposed rule making included standards that were unnecessarily restrictive.

► **General Dynamics/Convair** has been awarded a National Aeronautics and Space Administration contract to study creep, a problem involved in the development of a supersonic transport aircraft. Study will seek methods to correct or restrict the tendency of metals to creep or elongate when subjected to certain combinations of stress and high temperatures.

► **International Civil Aviation** Organization has assigned two teams of communications and air traffic control experts to Africa and the Middle East to recommend and assist in improvements of airways navigational facilities in these areas and prepare reports for governmental guidance in long-term handling of systems.

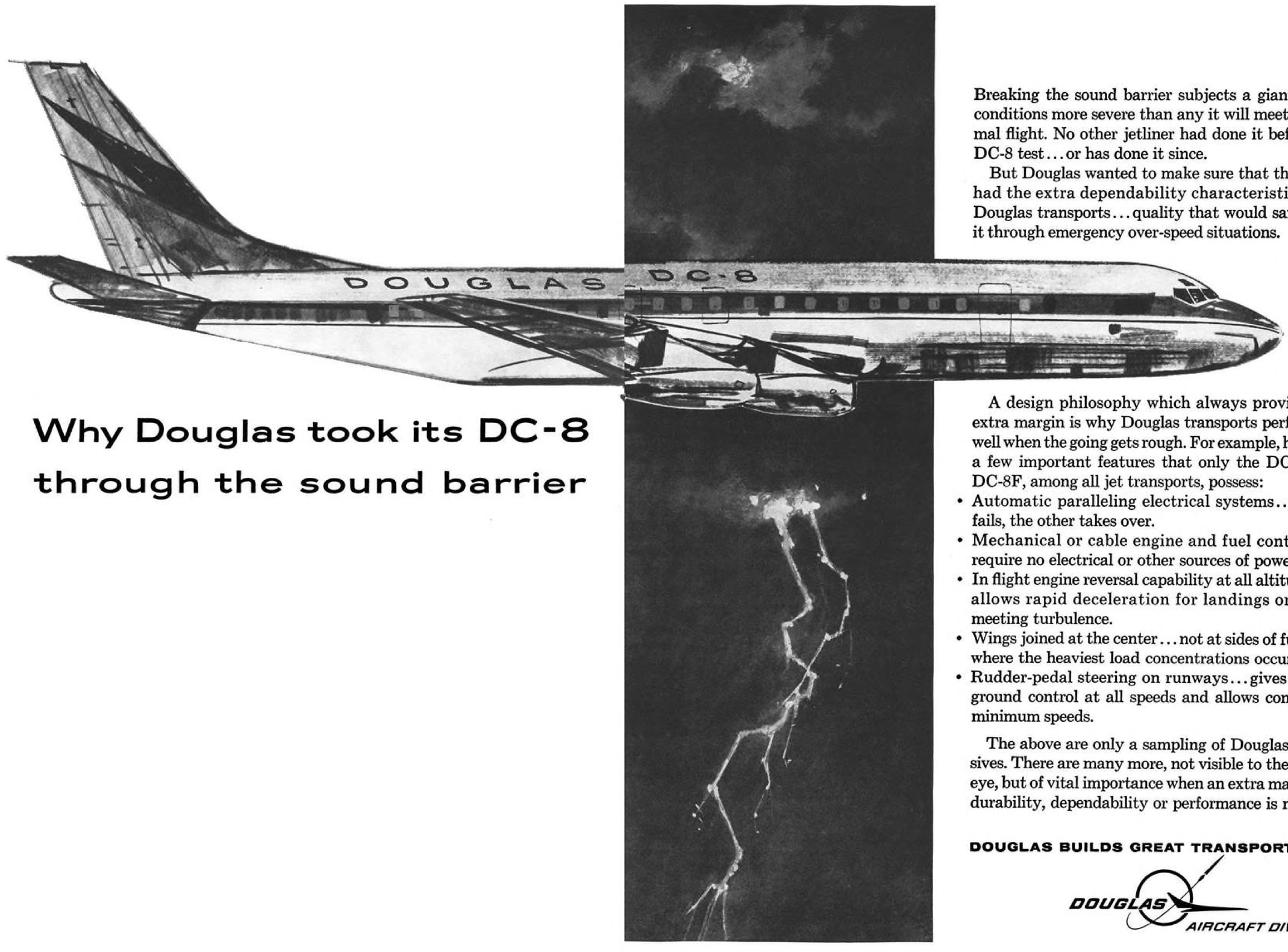
► **Japan Air Lines** will increase transpacific schedules to 11 round-trip flights per week beginning next spring. Six of the flights will operate to Tokyo from Los Angeles, four from San Francisco and one from Honolulu.

► **Mid-air collision** involving United Air Lines and TWA over New York City on Dec. 16, 1960, has resulted in 41 negligence suits against the airlines and the federal government totaling more than $30 million.



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Why Douglas took its DC-8 through the sound barrier

Breaking the sound barrier subjects a giant jet to conditions more severe than any it will meet in normal flight. No other jetliner had done it before the DC-8 test... or has done it since.

But Douglas wanted to make sure that the DC-8 had the extra dependability characteristic of all Douglas transports... quality that would safely see it through emergency over-speed situations.

A design philosophy which always provides an extra margin is why Douglas transports perform so well when the going gets rough. For example, here are a few important features that only the DC-8 and DC-8F, among all jet transports, possess:

- Automatic paralleling electrical systems... if one fails, the other takes over.
- Mechanical or cable engine and fuel controls... require no electrical or other sources of power.
- In flight engine reversal capability at all altitudes... allows rapid deceleration for landings or when meeting turbulence.
- Wings joined at the center... not at sides of fuselage where the heaviest load concentrations occur.
- Rudder-pedal steering on runways... gives better ground control at all speeds and allows control at minimum speeds.

The above are only a sampling of Douglas exclusives. There are many more, not visible to the naked eye, but of vital importance when an extra margin of durability, dependability or performance is needed.

DOUGLAS BUILDS GREAT TRANSPORTS

DOUGLAS AIRCRAFT DIVISION



TURBINE-POWERED BELL UH-1A, escorts a Vertol CH-21 tandem rotor troop carrier helicopter during a mission in South Vietnam. UH-1As have also worked as rescue vehicles. Note U. S. insignia has been removed, but "U. S. Army" and serial numbers remain.



ROCKETS FIRED BY A UH-1A impact on a target in South Vietnam, above right. Armament generally is bore-sighted to converge about 500 ft. ahead of the helicopters. Grenades and napalm also have been dropped from helicopters during some engagements.

Armed Helicopters Escort U.S. Troop, Cargo Aircraft in Vietnam Guerrilla War

By Erwin J. Bulban



TIGHT FORMATION IS HELD by low-flying UH-1As during escort mission for troop-carrying CH-21s, not shown.

Tactical employment of armed helicopters against ground personnel is being studied under field conditions for the first time by U. S. Army personnel in South Vietnam.

About 11,000 military personnel are providing technical training and aid to the Vietnamese, including arms and training in their use, transportation of men and supplies and evacuation of wounded (AW Nov. 12, p. 92).

Only three airports are available in the country, surface transportation is poor and the majority of movements, including surprise raids on Viet Cong guerrilla forces using paratroops from fixed-wing aircraft and ground troops from helicopters, are conducted by air.

Earlier helicopter support suffered severe casualties from hidden guerrilla forces, which the U. S. Army is countering by providing armed escort helicopters which are triggered into action whenever U. S. troop-carrying helicopters are fired upon. Initial Army unit to provide such support has been the Bell UH-1A-equipped Army Trans-



UH-1A FIRES A BURST of .30-cal. machine gun fire while flying at low altitude. Photo was not identified as being an actual combat scene and activity around trucks in the rear indicates that it may have been a practice mission. There also is a possibility that it may have been exploratory fire into a suspect area near a post.

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- Anaconda is an approved source of TFE hose for engine and airframe contractors and subcontractors.
- Anaconda offers technical services to NASA, Air Force, Navy, and prime and subcontractors in missile and aircraft work.

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GENERAL ELECTRIC XM75 grenade launcher mounted on Bell UH-1A helicopter was successfully demonstrated recently to Defense Dept. officials at an Army Materiel Command review at Ft. Bragg, N. C. Device, which loads 40mm. grenades, was designed by Springfield Armory, an Army Weapons Command facility, and developed by Ford Motor Co.'s Special Military Vehicles Operations under subcontract to GE's Missile Production Center in Burlington, Vt. GE makes turret, feed mechanism and other items, then assembles the complete weapon for Army. Helicopter vulnerability in South Vietnam fighting has emphasized need for this type of weapon. It is designed for use against sources of enemy ground fire directed at helicopters and against trucks and other light military vehicles.

port Tactical Transport Helicopter Command, transferred from Okinawa and armed with field-improvised machine guns and rocket packs.

Indications are that these efforts are to be increased soon with introduction of Bell UH-1B helicopters fitted with specially designed four-gun (two pairs on each side) traversing installations directed by internal tracking sights. This marks a considerable increase in firepower capability and improved crew safety.

Current armed UH-1As utilize an improvised gunsight consisting of a sheet of Plexiglas, adjustable vertically in a frame mounted from the cabin roof in front of the pilot. Bullseyes are marked on the Plexiglas. Each pilot calibrates the sight by taking his machine up for a practice mission, noting the impact of weapons on the ground or water and marking a "beadsight" alignment with the bullseyes on the helicopter windshield with grease crayon. Guns are former tank weapons, bolted to the helicopter's skid gear. Crews generally rely upon bullet-proof "flak" vests for personal protection, although plastic and aluminum lightweight "tipping" armor is being evaluated in Vietnam. Armor relies on tipping the penetrating slug broadside to lessen its penetration capability.

Turbine-powered UH-1As, undergoing their first combat experience, have shown considerable ruggedness and reliability in the field. They operate independently for days and weeks away from base facilities when assigned to forward ground units, with parts and fuel being airlifted to them. Maintenance, including engine changes, is generally performed by crews situated under trees and with rudimentary service facilities. Utilization is generally limited only by logistical support.

In addition to armed escort, unarmed UH-1As also provide troop-carrying, reconnaissance and gun-laying missions assisting piston-powered Vertol CH-21s and Sikorsky H-34 Army and Marine helicopters. Medical evacuation is also handled. In one such mission after dark, a UH-1 lifted 10 wounded and its three crewmen while under small-arms guerrilla fire. It then went on to fly approximately seven hours that night to transport 18 wounded Vietnamese out of battle areas. Aircraft often land in water up to doorsills in rice paddies to deliver or pickup troops —a pilot of an armed UH-1A, whose rocket pack had been hit by ground fire, doused the fire by dunking his helicopter in a convenient paddy in water over the doorsill.

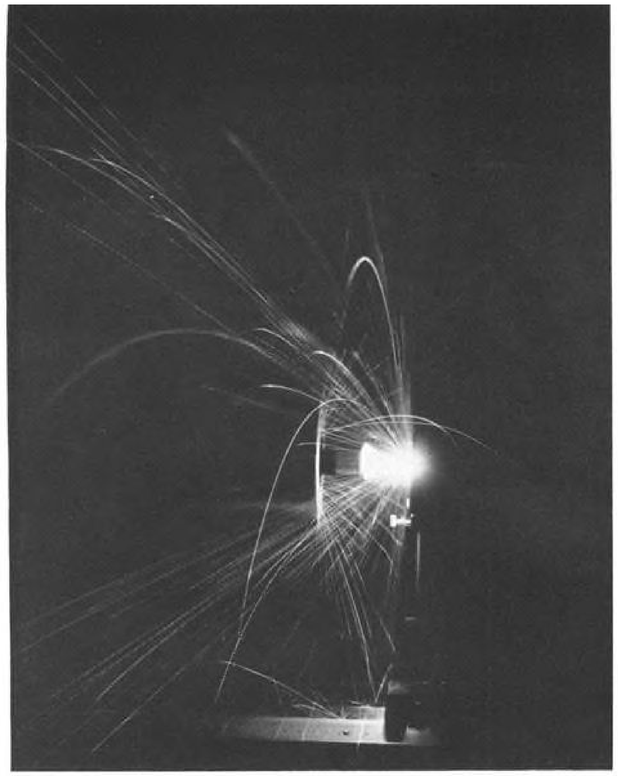
One UH-1A, attached to a medical evacuation unit, flew approximately 150 hr. in a month.

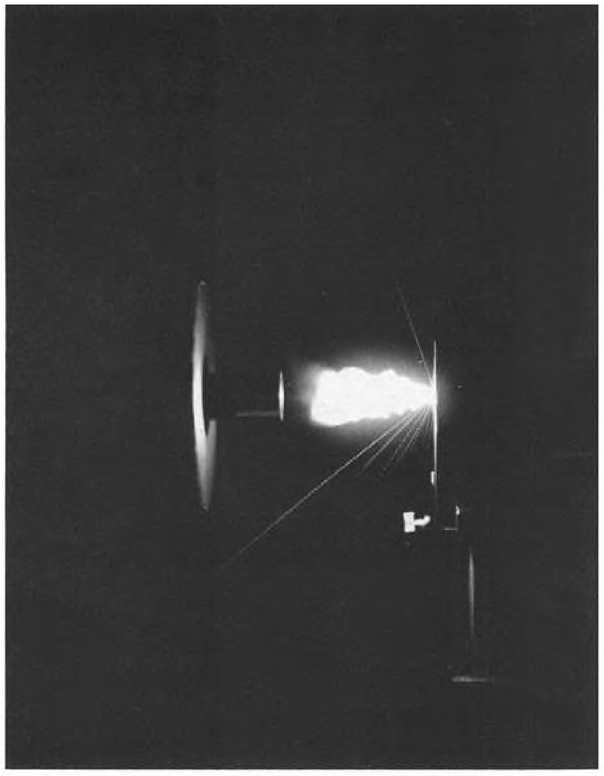
Strain of combat flying indicates some needed improvements. Tail boom skins have cracked, for example, due to stresses imposed by numerous sharp rudder deflections when flying at 100-110 kt. The manual often is tossed away in the battle area and sharp maneuvers are common to avoid enemy ground fire or to thread between trees in nap-of-the-earth flying to avoid detection and present a minimum target to the enemy.

UH-1A rotor-blade bonded honeycomb construction is standing up well under ground fire—slugs estimated at .45-cal. have completely penetrated these members at an angle without being noticed by the pilot until after landing.



MACHINE GUN, taken from a tank and jury-rigged to a UH-1A, is loaded prior to mission. Note vertical gun-charging rod behind man's right arm.

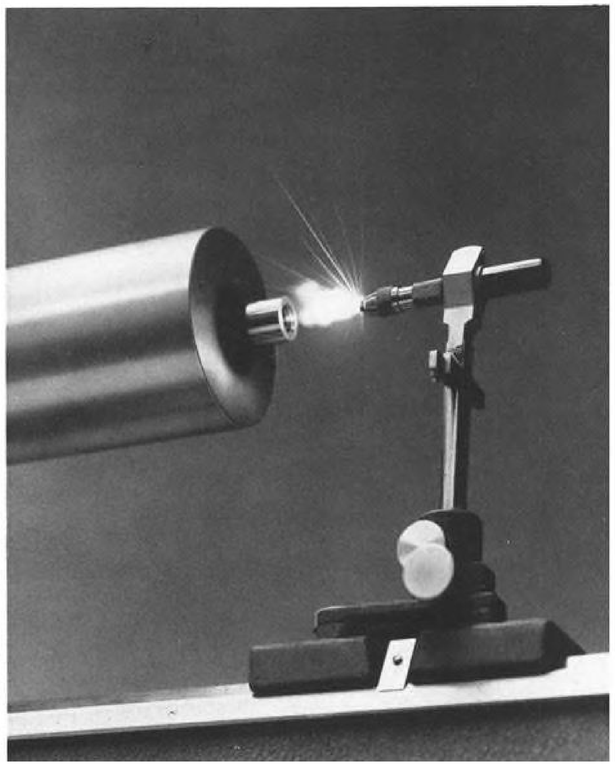


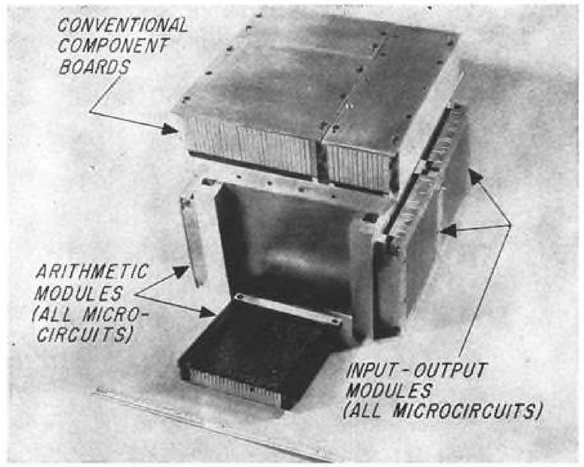


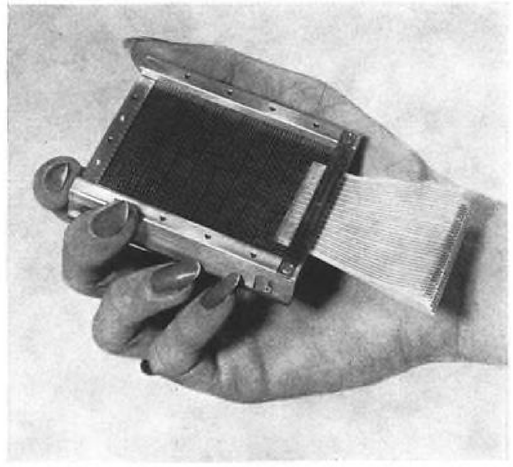
Laser Bores Holes In Tough Metals

Effect of a laser beam on various high-strength materials is demonstrated by Hughes Aircraft Corp. under laboratory conditions. The Hughes Model X400 high energy ruby laser vaporizes a .20-in.-dia. crater in a sheet of AISI-304 stainless steel sheet (upper left). Laser, operating at an output of 10 joules, with an input of 10,000 joules at 10 kv. generated temperatures of 4,300F. Similar experiment is carried out with carbon (upper right). A .20-in.-dia. hole is bored through tungsten (lower left), in 1,000th of a sec. at temperatures of 10,700F. Two carat industrial diamond is cut in half in less than a millisecond (lower right).









MICROMINIATURE DIGITAL COMPUTER, left, constructed largely of semiconductor microcircuits, weighs less than 17 lb., occupies 0.2 cu. ft. volume including input-output and digital-to-analog conversion. Computer was developed by Univac Division of Sperry Rand Corp. Parallel-type organization gives machine moderately high speed. Module containing 192 semiconductor microcircuits (right) is one of three that make up arithmetic unit. Seven-layer interconnection board is visible in view shown.

Microcircuit Use Slashes Computer Size

By Philip J. Klass

Operational microminiature digital computer with capacity sufficient for ballistic missile explicit guidance, which weighs less than 17 lb. and occupies a volume less than 0.2 cu ft. including input-output and digital-to-analog conversion circuitry, has been developed by the Univac Division of Sperry Rand.

New "Microtronic" computer, smallest machine of its capacity yet reported, is constructed largely of semiconductor microcircuits. It uses a magnetic thin-film memory which can be programed electrically with non-destructive read-out of stored data.

Feasibility Model

Feasibility model, designed and built with company and Air Force Systems Command funds, was demonstrated last week to government and industry representatives at the company's plant in St. Paul.

Major size and weight reduction in avionics equipment usually results in higher manufacturing cost. For this reason, Univac has placed heavy emphasis on using construction techniques which lend themselves to batch processes and automation, according to Sidney McDonough, head of Univac's microtronics department.

Comparison cited by McDonough suggests that this objective has been achieved. The new Microtronic computer is only $\frac{1}{5}$ the weight and $\frac{1}{6}$ the size of a predecessor computer with comparable capacity which Univac built in small quantities, known by the acronym of ADD. The latter employed cordwood construction with conventional miniature components and transistors. The new Microtronic computer is expected to cost only one quarter as much as the larger, heavier machine, McDonough says. Estimated cost of the new computer in quantities of a dozen or more is under $100,000.

Univac also placed considerable emphasis on a mechanical design which would provide efficient dissipation of internal heat without the need to use internal liquid or forced air cooling. In the new design, the hottest point inside the computer (semiconductor junctions) has a temperature which is only 8C above that of the external computer case, McDonough says, based on thermocouple measurements.

The computer is designed for operation over the ambient temperature range of −55C to 125C.

Computer Details

Because semiconductor microcircuits available at the time the machine was designed were relatively slow speed, Univac designed the computer for parallel operation to maximize computation speed. The feasibility model uses 16-bit word length for instructions. For the operand the word length can be 16 or 32 bits with the length determined by the computation precision desired and controlled by the computer program.

Here are the computation times for six different arithmetic operations:

- **16-bit add/subtr.:** 8 microsec.
- **32-bit add/subtr.:** 12 microsec.
- **32-bit product:** 29-50 microsec.
- **16-bit quotient:** 72 microsec.
- **16-bit sq. root:** 12 microsec.
- **Replace add:** 12 microsec.

Feasibility model is designed to provide 4,096 16-bit words of storage, but only 1,024 words were installed during last week's demonstration. The memory provides fully random access. Cycle time is four microseconds, but the limiting factor is the speed of presently available microcircuits rather than the thin-film memory itself.

Memory Capacity

Scratch-pad memory (destructive read-out) also uses magnetic thin-film and has a capacity of 516 16-bit words.

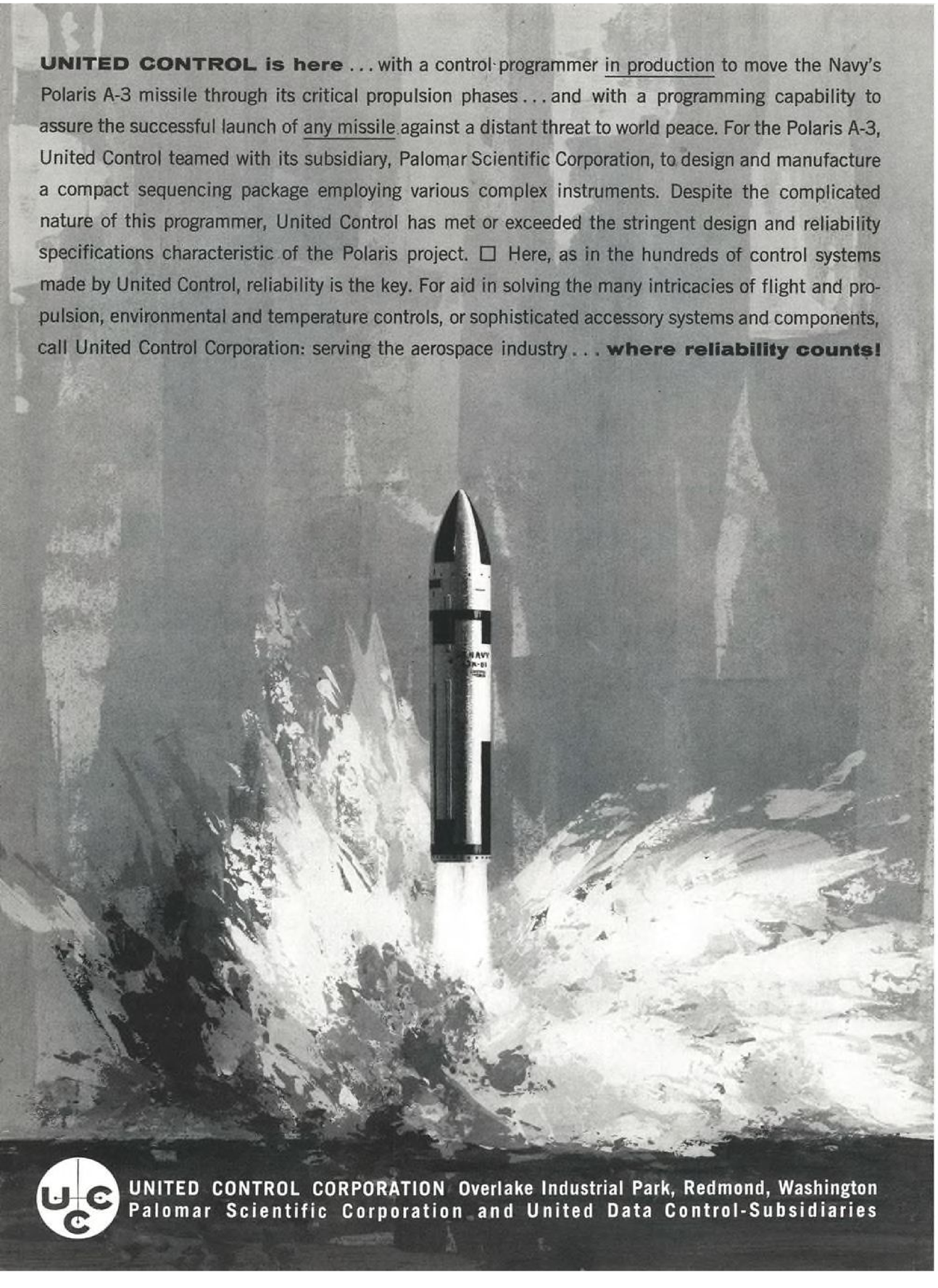
Physical organization of the computer is such that it can be made into a general purpose machine for a broader range of aerospace applications by installing additional memory capacity.

The next phase of the Univac project will be to build such a computer with expanded storage capacity, using an operand word length of 24-bits while retaining the 16-bit instruction.

Bulk of the semiconductor microcircuits used in the feasibility computer were supplied by Texas Instruments, with the remainder obtained from Signetics. A batch of Fairchild Semiconductor units are currently under life test at Univac.

The feasibility model contains a total

UNITED CONTROL is here . . . with a control programmer in production to move the Navy's Polaris A-3 missile through its critical propulsion phases . . . and with a programming capability to assure the successful launch of any missile against a distant threat to world peace. For the Polaris A-3, United Control teamed with its subsidiary, Palomar Scientific Corporation, to design and manufacture a compact sequencing package employing various complex instruments. Despite the complicated nature of this programmer, United Control has met or exceeded the stringent design and reliability specifications characteristic of the Polaris project. ☐ Here, as in the hundreds of control systems made by United Control, reliability is the key. For aid in solving the many intricacies of flight and propulsion, environmental and temperature controls, or sophisticated accessory systems and components, call United Control Corporation: serving the aerospace industry . . . **where reliability counts!**



UNITED CONTROL CORPORATION Overlake Industrial Park, Redmond, Washington
Palomar Scientific Corporation and United Data Control-Subsidiaries

of 1,243 semiconductor microcircuits plus a total of 709 conventional components for functions where no suitable microcircuits were available. This count does not include the individual deposited magnetic dots in the thin-film memory stacks. Of the 1,243 microcircuits, 596 are used in the central computer, which employs no conventional components, with another 340 in the memory and 307 in the input-output portion of the machine.

Previous Computer

Previous ADD computer had a total of nearly 29,000 conventional components, or roughly 15 times as many as are required in the new model because of the use of semiconductor microcircuits. (While the ADD had about 50% more memory and more built-in instructions, its computation speed was much slower.)

This is expected to have a salutary effect on the reliability of the new machine. If each microcircuit exhibits a mean-time-between-failure equivalent to that of three conventional transistors (based on having roughly the same number of semiconductor connections), then the new machine should have a mean-time-between-failure of about 15,000 hr., according to Univac's calculations.

There have been no failures to date in the feasibility model, but its total operating time has been relatively short.

Company tests on individual microcircuits, subjected to 4½ hr. of vibration tests at 12g at frequencies out to 2,000 cps. have produced no failures. A group of 300 Fairchild microcircuits have been operated in an arithmetic unit at room temperature for more than 3,000 hr. without a single failure, McDonough reports.

Univac's reliability group conducts its own detailed post mortems on any units that fail. Two semiconductor microcircuits which were "dead-on-arrival" from the supplier were dissected to determine the cause. One failure was due to a tiny scratch on a connection wire which caused it to break during shipment from the supplier.

Second failure was due to what is called "purple plague"—a crystallization which sometimes occurs during high-temperature bake-out tests allowing the connection wire to break loose from its point of bonding on the semiconductor crystal.

Important Lessons

Use of semiconductor microcircuits requires much closer coordination between the computer designer and the microcircuit designer than formerly was required when conventional components were used.

For example, computer designers have been oriented previously to use diodes wherever possible to replace transistors because of their lower cost, even when more diodes were required. But in microcircuits, there is little if any additional cost in the fabrication of transistors over diodes so now the computer designer can think in terms of all-transistor circuits with a gain in performance.

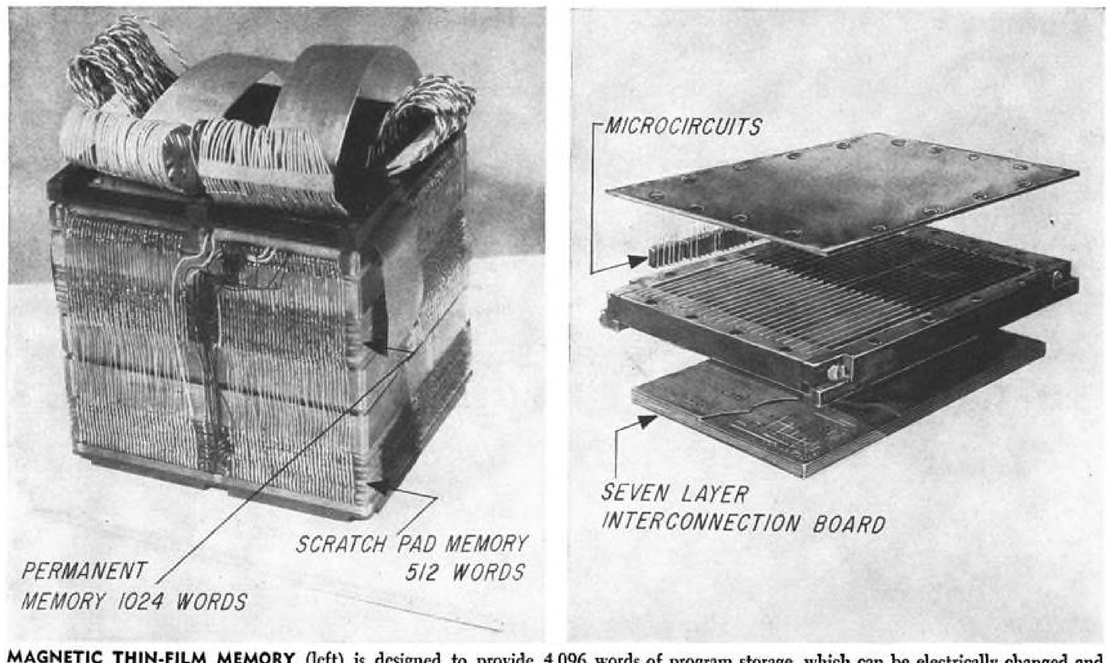
Similarly, the microcircuit designer must learn more about the requirements of the computer designer since a small change in the microcircuit design can have a major impact on computer complexity and cost.

Fan-out Capability

By working with Texas Instruments microcircuit engineers to modify their standard designs, Univac was able to reduce the number of microcircuits required for its new computer by 35%. In two of these microcircuits, for instance, emitter followers were added which increased the fan-out capability from 5 to 32, according to Ted Sammis, Univac project engineer. (Fan-out refers to the number of microcircuits which can be connected to the output of a previous stage.)

In some cases the microcircuit modifications were to increase speed or to reduce power consumption, important considerations for aerospace applications.

The feasibility model power consumption is only 53 watts. To achieve this low figure, Univac engineers used a basic clock rate 750 kc., about 30% lower than that of the ADD machine



MAGNETIC THIN-FILM MEMORY (left) is designed to provide 4,096 words of program storage, which can be electrically changed and read-out non-destructively, plus 512 words of scratch-pad storage. Only 1,024 words of program memory are installed in photo above. Microcircuit module construction details are shown (right). Long leads on one edge of the microcircuit are bent around body and soldered to metal risers (not shown) which are soldered to bottom laminated interconnection board.

and increased the memory cycle time from three to four microseconds. Yet by more ingenious logical design, the new Microtronic computer can perform arithmetic operations at least 50% faster than the ADD machine, Sammis says.

Although magnetic thin-film memories sometimes are thought of as heavy power consumers, the entire memory stack of the new computer consumes only 2% of the total required for the whole machine, McDonough says.

Central core of the computer package contains the magnetic thin-film memory. Mounted around the periphery of the cube-shaped memory are the three arithmetic modules and three similar shaped input-output modules, all fabricated entirely from semiconductor microcircuits. Atop the cube are mounted the functions which are built from conventional components on small printed circuit boards.

Modules containing microcircuits are packaged so densely that they are essentially a solid block, but there is no overall encapsulation so that individual microcircuits can, if necessary, be replaced.

Texas Instruments standard microcircuits have five leads extending from the long edge on one side of the rectangular package, with another five leads extending from the opposite long edge. Univac obtains special units with extra long leads so that those along one edge can be bent back across the body so all 10 leads protrude from one edge.

Company Process

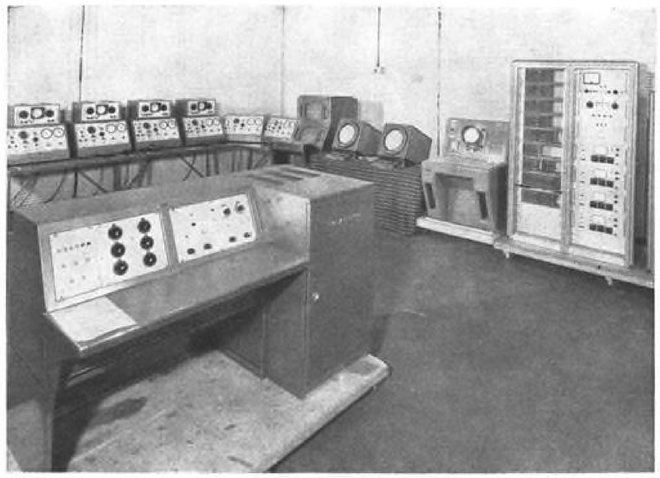
Microcircuits are stacked by hand in a frame, separated by thin spacers which serve to transfer internal heat to the external heat sink, and are electrically interconnected by means of a laminated seven-layer printed circuit board. The latter is prepared by a Univac-devised process involving pressure casting, photo-etching and other batch process techniques.

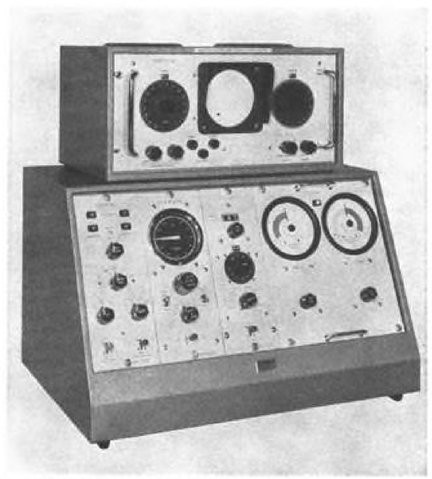
Microcircuits are hand-soldered to an intermediate element which in turn connects to the laminated interconnection board. Each soldered connection is inspected under a microscope to ensure a good joint. External connection from each module to the rest of the computer is accomplished by means of flat plastic multiconductor cabling which also is soldered.

The only quick-disconnect type electric connector incorporated in the entire computer is the one employed for connecting the computer to its external environment.

Special soldering tool has been developed to facilitate removal of a defective microcircuit from the module without damage to the closely spaced adjoining units.

With improved, higher-speed microcircuits expected to be available in the near future, McDonough predicts that it should be possible to increase the computation speed of present design by a factor of 4:1, while slashing its already low power consumption by 75%.





SOLARTRON RADAR SIMULATION SYSTEM for RAF navigation and control school (left) shows instructor's console in foreground. Main computing racks are at right in photo (doors removed) and aircraft control and monitor units are in background. Note precision approach radar for GCA simulation at rear center. Each control and monitor (right) simulates separate aircraft, with digital indication of speed and altitude. Monitor at top shows target positions individually or collectively. Calibrated range and bearing strobe is provided.

Gatwick, RAF Will Use Radar Simulators

By Herbert J. Coleman

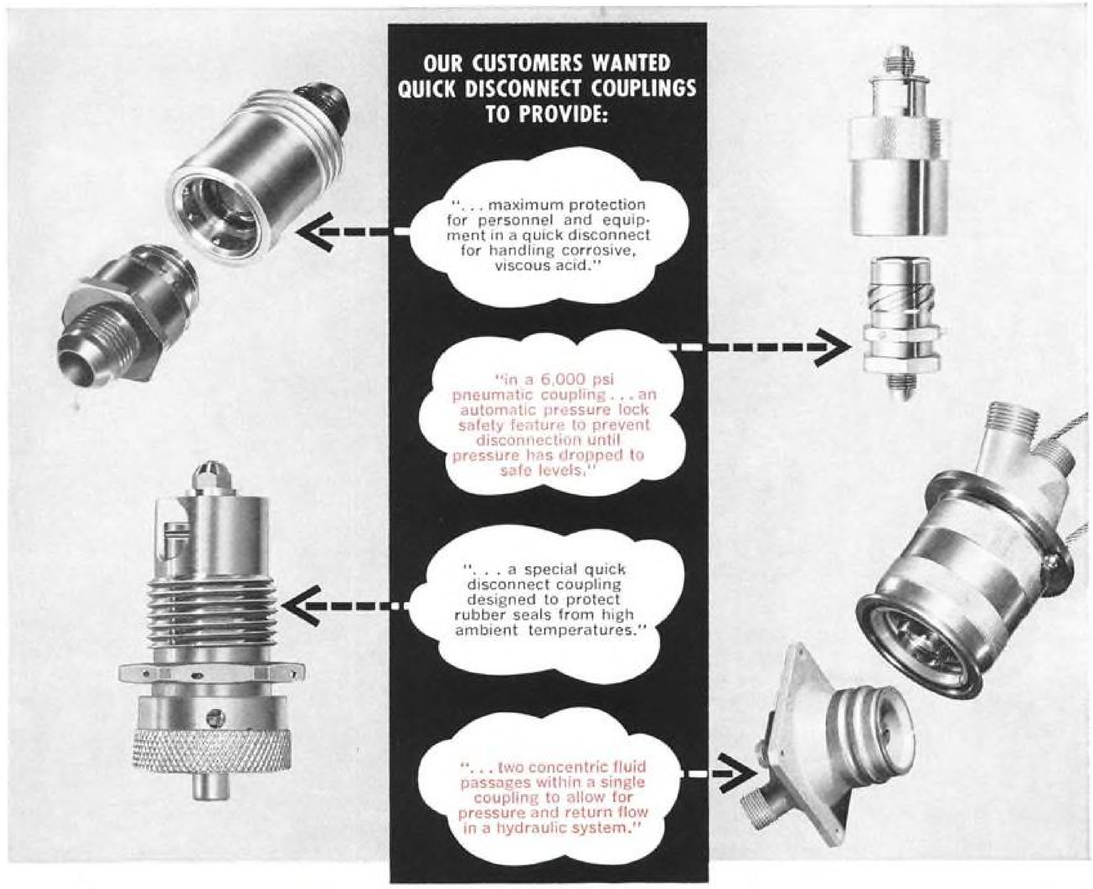
London—Fully transistorized radar simulator system developed here by Solartron Electronic Group, Ltd., for use by Royal Air Force and civil airports in training air traffic controllers will enter service soon at London (Gatwick) Airport tower, tied in with the Gatwick Marconi live radar.

Same type, the SY-1190, will be installed by the RAF at its Central Navigation and Control School, at RAF-Shawbury Station, early in December. Both civil and military units simulate:

- **Commutated Aerial Direction** Finding (CADF) with responses from radio transmissions on both VHF and UHF. Realism is added by simulation of the "cone of confusion" found when an aircraft is overhead and traces shorten and wander.
- **Surveillance Radar Element** (SRE) simulated in a Cossor 787 search radar; four aircraft are simulated and each are controllable in speed, heading, altitude.
- **Secondary radar responses**, simulated according to mode selected by the "pilot" and display operator, such as IFF. Any two of the responses can be picked up by a Standard Telephones & Cables SLA-3-C precision approach radar to allow two "final controllers" to handle two aircraft on the glide path simultaneously.

Equipment consists of two 6-ft. rack assemblies housing power supplies and computing elements, chief instructor's console, six aircraft control units and four pilot monitor units.

Aircraft control units can be adjusted for speed, heading and altitudes. Pilot's



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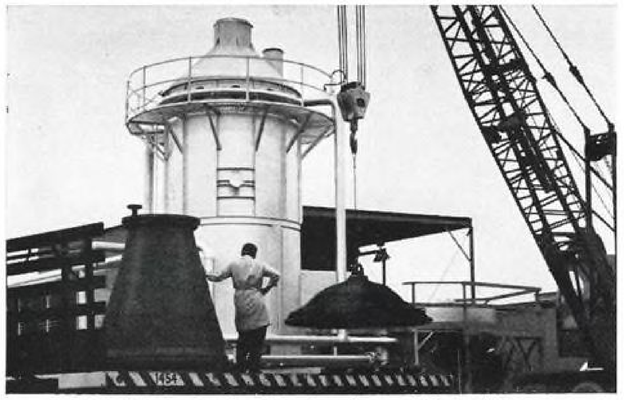
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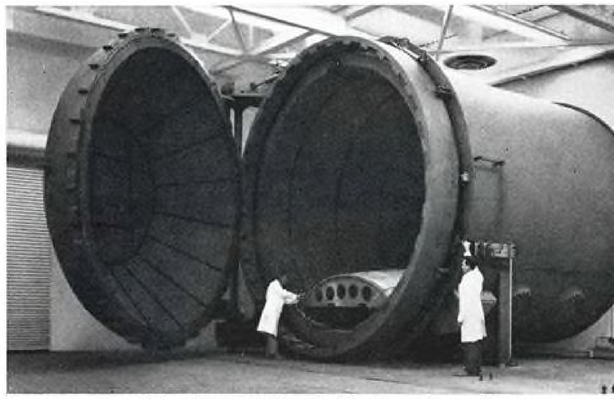
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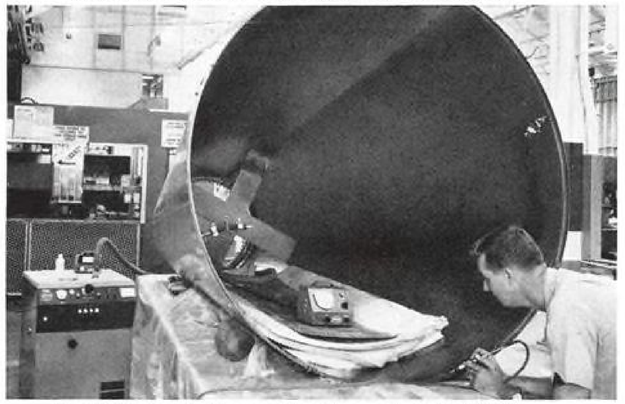




Rohr-built hydroclave for fabrication of non-metallic nozzles



Rohr autoclave is largest of its type in the world



Brazed stainless steel honeycomb radiator-condenser for SNAP II

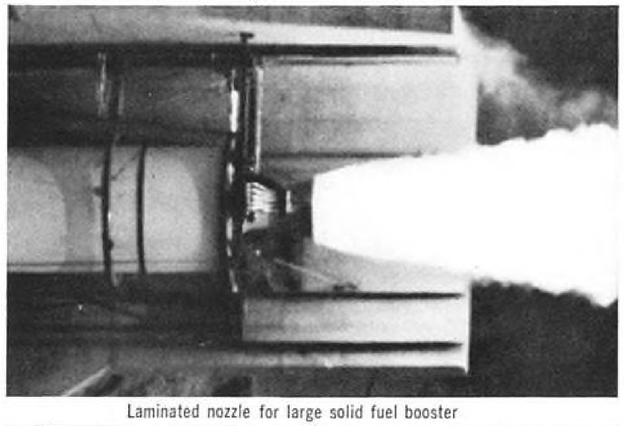
The tools, the techniques and talent for building space flight structures

The products and production facilities pictured here prove Rohr's capability in the field of fabricating complex space flight structures. From ground support equipment to propulsion hardware to satellite components the capability is here. A unique combination of men, imagination and modern machines solving serious problems in manufacturing methods and materials. Address specific questions to Marketing Manager, Department 145, Rohr Corporation, Chula Vista, California.

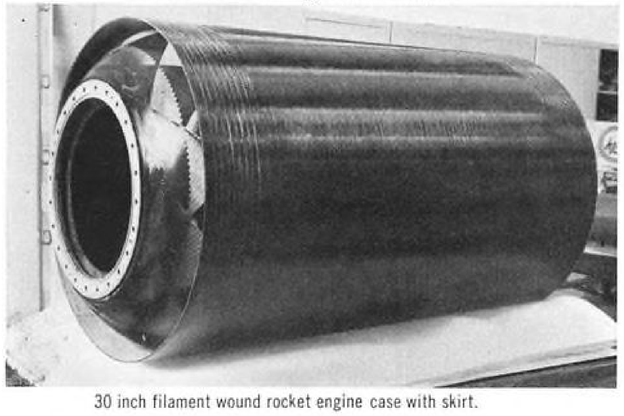
MAIN PLANT AND HEADQUARTERS: CHULA VISTA, CALIF./ PLANT: RIVERSIDE, CALIF. / ASSEMBLY PLANTS: WINDER, GA.; AUBURN, WASH.

ROHR CORPORATION

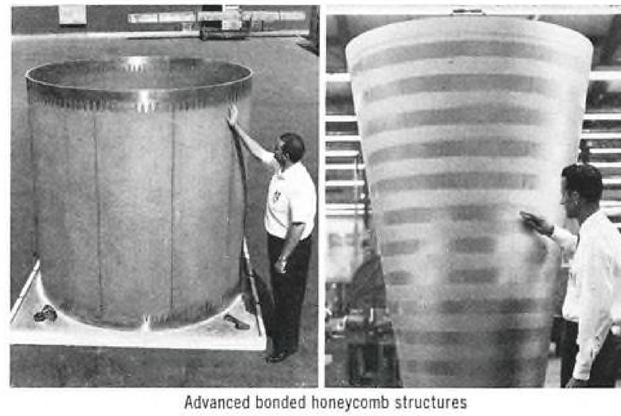
OFFICES IN WASHINGTON, D. C.; DAYTON, OHIO; HUNTSVILLE, ALA.; HOUSTON, TEXAS.



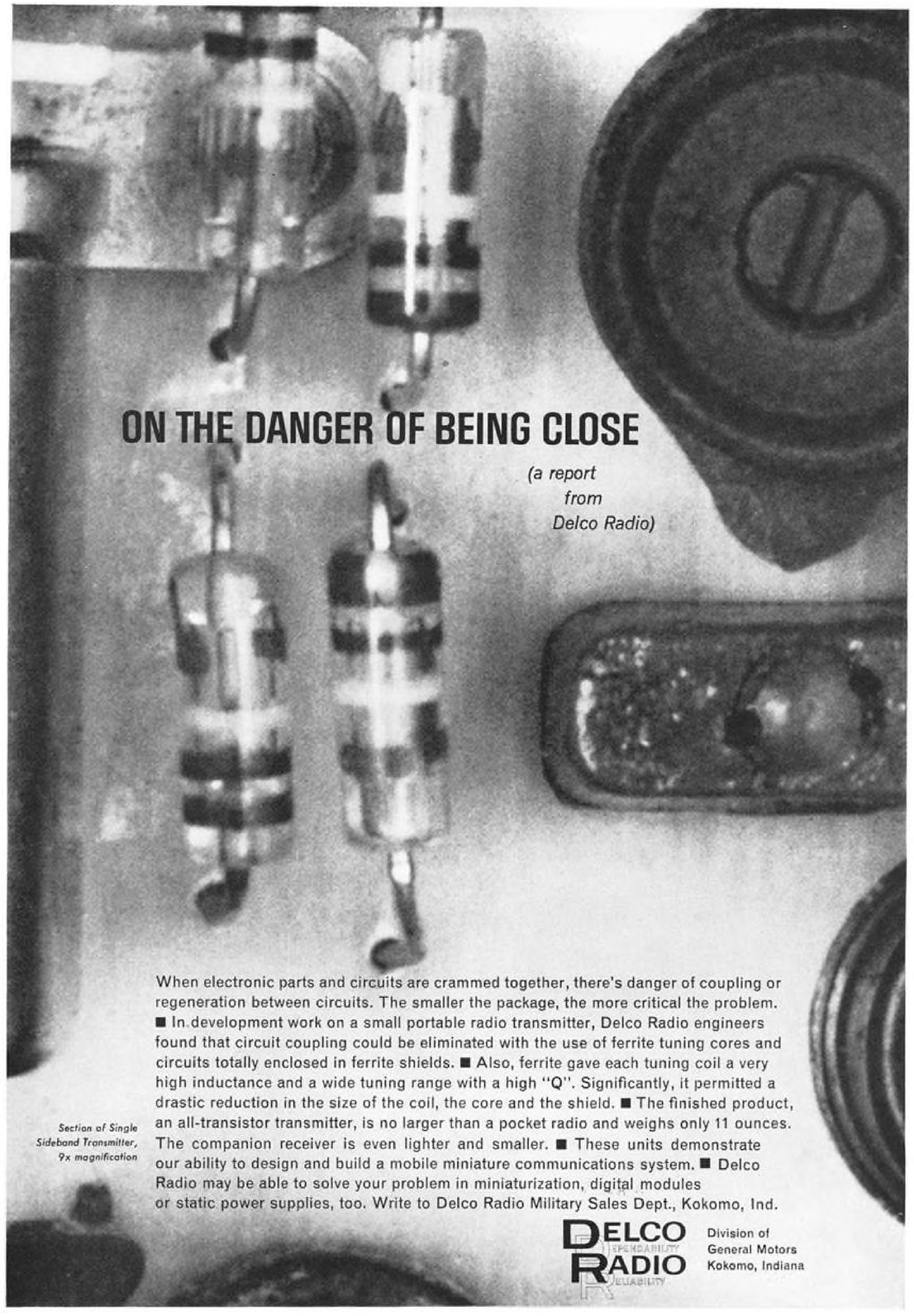
Laminated nozzle for large solid fuel booster



30 inch filament wound rocket engine case with skirt.



Advanced bonded honeycomb structures



monitor unit is a means of estimating position from the radar by range and bearing.

However, the equipment for Gatwick is considerably simpler. Besides the ability to lock into the Marconi S.232 radar, it can be used with the Cossor ACR.6 live radar. Ministry of Aviation, which controls Gatwick, will use the simulator for controller continuation training. Additional feature is provision of radar beacons for reporting points; locking the training unit into the live radar adds further complexity for the student.

Solartron also is developing a video map for use with ATC radar display systems. Resolution is on the order of a thousandth part of the maximum range to be displayed; this implies a line thickness of 200 yd. in a range of 100 naut. mi.

Linearity does not exceed 100 yd., or 1% of the actual range, whichever is the greater. Solartron also says that display expansion ratios in excess of 100:1 are possible, so that very short ranges can be used if necessary. System uses a moving coil deflection system to keep bearing accuracies high.

Video map now under development at Solartron's production plant near Farnborough is predicated on London (Heathrow) Airport, the main international arrival and departure center, and includes visual presentation of the airways boundaries along with the Heathrow runway layout.

These units, or variations on them, will be used when Ministry of Aviation establishes its new joint civil-military air traffic control headquarters and regional organization.

New headquarters will be headed by Air Vice Marshal Sir Laurence Sinclair, who has been appointed by Minister of Aviation Julian Amery as first controller of the National Air Traffic Control Service System.

Initial steps toward eventual amalgamation have already been made. For instance, four former Royal Air Force radar centers, one in Northern Ireland and three in Great Britain, are now being used to control both civil and military traffic in the upper airspace, over 25,000 ft. Starting early next year, eight new civil radar centers will come into service.

Under the United Kingdom concept of airspace usage, the space will be divided vertically into three layers:

• **Upper airspace,** above 25,000 ft., will consist of a single entity within which an area control system will serve all aircraft.

• **Middle airspace,** from 5,000 ft. to 25,000 ft., divided into the controlled airspace system—airways and control zones, and the remainder. Aircraft flying in the controlled system will get both planning and radar control services. In the remainder of the airspace, services such as radar surveillance, military jet aircraft recovery and flight information will be made available.

• **Lower airspace,** outside of control zones and below 5,000 ft., in which aircraft will follow rules of the air, but with services such as flight information, diversion control and distress aids available.

To cut the workload of radar controllers, a new section is being developed which will be responsible for identifying all aircraft entering into the control system. Each so-called "raw" blip will then be marked to indicate it is under control and for allocation to sector radar controllers.

For the future, Ministry scientists are studying possibilities of semi-automatic radar tracking, which would be capable of feeding an automatic data processing system in the flight planning section.

Target date for the new London control center is 1965. Construction of several sector control centers is now under way.

FILTER CENTER

► **Soviets Propose Gravity Wave Test**—Possibility of measuring low-frequency gravitational waves by means of a Michelson type interferometer with one arm perpendicular and the other parallel to the direction of wave propagation, in which waves would cause periodic shift of interference bands, has been suggested by Soviet scientists. All optional paths in the interferometers would have to be in a vacuum. Several such devices would have to be used and their measurements correlated because the direction and frequency of gravitational waves is unknown, according to M. Ye. Gertsenshteyn and V. I. Pustovoyt, writing in the Zhurnal eksperimental-'noy i teoreticheskoy fiziki, p. 605.

► **Sign of the Times**—Microelectronics engineering department has been formed by Sprague Electric, North Adams, Mass., one of the nation's largest producers of conventional components. The action follows on the heels of the announcement that Corning Glass Works, another major component supplier, has acquired "a substantial interest" in the Signetics Corp., a major supplier of semiconductor microcircuits. The five-man Signetics board will be expanded to include three directors from Corning.

► **Laser Research Summary Available**—"Lasers for Aerospace Weaponry" is the title of a 48-page report prepared by Air Force's Aeronautical Systems Division and now available for $1.25 from the Office of Technical Services, Commerce Dept., Washington 25, D. C. The report was prepared last spring and therefore does not include recent advances but is a good summary of basic laser technology to that date.

► **Particle Acceleration by Light**—Experiment which disclosed that an intense beam of light directed along the axis of a long solenoid through which an electric current is passing accelerates charged particles in the path of the beam, has been reported by Prof. A. Kolomenskiy and candidate of science A. Lebedev according to Izvestia. The two Soviet scientists suggest that the effect could be used to accelerate particles to very high energies in basically new types of accelerators having advantages over present designs. Also, it could be used for amplification of radio waves, the two Soviet scientists suggest.

► **Qualified Products Lists Planned**—Defense Electronics Supply Center (DESC) will soon establish a Qualified Products List (QPL) for the following items:

• **Variable resistors,** wirewound, precision to MIL-R-12934C.

• **Copper-clad laminated** plastic sheet, for printed wiring, to MIL-P-13949C.

• **Variable resistors,** non-wirewound, lead-screw actuated, to MIL-R-22097B.

• **Fixed film resistors,** established reliability, to MIL-R-55182.

Interested manufacturers should contact DESC, 1507 Wilmington Pike, Dayton 20, Ohio. Attn: DESC-EQ.

► **Martin Balances Computer Loads**—Better utilization of digital computer facilities at Martin's Baltimore and Denver facilities is expected as a result of high-speed data transmission system which went into operation in December. At night, leased telephone circuits not in use are employed to transmit data from Denver to Baltimore or vice versa at a rate of up to 5,000 alphanumeric characters per second for processing by least loaded facility.

► **Call for Authors**—Upcoming avionics conferences, which have issued calls for reports, together with closing date for receipt of abstracts, are as follows:

• **Human Factors in Electronics,** Washington, D. C.: 300-word abstracts by Feb. 1 to Rube Chernikoff, Naval Research Laboratory, Code 5124, Washington 25, D. C.

• **Antennas & Propagation Symposium,** Boulder, Colo.: 100-word abstract and 1,000-word summary by Mar. 1 to Herman V. Cottony, NBS Boulder Laboratories, Boulder, Colo.

• **Wescon,** San Francisco: three copies of 200-word abstract and 1,000-word summary by Apr. 15 to Dr. J. D. Noe, Suite 2210, 701 Welch Road, Palo Alto, Calif.

Space Control Center to Open in 1964

By Barry Miller

New multi-million dollar Integrated Mission Control Center (IMCC) which will directly control and command National Aeronautics and Space Administration's manned spacecraft flights, beginning with Gemini rendezvous missions, is expected to begin limited operations in Houston by mid-1964.

Situated within building complex J-3 at the Clear Lake site of NASA's Manned Spacecraft Center, the Integrated Mission Control Center will be the central control and direction point for all activities related to operational support of the agency's manned space flight missions.

It will have jurisdiction over and will direct the Ground Operational Support Systems (GOSS). This includes all of the communications, data handling and tracking, and data acquisition components, such as the Project Mercury Network and flight operations support systems, associated with ground support of manned space flight.

An industry contractor, who will have responsibility for implementing the center and integrating GOSS into it may be picked by NASA shortly after the first of the year. Ten large avionics companies were invited to submit bids for this role earlier this year (AW Dec. 3, p. 107).

Companies believed to be bidding include International Business Machines, Philco's Western Development Laboratories, Bendix, Raytheon, Lockheed, International Telephone and Telegraph, General Electric, Radio Corp. of America, Hughes Aircraft and Space Technology Laboratories.

In an earlier procurement, IBM was selected (AW Oct. 22, p. 26) to supply the real-time data processing complex for IMCC and will assume associate contractor status.

IMCC also will support the Operations Directorate staff at Manned Spacecraft Center. This staff may direct spacecraft crews and exercise policy control over the spacecraft mission profile.

Target Date

Tentative plans call for IMCC to become at least partially operational by July, 1964, for the Gemini rendezvous missions and be fully prepared for the orbital Apollo flights in late 1964 and Apollo lunar flights in the first quarter of 1967.

Besides its complexity and enormity, the IMCC is significant in a number of respects. It looms as the hub of all future manned space flight operations. It will incorporate a great many training, simulation and flight safety features. Additionally, it can exercise its own direct contact with spacecraft, supplementary to the contact it maintains through the near and deep space instrumentation facilities.

IMCC will contain a pair of mission operations control rooms where the operational control team will be situated with staff support personnel nearby. Its technical systems will support GOSS, which will have the following functions:

- **Exercising command control** using ground-based sources of information and data during normal or alternate missions and during any emergencies.
- **Providing central control** and direction for flights of unmanned spacecraft employed in manned space flight programs.
- **Providing over-all direction** and control of all mission support personnel during all phases of a mission from prelaunch through recovery.
- **Providing scientific and engineering** data to advance manned space flight and supporting technologies.

Over-all mission responsibility and detailed flight responsibility within IMCC rest with the operational control team, the decision making unit. It exercises its responsibility by directing any GOSS facility and offering directions to the spacecraft crew. Staff support personnel, adjacent to the mission control rooms, are the recommendation and detail monitoring group and, at times, serve as executors of operational control team decisions.

Recovery Control Centers

IMCC will direct the Recovery Control Centers (RCC), which will be the control points in the ground support of spacecraft re-entry and landing. RCC systems are expected to have high-speed data access to the IMCC computer complex, simulation and training systems, communications systems and recovery control systems.

IMCC's physical plant consists of mission operations and support wings and a mechanical support building. The mission operations wing is a three-story section with 113,000 sq. ft. and encompasses the two mission operations control rooms and the following mission systems areas:

- **Communications areas,** including among others, voice and intercom equipment rooms with sufficient space for at least 150 intercom stations: teletype message center containing teletypewriter equipment and high-speed parallel-bit page printers operating directly from communications equipment: communications control room containing communications coordinator's position, communications director's console, wall-mounted display, complete technical control subsystems including monitoring console, teletype page printers and transmit/receive units; data transmission terminal equipment room to house terminal equipment for high- and low-speed data lines, plus rooms for commercial line distribution terminals and liaison.
- **Computer complex areas** including input/output data processing subsystem (up to three medium-scale data processing subsystems), up to five large-scale data processing subsystems, up to five medium-scale data processing subsystems or their equivalent.
- **Mission control areas,** directly associated with mission control functions, are on the second and third floors of the mission operations wing. These are duplicate areas, each having its own mission operations control room, so that parallel real-time mission operations or simulation and checkout exercises can be conducted.

Mission operations control rooms will contain operating positions for personnel directly concerned with mission operation and will have group display subsystems for use by mission control personnel and visitors. There will be 10 to 15 operating positions or consoles. Surrounding the control rooms will be data monitoring, data analysis and staff support function stations, all containing displays and intercoms.

- **Recovery control and communications** areas will contain operating positions, intercoms with appropriate display and plotting surfaces and closed-circuit TV.
- **Closed-circuit TV equipment area** housing terminal equipment, camera control, video switching and distribution, pulse generation and distribution facilities.

The three-story, 132,000-sq.-ft. support wing is primarily for engineering office space, laboratory and technical services. The mechanical support building will contain equipment for critical and standby power to IMCC and chilled water for emergency air conditioning.

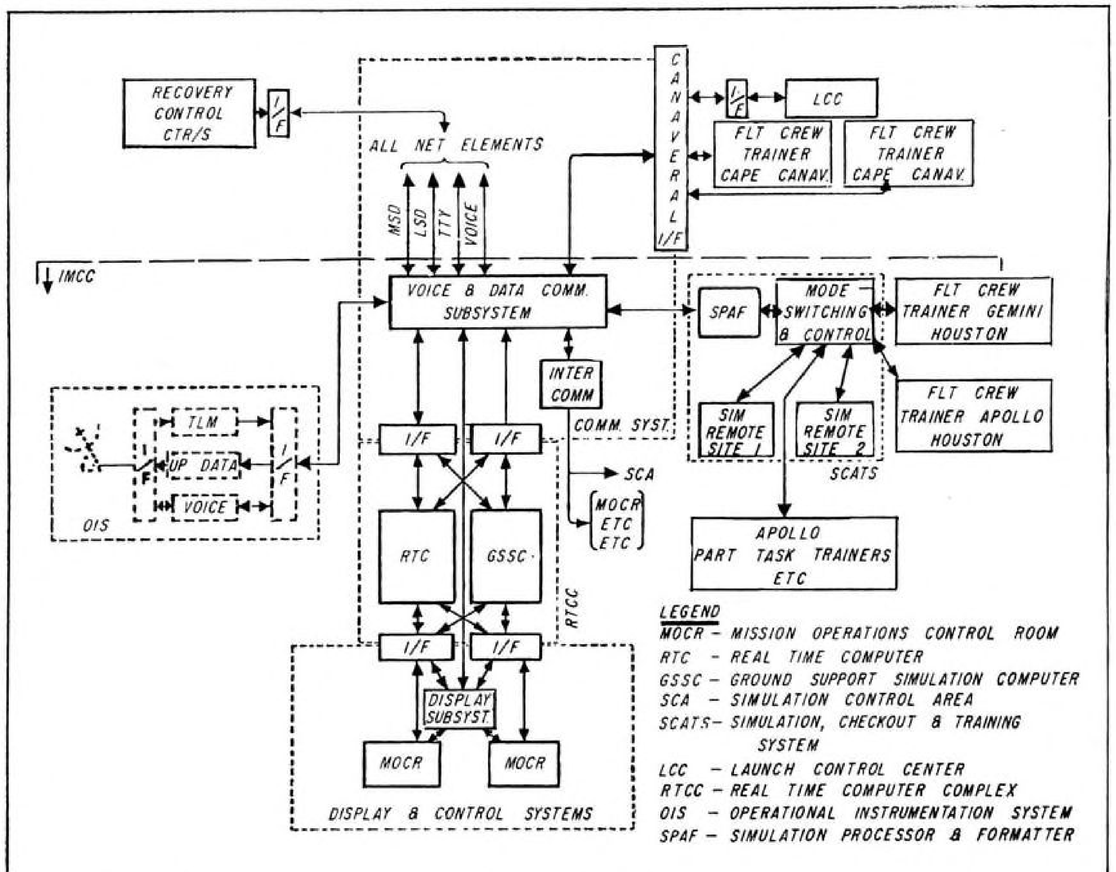
IMCC will have five major support systems, or components. These are:

- **IMCC communications systems.**
- **Simulation, checkout** and training system (SCATS).
- **Display system.**
- **Operational instrumentation system.**
- **Real time computer complex.**

IMCC's communications system will be the terminus of the GOSS ground communications system and will provide all communications within IMCC. It will support the two mission operations control rooms and their support areas simultaneously without degrading performance or reliability of either. It will bring one control room up to mission readiness status while the other is involved in a mission.

During a simulated or real mission, beginning at countdown, IMCC communications will link itself with GOSS communications and spacecraft communications, routing and collecting data within the IMCC. During nonmission periods, IMCC communications will support normal administrative traffic, logistics traffic, checkout and preparations for missions.

For the simulation, checkout and training system, IMCC communications will provide spacecraft-to-ground communications before and after liftoff



INTEGRATED MISSION CONTROL CENTER (IMCC), shown in block diagram with its five principal elements—communications, display, operational instrumentation, real-time computer complex and simulation, checkout and training systems. Above the dashed horizontal line are portions of National Aeronautics and Space Administration's Ground Operational Support Systems.

Apollo Crew Trainer Competition

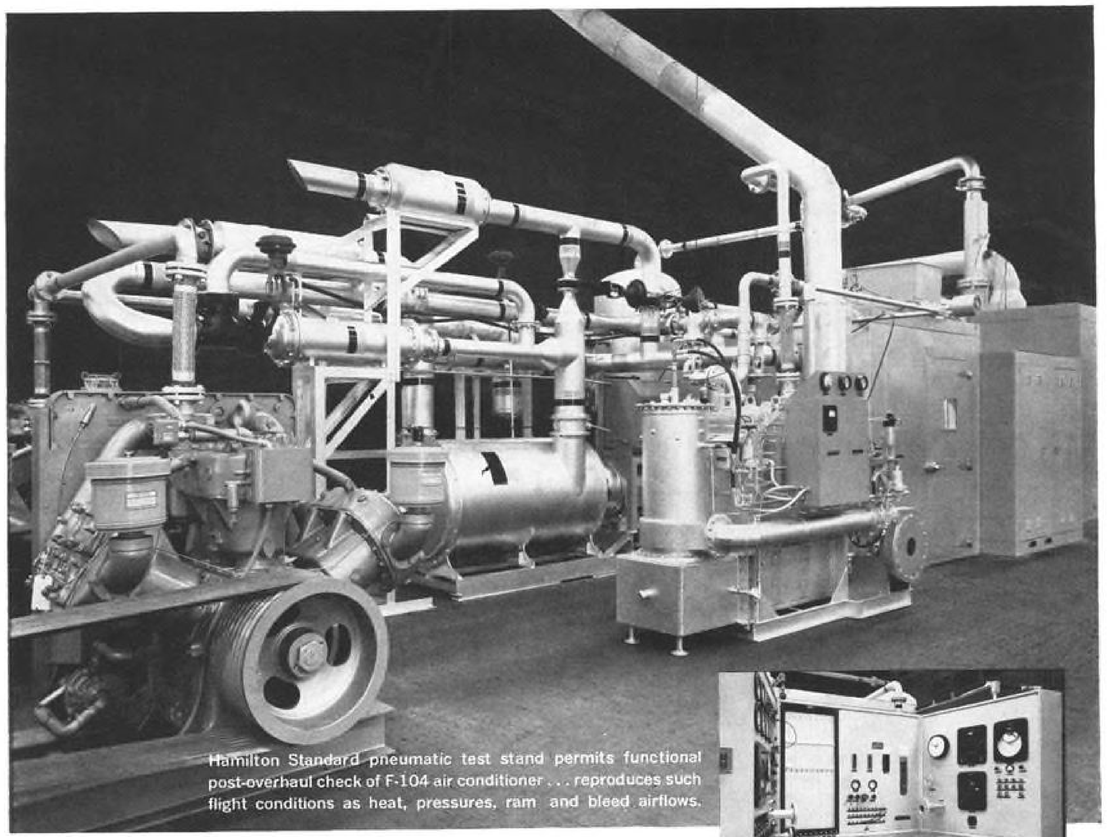
Competition to select a contractor to design and develop two manned spacecraft simulators, or trainers, which are to provide realistic training of spacecraft crews and to aid in checking out the Integrated Mission Control Center (IMCC) under simulated flight mission environments is being conducted by North American Aviation's Space & Information Systems Div.

As spacecraft contractor for the Apollo command and service modules, North American is responsible for the trainers and has invited industry to assist in the development task. Among the nine companies asked to submit bids as a result of a preliminary screening are Ling-Temco-Vought, Link Division of General Precision, Curtiss-Wright, Minneapolis-Honeywell, McDonnell Aircraft, Goodyear, Martin and ACF Electronics. Proposals are due in January.

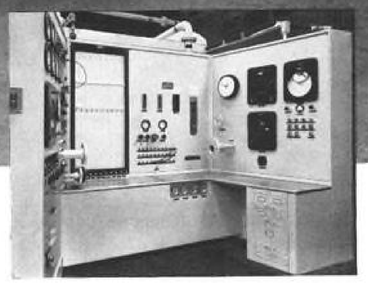
Trainers will be complete Apollo spacecraft plus support equipment needed for realistic training of the crew. They will include a computer to provide feedback information to activate spacecraft displays and provide basic mission profile data. These data will enable the training controller to change flight envelopes or alter on-board systems performance.

One Apollo trainer will be located at Cape Canaveral, the other at the Manned Spacecraft Center in Houston. Similar Gemini trainers and possibly lunar excursion module trainers also will be made available for similar interfacing with IMCC's simulation, checkout, and training system (SCATS).

A pair of additional Apollo flight crew trainers, called part task trainers, to be installed at Houston, will permit realistic training for launch and re-entry and orbit and rendezvous.



Hamilton Standard pneumatic test stand permits functional post-overhaul check of F-104 air conditioner . . . reproduces such flight conditions as heat, pressures, ram and bleed airflows.



Flight lab for the F-104 air-conditioning system

The Lockheed F-104 Starfighter's air-conditioning and pressurization system "flies" within this pneumatic test stand, designed and built by Hamilton Standard.

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Building test stands of this type demands a high degree of technical competence in systems engineering, electrical circuitry, pneumatics, hydraulics, electronics, and packaging. At Hamilton Standard, these capabilities are integrated with quality manufacturing.

Hamilton Standard has produced test stands for environment conditioning equipment, jet engine fuel controls, propellers, and a broad range of related aerospace systems and components. For the solution to your aircraft and missile test equipment problems, write: Sales Manager, Ground Support Equipment, Hamilton Standard Division of United Aircraft Corporation, Windsor Locks, Connecticut.

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for the IMCC and remote areas and pre-launch countdown communications between IMCC and Cape Canaveral and the recovery control centers.

It also will furnish network communications circuits between IMCC and remote sites where a simulated remote site in IMCC will represent the worldwide network in a training or simulation exercise.

The communications system is expected to involve voice, television and digital data. During mission periods IMCC will control all communications. In non-mission periods, the control of GOSS communications will be exercised by Goddard Space Flight Center in Greenbelt, Md.

Digital Systems

Digital systems to be employed will include teletype, low-speed serial bit stream, high-speed serial bit stream and telemetry composite bandwidth data links. The IMCC digital communications processing system will accept data words in various formats at speeds from 45 bits/sec. to 2,400 bits/sec. and up to bit rates compatible with video bandwidth links. The processing system will upgrade the signal, detect and correct transmission errors, safeguard and relay data to proper parties in desired format and speed.

Traffic storage capacity is also planned.

In non-mission periods, teletype will be the normal communications mode, with other modes available for checkout and simulation. In mission periods, digital communications will consist of teletype traffic such as tracking data, telemetry data, message text and real-time computed traffic, low-speed data, high-speed data and telemetry composite.

Video Circuits

Two incoming video circuits will carry display information consisting of video from the launch area with remote control camera selection and video transmitted from the Apollo spacecraft through the Goldstone sites of the Deep Space Instrumentation Facility.

Simulation, checkout and training system (SCATS) will support checkout of IMCC systems and the training of operational personnel under typical mission environments, according to Manned Spacecraft Center plans.

SCATS is envisioned as a means for implementing system checkout for operational readiness checkout and general training of flight controller personnel.

The implementation checkout will require continuing checkout and debugging of the operational and simulation systems. For operational readiness checkout, a comprehensive test program will assure that all parts of IMCC, including display systems, dynamic tracking and data system, dynamic telemetry data networks, simulation training system and voice systems are exercised.

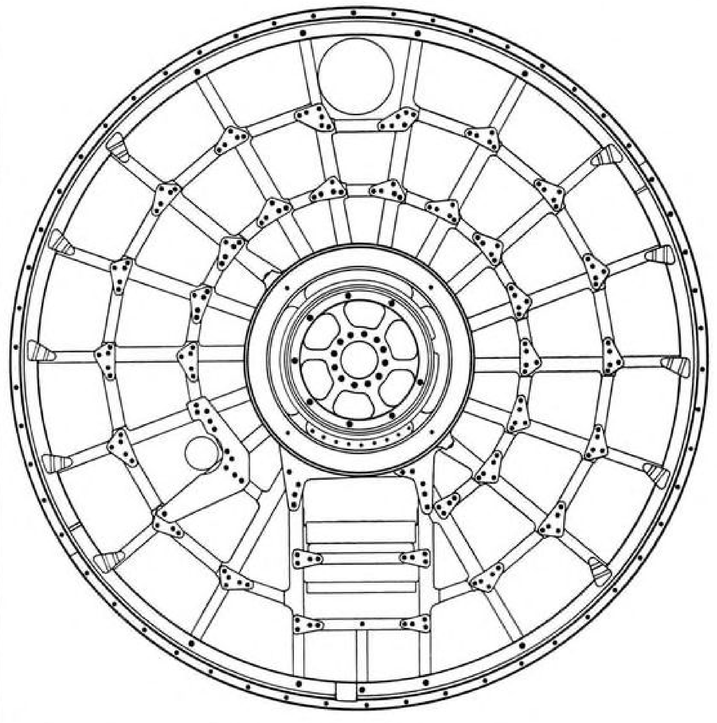
Display system will provide facilities for displaying both computer-derived and unprocessed data, obtained from ground support elements and the spacecraft. It will include display control, selection and generation equipment, terminal display devices in the mission control rooms and adjacent staff support rooms and for various system interfaces.

The display system will be capable of handling a number of formats, alpha-numeric, X-Y plots, video, bi-level indicators and meter type information, among others.

It will support mission control, decision making and command initiation by the operations director and flight director. It will provide for monitoring crew biomedical and life systems performance, vehicle system performance, vehicle spatial position-vs.-time relations and ground systems status.

Information derived in the form of spacecraft telemetry data, ground-based radar data or manual inputs from the flight controllers at remote sites is to be made available to the communications terminal equipment at the IMCC to be routed to the computer complex,

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..... NEWS OF DEFENSE TECHNOLOGIES

RE-ENTRY

One hundred and ten successful re-entries into the earth's atmosphere from ballistic, space-probe, and orbital trajectories—both heat sink and ablation vehicles of various configurations, weighing from 80 to more than 5000 pounds—this is the record achieved by General Electric during the past four years.

From the first flight test of the G-E Mark 2 nose cone on June 13, 1958, through the first successful recovery of a satellite re-entry vehicle on August 10, 1960, to the successful intercept of Nike-Zeus Target Vehicle on July 19, 1962, General Electric has pioneered in advancing technology for the development of ballistic re-entry vehicles, space probes, and recovery capsules. More than 350 vehicles have been produced and delivered under U.S. Air Force and NASA programs, with over six tons of hardware recovered successfully from space altitudes.

Information telemetered and recovered from these vehicles has furnished invaluable data that is leading to the advanced re-entry concepts needed for more sophisticated weapon systems, exploration of outer space, and entry into other planetary atmospheres.

As payload weights increase and space missions become still more complex, General Electric will meet these challenges with a broad re-entry capability and demonstrated reliability gained from repeated successful performance.



G-E MARK 6 is the largest re-entry vehicle ever flown on a U.S. intercontinental ballistic missile. It has been proved successful on long-range flights aboard the U.S. Air Force's powerful TITAN II missile.



NERV (Nuclear Emulsion Recovery Vehicle) has probed 1250 miles into space to obtain radiation data for the NASA. It was the first vehicle equipped with a discontinuous heat shield to achieve successful re-entry.



G-E MARK 3 re-entry vehicle holds the world's distance record for its flights in excess of 9000 miles. Developed for use on the U.S. Air Force's ATLAS and TITAN I missiles, it now is operational on the ATLAS.



THIS G-E CAPSULE was the first man-made object recovered from earth orbit. A high percentage of vehicles orbited by the United States were developed by G.E. under the Air Force's satellite research program.

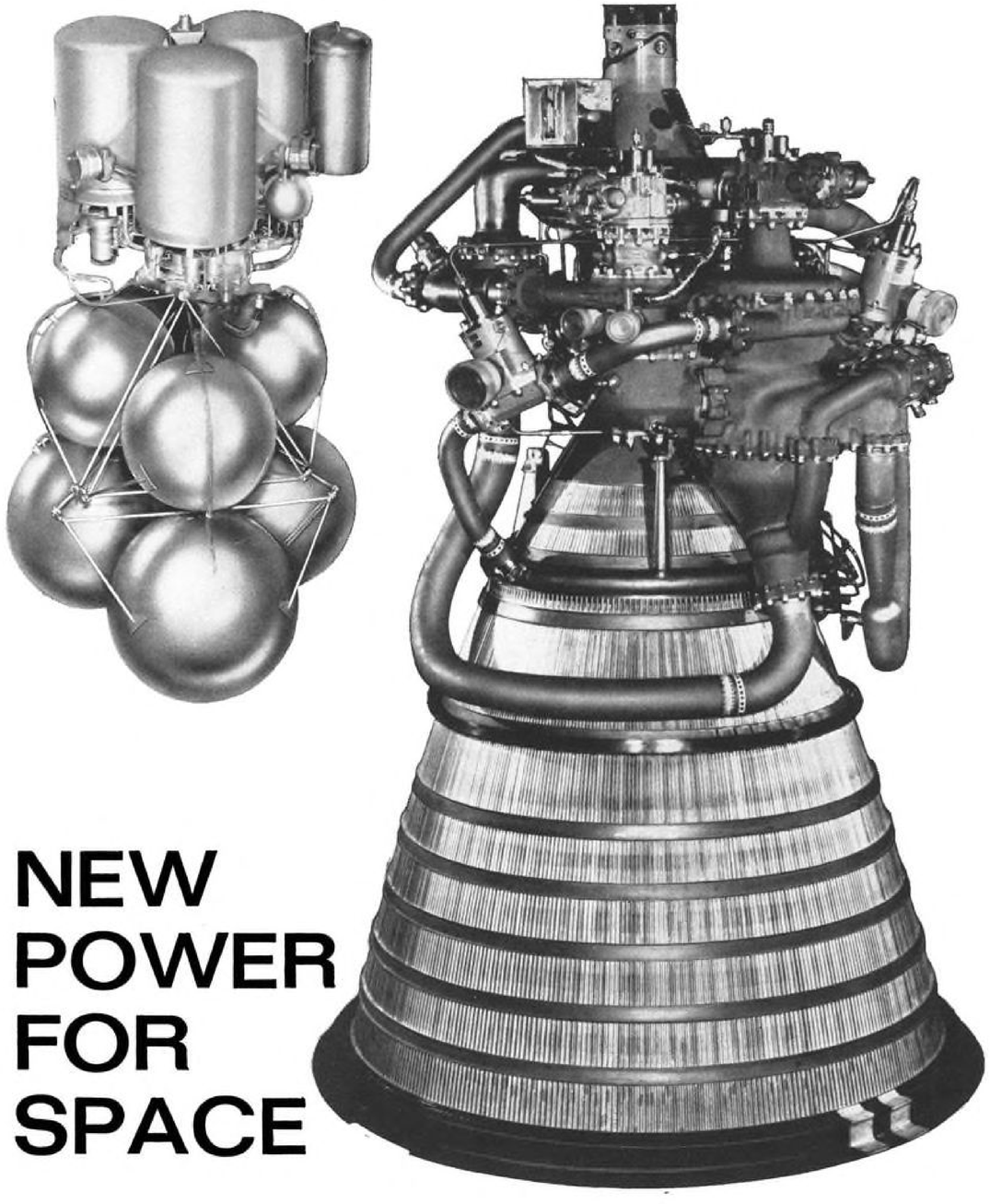


ICBM TARGET VEHICLES currently are being flown to test various components of the U.S. Army's Nike-Zeus missile defense system. Such tests employ miss-distance indicators for the evaluation of intercept accuracy.

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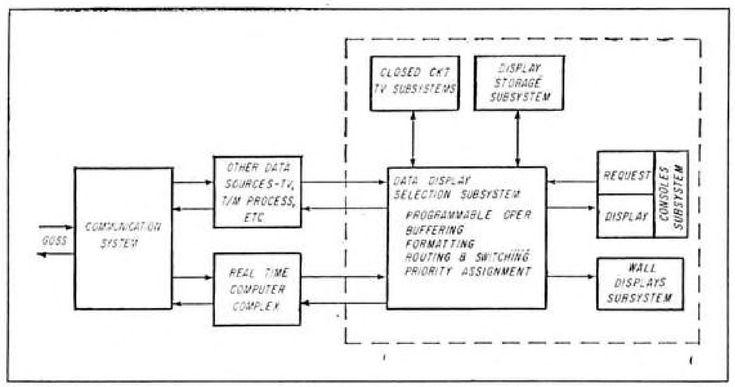
AEROSPACE AND DEFENSE GROUP



NEW POWER FOR SPACE

These new powerplants are an RL10 liquid-hydrogen rocket engine for propulsion in space, and a model of a fuel cell to provide electricity in manned lunar vehicles. Their mission: Power for space. Their designer and builder: Pratt & Whitney Aircraft for the National Aeronautics and Space Administration.

Pratt & Whitney Aircraft
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BLOCK DIAGRAM of the Integrated Mission Control Center display system (within dash lines) can accept inputs from the IMCC's real-time computer complex, television, telemetry, communications, data storage and other sources.

the display system or both. These data will be real-time information related to the status and performance of the spacecraft and ground systems.

Display system, according to NASA instructions, is to accept mission data inputs simultaneously or sequentially from the computer complex, the communications system, data storage subsystems, local telemetry systems, TV subsystems and manual inputs from the operations personnel.

Emphasis will be on display devices capable of handling several formats to minimize the number of devices and increase flexibility.

Display Devices

Display devices are to be capable of presenting different quantities in identical or different formats simultaneously on the same display, possibly superimposed on one another. One example, cited in NASA's work statement on IMCC, is the display of a computed orbital track superimposed on the stored nominal orbital track, all of which is superimposed over a reference world map. Latitude and longitude, indicated alpha-numerically, might appear elsewhere on the display.

Operating in selectable modes, the display system is intended to have programed, requested and forced modes of display. Forced mode refers to that situation in which operations personnel are alerted to data, not in display, which are approaching or exceeding critical levels.

The operator will be able to override the forced display to protect other critical displays.

Data display system will be divided into four functional areas or subsystems necessary to drive and control display equipment. The four subsystems are:

• **Console and wall display**—Terminus of display information will be in display devices associated with mission control rooms and technical support consoles and wall displays. The control for the display capability of each console will be exercised through a display request section of the console.

• **Data display selection**—Through this key subsystem, data flow intended for display and operation of the system is controlled. It is to operate as an on-line display control point to provide buffering, signal conditioning, format conversion, switching between data sources and display systems, restriction of request capability and priority of assignment. It is programmable for automatic functioning, can accept manual requests and has override capability for forcing displays under priority contingency conditions.

• **Display storage**—Two storage devices, one possibly a magnetic storage element and the other a photo-scan recovery microfilm card file, will assure display storage capacity. The former would store tabulations of mission-oriented data available on a pre-mission basis or could store fixed formats, footprints or overlays for some of the display presentations, while the latter would offer easily accessible storage of drawings, charts, maps, texts, formulas or pictorial data for mission support.

• **Closed-circuit television**—Image information will be relayed by this subsystem to console- or wall-mounted television monitor screens. Special TV effects, like split screen, selective blanking of portions of the screen and blinking effects are planned. High-resolution TV may be projected onto large display screens.

Instrumentation System

Operational instrumentation system (OIS) will support the mission control rooms as a real-time data acquisition and processing system. Between missions, the instrumentation system will complement the SCATS in handling operational interface problems.

It will be used to participate in all missions as a real-time data gathering facility. It can provide telemetry data unlimited by communications line bandwidths.

During lunar missions, OIS will supply data necessary to determine the status of the lunar communications equipment aboard the orbiting spacecraft. It may have a large multiband antenna, an RF receiver system, telemetry, an up-data link and a communications interface system. It will provide:

• **Lunar communications checkout,** supplying data obtained in real time from the orbiting spacecraft to the IMCC computers for processing and display at the mission control room consoles.

• **Mission participation**—It can be connected to IMCC computer and mission control room so that it may function as a real-time operational site when a spacecraft is in range. Outputs from its tracking, telemetry and up-data systems would be fed through the communications interface and the IMCC operational computers much as data are transferred from remote GOSS sites. The operational instrumentation system would offer a high quantity of such data.

• **SCATS interface**—OIS can supply data to actuate SCATS remote site consoles.

• **Communications interface** – Communications interface will connect the high-rate (120,000-bit) OIS to the lower-rate (2,000-bit) IMCC communications interface.

Computer Complex

Computer complex, for which IBM has responsibility, will be an integral part of IMCC and will support simulations and real-time flight control of manned space flight programs.

Flight controllers are expected to rely heavily on the real-time computer complex to supply information and recommendations in the event of abort, contingencies or alternative manned space flight missions. The computer complex must keep controllers informed of all information needed to make crucial decisions.

This task will require monitoring of spacecraft trajectory on the basis of tracking data supplied to it and processing data from the spacecraft systems to determine precisely and display mission status.

If a primary mission cannot safely be accomplished, the computer program will recommend an alternate mission. It must be capable of recommending a suitable abort trajectory in the event an abort becomes necessary during any phase of the mission.

A manual control will be available to controllers for override or redirection of any of the logical actions of the computer program.

Lightning Radiation May Spotlight Storms for Weather Spacecraft

Detection of electromagnetic energy radiated by lightning may provide future weather spacecraft, such as Nimbus with a capability for spotting thunderstorms now hidden from Tiros cameras by cloud layers between the satellite and the storms.

International Business Machines Corp.'s Space Guidance Center at Owego, N. Y., is completing a $52,000 study for the Weather Bureau on the parameters of a detection system for use in weather satellites. Objectives of the HF sferics (high frequency atmospherics) study are to determine the character or "signature" of energy radiated by lightning and ascertain the signal-to-noise ratio that might be expected at satellite altitudes.

Richard Hallgren and R. B. MacDonald, IBM atmospheric physicists, are in charge of the project. The method they use to determine the stretch of lightning-generated high-frequency signals is relatively simple.

Weather observers at the Broome County Airport near Owego detect thunderstorms in the area with radar and notify Hallgren and MacDonald, who turn on two receivers set at frequencies between 100 mc. and 600 mc.

The signals are displayed on an oscilloscope and recorded on 35 mm. film. Since distances from the antennas to the lightning flashes are known through either radar or visual observation, it is possible to plot amplitudes against distances traveled by signals and thus determine signal strengths.

Some ground-based sferics networks in the 10 kc. portion of the lightning signal spectrum are now in use to detect and track storms. This is the maximum energy portion of a lightning flash, but low frequency signals cannot penetrate the ionosphere, or are so attenuated that a system for detection of low frequency lightning pulses would be useless in a weather satellite.

Another attractive feature of high frequency detection systems is the relatively small antenna required—10 ft. or less in length—in a satellite sensor system.

Stanley D. Soules, research physicist at the Weather Bureau satellite center, Suitland, Md., indicated that the next step in sferics development may be flights in aircraft and balloons.

"If the data in the current study is encouraging, it might be possible to proceed with breadboard systems in aircraft and balloons in six months to a year," he said.

Since development of an HF sferics flight system could be developed largely from off-the-shelf components, Soules is hopeful that the IBM and follow-on studies indicate it would be feasible to include it on one of the four Nimbus research and development flights scheduled to begin in the fall of 1963.



Project Fire Re-entry Model Studied

Scale model of Project Fire is being readied for test in Langley Research Center's Unitary Plan Wind Tunnel. Force tests in the tunnel are designed to determine static stability characteristics of the model. NASA's Project Fire is designed to obtain data on high-speed re-entry (AW Dec. 17, p. 53)

CAREER OPPORTUNITIES IN THE

5 AREAS OF *DALMO VICTOR* SYSTEM CAPABILITIES

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3 MICROWAVE SYSTEMS Dalmo Victor has been deeply committed in microwave systems for many years. Leadership has been established in telemetry, automatic tracking, countermeasures, and distance measuring with capabilities for satellite rendezvous control and soft lunar landings.

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5 GROUND SUPPORT EQUIPMENT In participation with California Technical Industries, another Textron company, Dalmo Victor supplies a wide range of ground support and ground environment equipment. From a highly effective combination of facilities and talents, Dalmo Victor provides important single-source responsibility.

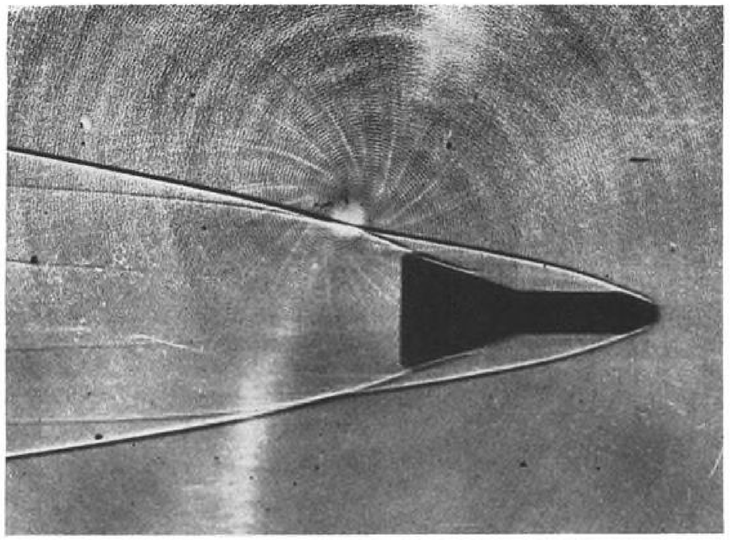
The page opposite describes one of the many Dalmo Victor achievements. Scientists and engineers of unusual ability are needed to further this and other Dalmo Victor concepts. If you would like to work in this creative atmosphere, and enjoy the many advantages of living in the San Francisco Peninsula area, investigate a career with Dalmo Victor. It can be most rewarding.

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DALMO VICTOR MEASURES THE "MISS" IN MISSILES *How close does an attacking missile approach a target? Dalmo Victor's non-cooperative Distance Measuring System gives a continuous digital readout of the range—accurate to the foot! Typical of Dalmo Victor's microwave versatility is this company-sponsored research and development project. This DV concept uses high resolution pulse radar techniques—with both the transmitter and receiver housed in the target. Not only is this new system important for missile evaluation and scoring, but its accurate range measurements can offer important advantages for satellite rendezvous, orbital docking, lunar landings and other sophisticated space operations.* ☐ *Microwave systems are another example of Dalmo Victor's project capabilities. DV is in the vanguard of the new developments in our major product areas.* ***If you are interested*** *in becoming a part of these challenging programs, Dalmo Victor currently is inviting applications from qualified scientists and engineers. For further information contact: Director, Scientific and Engineering Personnel.*

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Navy Tests Models in New Shock Tube

Relatively fragile missile models are flown through a new two-stage shock tube at the Naval Ordnance Laboratory, White Oak, Md., at velocities of more than 18,000 fps. The model shown in the shadowgraph was made of tungsten and titanium and was fired at a velocity of Mach 13. NOL scientists said the launcher achieves higher velocities because the driver gas is heated, thereby increasing its pressure by compression rather than combustion. In shock tubes where a chemical explosive is used in the driver gas to raise its temperature and thus increase the pressure of the gas, residue from the explosion contaminates the gas and thereby makes it heavier and less efficient.

Ship Station Planned For Test of Syncom

USNS Kingsport, recently converted from a World War 2 Victory Class freighter to a seagoing satellite communications station, will participate in testing of NASA's synchronous equatorial communications satellite (Syncom), which is scheduled for launch early next year (AW Aug. 20, p. 80).

During the test the ship will supplement land-based communications and tracking stations.

Designed and developed under the aegis of the Navy's Bureau of Ships at the Philadelphia Naval Shipyard, the vessel is officially attached to the Military Sea Transport Service (MSTS) but will be operated by the Army Satellite Communications Agency (Satcom) in conjunction with its Defense Satellite Communications Program. This program was organized for development of systems to fulfill military communications needs and requirements.

Exterior modifications of the ship include a 52-ft. pressurized radome constructed of Hypalon-coated dacron, situated on the aft deckhouse, and a yagi antenna on the foremast for Syncom telemetry and command.

Radome houses a 30-ft. aluminum parabolic tracking and communications antenna. Its triaxial mount, developed by General Electric Co.'s Ordnance Division, permits simultaneous motion in three directions.

It can rotate in azimuth while at the same time moving in elevation and rolling laterally, thus compensating for the roll, pitch and yaw of the ship and ensuring the equivalent of a stable platform. Mechanical power system employs direct-drive d.c. torque motors; this technique of power transmission eliminates much of the backlash that is associated with conventional gear trains.

Communications equipment aboard the Kingsport provides a two-way, wideband, high-speed microwave data link with mainland stations, as well as a high frequency communications link to facilitate direct test coordination between ship- and land-based stations.

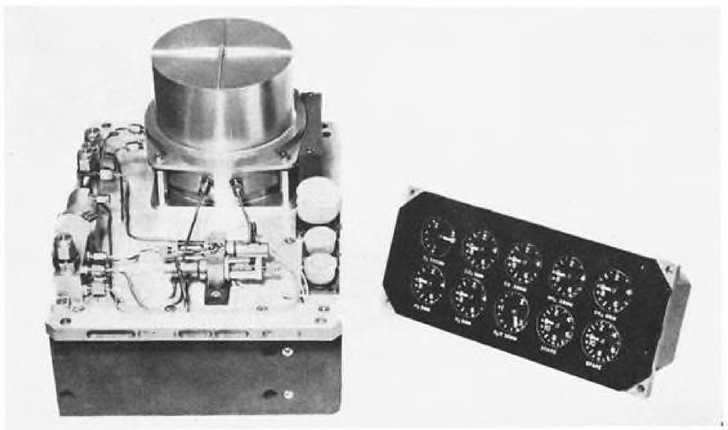
Plastic Film Designed For Comsat Erection

Plastic film, which disappears, or photolyzes, under the combined influences of hard vacuum and ultraviolet radiation and appears to offer several promising applications in the erection of passive communications satellites and other space structures, has been developed by the Goodyear Aircraft Corp.

Film would be used as an inflatable bladder for erecting wire grid structures, which would become rigidized and retain their shapes after the film had photolyzed.

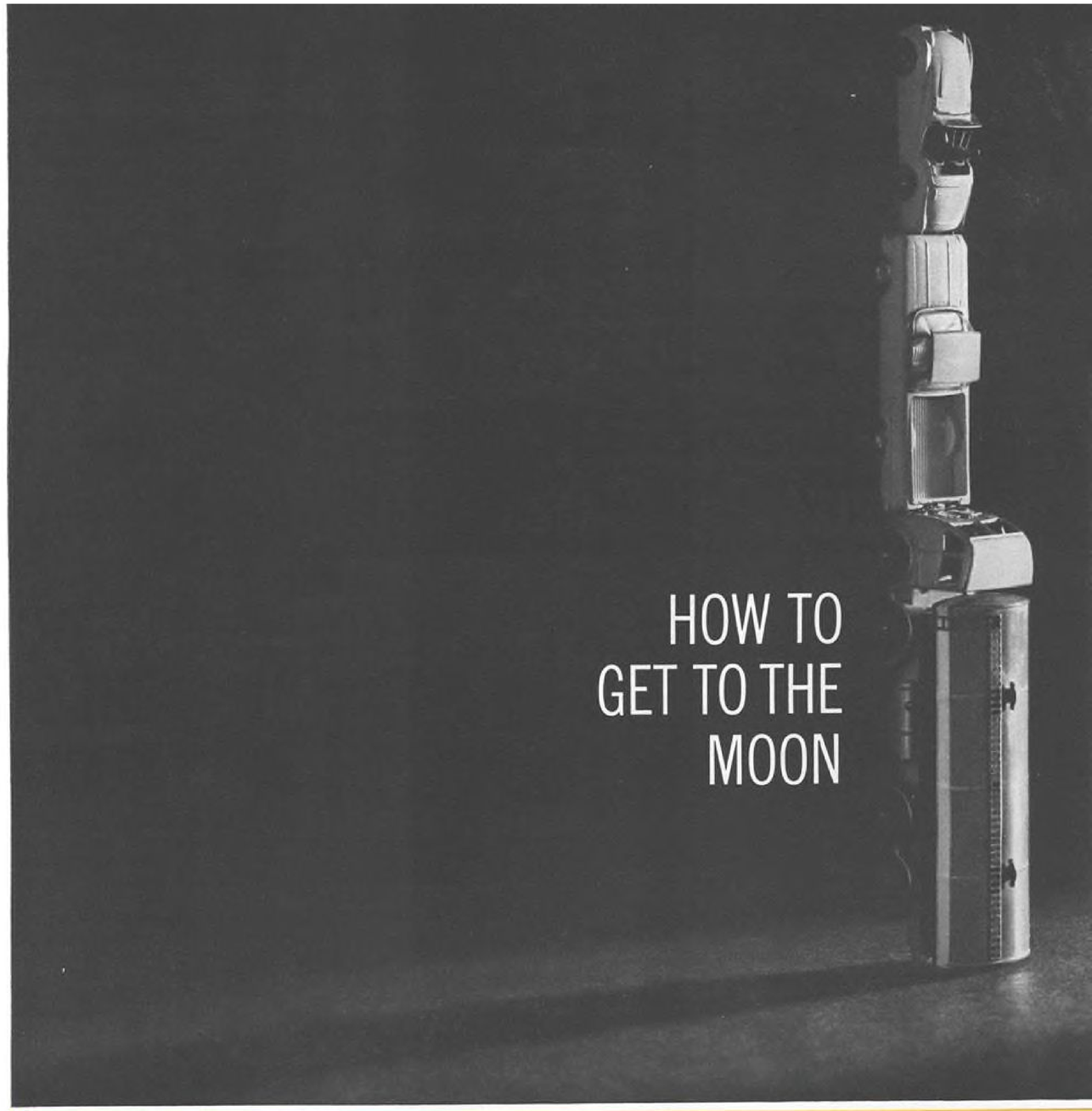
Inherent advantage in this technique lies in the fact that the structure would not depend on gas pressure for rigidization, as did the Echo satellites, and thus would not be subject to degradation in shape due to meteoroid impact or thermal stresses.

In addition, the total surface area of the satellite would be reduced after the film photolyzed, thus reducing perturbations due to aerodynamic drag and solar radiation pressure.



Spaceborne Gas Chromatograph Delivered to NASA

Beckman Instruments, Inc., Fullerton, Calif., has delivered a spaceborne gas chromatograph to NASA's Manned Spacecraft Center at Houston to monitor closed atmosphere in a manned space vehicle. Total package, which weighs 12 lb. and uses only a few watts of power, consists of analyzer unit, panel readout and helium storage tanks. Device will automatically and continuously monitor atmosphere to detect variation and permit correction.

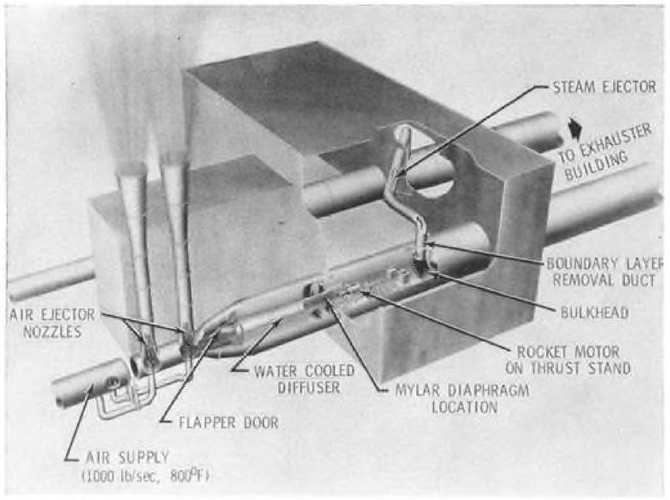


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NIGHT PHOTO OF CELL J-2 in operation (left) shows "tracers"—incandescent oxide particles in exhaust—propelled about 350 ft. high. Cutaway view of cell (right) indicates over-all configuration during test of full-scale rocket motor.

Modified Jet Cell Tests Missile Motors

By Warren C. Wetmore

Rocket Altitude Cell J-2—a modification of a test cell formerly used for jet engines at the Air Force's Arnold Engineering Development Center, Tullahoma, Tenn.—is being used for test-firings of full-scale Minuteman ICBM second- and third-stage rocket motors and Skybolt ALBM second-stage motors.

Conversion of the cell was completed by ARO, Inc., contract operator of the center, in less than six months between start of the design and the first operational firing, which was of a Minuteman third-stage motor. Cell is designed to accommodate solid-propellant motors developing thrusts as great as 60,000 lb. at simulated pressure altitudes of up to 135,000 ft. and temperatures as low as −120F.

This limited capability is in keeping with the cell's mission of testing rocket motors under conditions encountered during boost phase.

Scope of the tests includes ignition reliability, interior ballistics performance, base heating environment, nozzle geometry, thrust decay and operation of thrust termination and thrust vectoring systems.

Basic test cell structure is 20 ft. in diameter and 60 ft. long. Thrust and vibration generated by operating rocket motors are borne by a large steel thrust butt.

The test cell has two exhaust systems:

• **Rocket exhaust system,** which operates while the rocket is firing. The exhaust gases from the rocket pass into a water-cooled diffuser and are discharged to the atmosphere by means of dual air ejectors which are 85 ft. high at the exit plane. Throat diameter of the driving nozzles is 1.5 ft. The stacks are 5 ft. in diameter and are fitted with diverging conical sections having an exit plane diameter of 10 ft. During a rocket firing the entire apparatus is cooled by water spray. Ejectors are supplied with air at a rate of 500 lb./sec. from the continuous air supply system—a large electromechanical pump—which served the original jet test cell. During a run, another 500 lb./sec. of air is obtained from a high pressure storage tank. Prior to entering the ejectors, air from both sources is conditioned to approximately 800F and 130 psia. for improved pumping.

• **Auxiliary exhaust system,** consisting of a steam-driven ejector and the original cell exhauster arranged in tandem. This system is used for evacuation of the cell before a run and for removal of recirculating exhaust gases and leakage during a run.

In a typical run of Cell J-2, the test cell is isolated from the ejectors by means of a 0.05-in.-thick laminated Mylar diaphragm inserted in the diffuser (see artist's conception p. 64). The rocket motor to be tested is installed in the thrust stand and all instrumentation and functional equipment on the motor is connected, including a circuit between a pressure transducer in the thrust chamber and an explosive cord attached to the Mylar diaphragm. Motion picture and television monitor cameras are focused on the motor.

Cell Closed

Cell is then closed and sealed. After the instrumentation is calibrated, the cell is evacuated to 0.03 psia. by the auxiliary exhaust system coupled with the steam ejector. The instrumentation is recalibrated at the low pressure and the thrust-measuring load cells are calibrated by a remotely operated deadweight system, which has an accuracy of 99.9%.

During this time, the air ejectors on the other side of the Mylar diaphragm are operating from the continuous air supply. About 20 sec. prior to ignition, air from the high-pressure tanks is also fed into the ejectors, bringing the total flow rate to 1,000 lb./sec. Then the ignition circuit is closed, firing the pyrotechnic squib and igniting the rocket motor.

Gas Exhaust

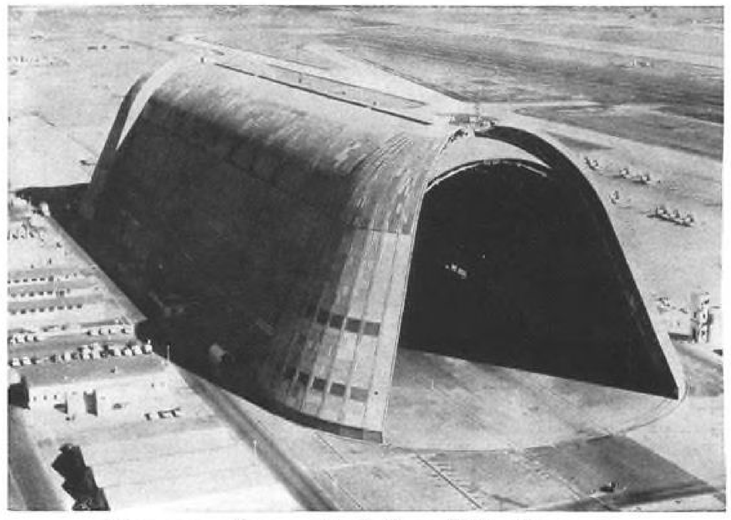
When the chamber pressure in the motor achieves a preset value, the pressure transducer triggers the explosive cord on the Mylar diaphragm, permitting the exhaust gases to escape to the air ejectors.

Pressure in the chamber will fall about 15,000-20,000 ft. during a firing, depending on the size of the motor being tested.

At burnout a flapper door on the downstream end of the diffuser is closed to seal the test cell, and the air supply to the ejectors is shut down. The auxiliary exhaust system maintains pressure in the cell until completion of the post-firing tests, such as evaluation of thrust decay, and post-firing calibrations.

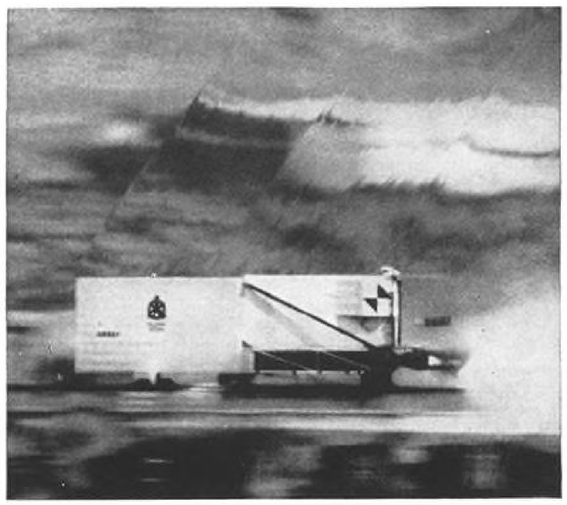
Expended motor is removed for examination for faults that might cause failure. Raw data obtained from the instrumentation, which was digitized and recorded on high-speed magnetic tape during the run on as many as 400 channels, are reduced by means of an International Business Machines 7070 digital computer and plotted.

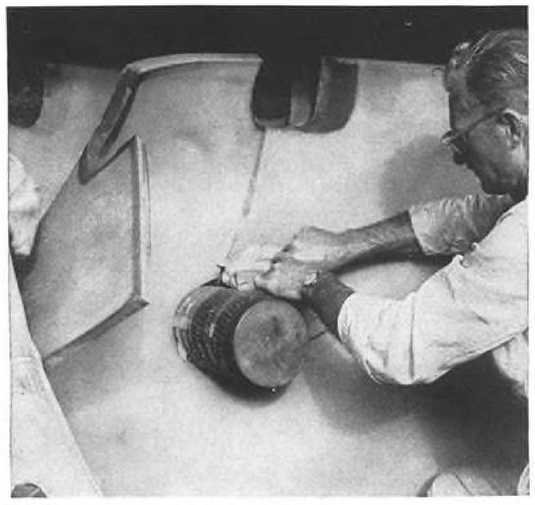
Designation of a test cell described in a previous issue (AW Sept. 25, 1961, p. 225) has been changed from J-2 to J-2A. Cell J-2A is located downstream of Cell J-2, beyond the bulkhead shown in the drawing.



Hangar Converted for Rift Program

Airship hangar built during 1930s at Naval Air Station, Moffett, Calif., will be renovated for manufacture and assembly of NASA/Lockheed Missiles and Space Co. Rift (reactor in-flight test) nuclear rocket stage. Hangar is 1,100 ft. long, 300 ft. wide and 195 ft. high. It will have space for stage assembly and reliability testing, component manufacture and component assembly.





Plastic Material Catches Artillery Shells in Tests

Rocket sled traveling at more than 400 mph. at China Lake, Calif., contains layers of unicellular plastic material to catch 155 mm. howitzer shells in Army program to develop shells with improved power and more accurate and uniform firing characteristics. At left, shell is photographed a fraction of a second before impacting in the material, called Ensolite, developed by U. S. Rubber Co. At right, shell is removed undamaged from the plastic for study by engineers from Army's Picatinny Arsenal, N. J.

PRODUCTION BRIEFING

Moog Servocontrols, Inc., has received a $1-million contract from General Dynamics/Pomona for production of electrohydraulic servovalves for the flight control system of Navy's advanced Terrier/Tartar guided missiles.

United Control Corp., Redmont, Wash., has been awarded a $2.7-million follow-on contract from the Boeing Co. for production of special ground-based environmental control systems equipment for use in the Minuteman missile program.

Graduate Research Center of the Southwest, Dallas, Tex., will develop scientific experiments in lunar, planetary and space exploration under a $1.5-million National Aeronautics and Space Administration contract.

Bendix Corp.'s Eclipse-Pioneer Division has been awarded a $500,000 Air Force contract to develop a hot-gas servo control system of the type which can be used on the GAM-87A Skybolt missile. System is generated by the combustion of a solid propellant, which is ignited when the missile is launched. Contract contains a $400,000 option for procurement of six additional systems.

Operations Research, Inc., Silver Spring, Md., has been awarded a $242,000 Navy contract to upgrade and extend the Reliability Maturity Index System, now being used in management control of the Polaris program.


Minuteman launch controls

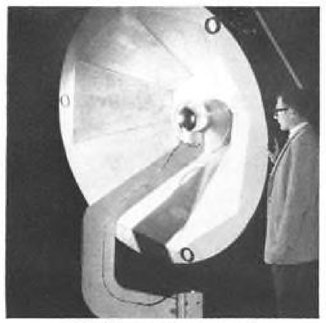

Electronic circuitry design


Solar power research


Circuit card assembly

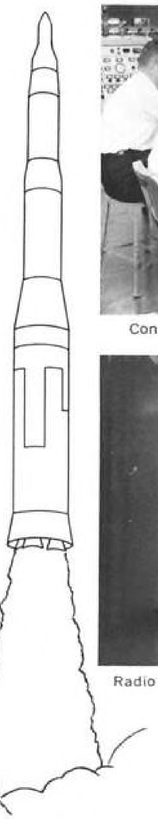

Computer technology advancement


Console design and manufacture


Satellite control research


Electronic circuit inspection


Radio frequency interference studies



Electronics capabilities – at Boeing Aero-Space Division

More than 4,000 of Boeing's Aero-Space Division's personnel are engaged in electronics research, design, manufacturing and applications activities.

Twenty-one electronics organizations provide everything from advanced research to the components and total systems required by the Division's programs. General areas of activity include countermeasures, radar optical systems, infrared, communications, radio navigation, antenna development, electrical materials and radiation-effect studies.

Currently, Aero-Space Division is manufacturing the launch control system for Minuteman, flight electronics for the X-20 Dyna-Soar space glider, hydrofoil autopilot system interface equipment, security systems, an orbital tracker and airborne communications.

In electronics, as in all phases of systems management, emphasis on quality control and reliability engineering has contributed toward the Division's outstanding record of performance. It has also assured the design and development of superior products, manufactured and delivered on schedule.

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CHANCE VOUGHT/NAVY F8A reaches end of 1,000-ft. stroke of ground-based catapult in recent Marine Corps test. One of the nylon catapult tapes can be seen running through pulley in left foreground. Test system has centerline track, but operational version will not.

Marines Testing 'Package Airfield' Designs

By Donald E. Fink

Philadelphia—Advanced lightweight catapult and arresting gear designs are taking shape at the Naval Air Engineering Laboratory here as final selection nears of aircraft launch equipment for the Marine Corps' SATS (short airfield tactical support) program.

Target operational date for the program, which calls for 12 mobile "packaged" airfields, is June 30, but all the systems will not become operational until late 1963.

Short-field concept involves establishing airfields on rough beachheads in three to four days and operating them for 30 days or 1,600 sorties with minimum outside logistics support other than fuel and armament.

Main components of the airfield packages will be:

• **Aluminum matting** for a runway 2,000 ft. long and 60 ft. wide and for taxi strips and parking areas. Matting sections, which will be coated with a plastic-base, anti-skid compound, will be palletized for easy shipment. The sections will consist of two extruded aluminum plates, 2 ft. x 10 ft., with supporting cross members sandwiched between the plates.

• **Two portable catapults,** either the reel type which uses two large nylon tapes and a slingshot effect to propel aircraft down the runway, or the cable type which uses a closed-loop cable to pull aircraft to takeoff speed. The catapults will be powered by one of two powerplants—a reel driven by two Pratt & Whitney T34-9W turboprop engines, rated at a total of 13,600 shp., or a cable-pulling capstan linked to a free turbine turned by a General Electric J79 gas turbine rated at about 16,000 lb. of thrust.

• **Two portable arresting devices,** which will use cable pendants for landing hook engagement and two nylon tapes, restricted by a braking device, for arrestment. Woven tapes will be 8-10 in. wide and ⅜-in. thick.

• **Two runway end barricades,** which probably will be patterned after the Swedish Safeland type, consisting of upper and lower horizontal nylon tapes and a series of vertical nylon streamers spaced to distribute the arresting forces evenly over the wing and tail surfaces of the aircraft.

• **Portable control tower,** complete van-mounted navigational aid and instrument landing system and portable runway and landing light system.

• **Erectable maintenance shelters,** vans for crew briefings and rubber fuel containers for a tactical fuel depot. Other aids, peculiar to carrier-type operations, such as a mirror-optical landing system, also will be included.

Three airfield packages, which will cost about $9.7 million apiece, will go to each of the Marine Corps' three air wings. Three will be kept as spares. Two officers and 25 enlisted men, comprising the launch and arrestment crew, will be designated SATS personnel and assigned to each portable unit. Remainder of the support complement will be taken from fixed bases where the squadrons normally operate.

About $20 million has been spent on research and development of operational components since the program was begun in earnest in August, 1961, a Navy spokesman said.

The short-field concept originated in basic form during World War 2, but serious consideration was not given to it until the Marines started flying heavy jets. The limited "brush fire" war threat in the late 1950s and early 1960s prompted allocation of funds for serious development of the concept, which has taken on new importance since U. S. involvement in South Vietnam and the Cuban crisis.

Program manager for the short airfield development is Lt. Col. G. C. Greenfield, head of the equipment and logistics section of the aviation logistics and material branch.

Technical management is the responsibility of the Air Engineering Laboratory, which is part of the Naval Air Material Center in Philadelphia. The mechanical components directly connected with aircraft launch and recovery are developed here.

Catapults posed the biggest problems, since high performance had to be realized from devices that were light enough to be airlifted. Catapults developed so far will exert 1½-2g on the launch aircraft and will provide about 50% of takeoff power. Shipboard steam catapults exert much higher g-forces and provide about 90% of takeoff power, but they are not compatible with mobile operations because of greater weight and bulk.

Catapult development has progressed in stages along two parallel courses. At least seven versions of the cable and reel type have been built as interim devices to develop and test components such as clutch assemblies, centerline tracks and attachment bridles.

Choice has now been narrowed to two

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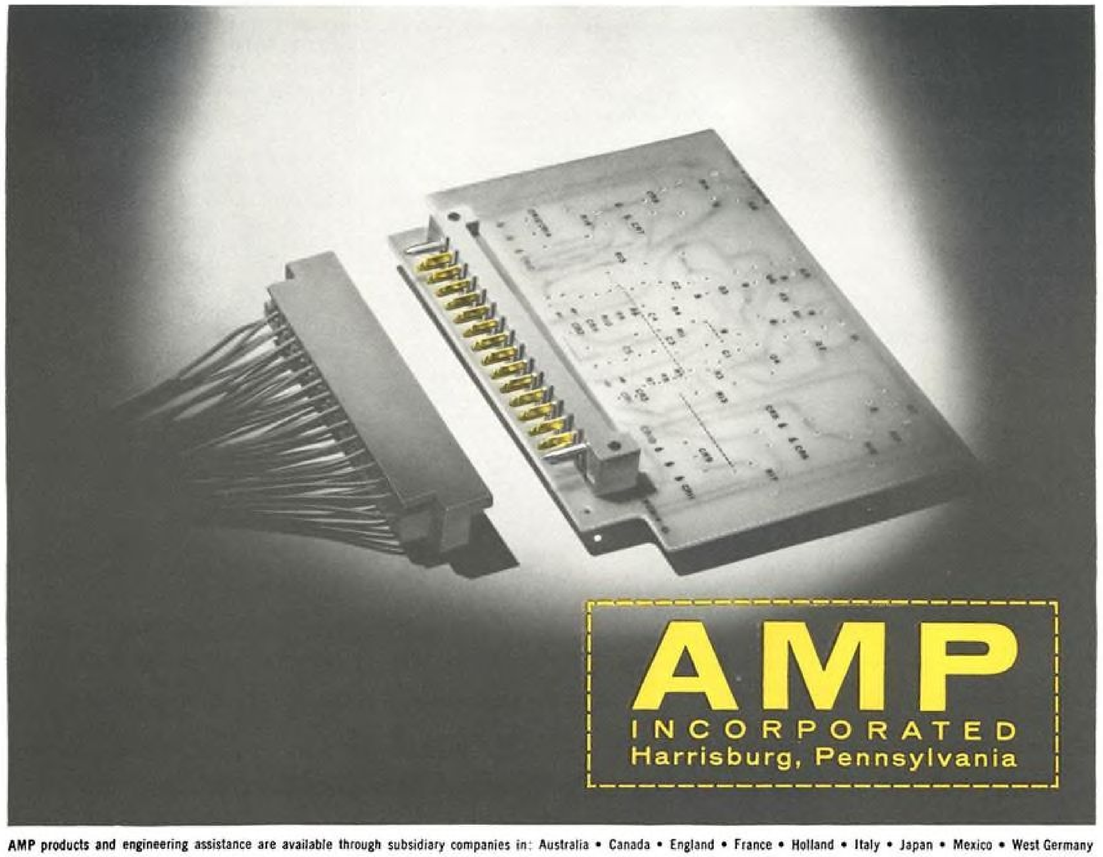
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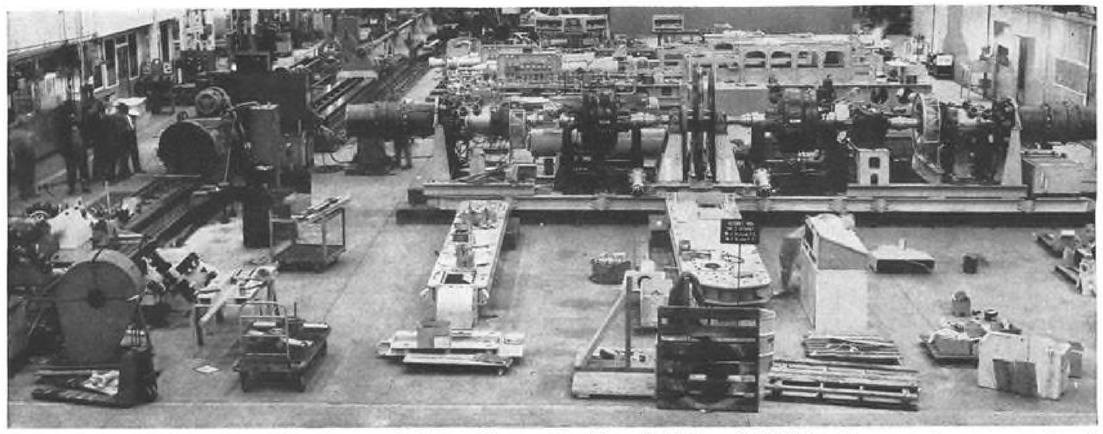
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RE-5 DEVELOPMENTAL CATAPULT, shown in final assembly stage, has Pratt & Whitney T34-9W turboprop engines set at each end of frame. Black drum-like devices are hydro-drive clutches. Tape reels and lead-out guides are located in the center. The RE-5 was built as an interim catapult to perfect the clutch assembly. RE-8 will have the same basic configuration as that of the RE-5.

designs, both in the 50 million foot pound class. They are:
• **RE-8, reel type,** developed by E. W. Bliss Co., Canton, Ohio.
• **CE-2, cable tow,** developed by All American Engineering Co., Wilmington, Del.

Early development models had track-mounted nose wheel shuttles which served both to guide the aircraft down the runway and to overcome the resultant nose-up forces generated when tension is applied to the towing bridle.

Track and shuttle system added weight to the airfield package, however, and extended the installation time, since it had to be anchored. Specifications now call for a trackless system. Successful tests with trackless versions of both systems, using dead loads and ballasted airframes, have been conducted at the Naval Air Test Facility in Lakehurst, N. J.

Live tests with piloted aircraft will be conducted early next month, and final selection of the catapult for the operational system is scheduled for May or June.

RE-8 has the two engines facing each other at opposite ends of a large frame. Powerplant will be set to one side of the runway. In the center of the frame is a dual-track tape reel with special hydro-drive clutches on each side.

Clutches, developed by Douglas Aircraft's Vortec Products Division, use water as the working fluid between two impeller wheels. Clutch can be throttled for smooth acceleration by moving a sleeve over the powered impeller wheel and regulating the flow of water. One of the clutches is driven directly by its engine. The other is driven through a reverse gear, because of the reversed engine position.

Tapes from the reel are played out to large pulleys at each edge of the runway. Tape to the opposite-side pulley runs in a channel under the runway matting. From the pulleys, the tapes are strung down the runway where they connect with cable pendants which attach to the aircraft launch bridle.

Aircraft is attached to the bridle and then restrained with a standard carrier hold-back hook. Tape tension is increased and aircraft power is applied until the hold-back shear pin fails. Aircraft is then propelled by its own power, with an assist from the rapidly reeled tapes. Tapes act as slingshot bands when the aircraft reaches the "bite" position opposite the reel and aircraft is accelerated to takeoff speed.

CE-2 catapult uses a single cable loop, one portion of which runs from the aircraft bridle up the runway, around a pulley and over to the power unit, which also sits off the runway. Unit, called the LM 1500, consists of the J79 gas turbine engine which exhausts into a free air turbine. LM 1500 may be used to power the operational version of the RE-8 due to shortage of T34 engines.

Turbine is linked to a large capstan, extending from one side of the unit. Cable is looped 2½ times around the capstan, threaded through a hydraulic shock compensator and then strung back along the runway, where it is looped through two more pulleys and back to the rear of the bridle.

In operation, the CE-2 works like a rope tow on a ski slope. As the capstan is turned, it winds the cable on and off at the same speed, pulling the bridle along the runway and launching the aircraft.

Marines are striving for a launch sequence of 90 sec., but bridle return on the development models has been slow. Small auxiliary engine probably would be used on the operational CE series catapult to return the bridle to the launch position. Return of tapes and cable pendant on the RE series has not been completely worked out since the centerline track was eliminated.

Arresting gear will use nylon tapes attached to one of three braking devices now undergoing Navy evaluation:
• **Bliss-developed M20-mod 1,** which uses a large brake drum, similar to that on a Boeing B-52 bomber, and conventional brake shoes to stop the tape reels.
• **All American M-24,** water twister, with tape reels attached to a large paddle wheel set in a tub of water. Energy of landing force is dissipated by churning the water.
• **Vortec M-21,** which uses a Vortec clutch with one impeller wheel attached to the tape reel and the other locked in place. Arrestment energy again is dissipated into the working fluid.

Short-field installation sequence would be coordinated with normal Marine amphibious landing. As soon as a beachhead is secured, the SATS task force of about 25 LST-type ships will move in and unload the equipment. All equipment can be airlifted in Lockheed C-130s or C-141s.

As components are being unloaded, Seabees or Marine engineers will level a dirt bed for the runway. Matting, which has interlocking devices, has been tested on several types of terrain. It will form a satisfactory runway on wet soil.

Air cover during the field installation will be supplied from aircraft carriers or from friendly land bases close enough to permit limited strike missions. When the field is operational, the carriers will be released for duty elsewhere.

Fuel can be pumped up to 10 mi. inland from off-shore tanker ships, or supplied in limited quantity by airlift.

Extended, close-support missions will be flown from the short field until the campaign is ended or the battle line moves beyond economical strike range.

Field will be capable of handling all Marine aircraft in their heavily loaded, ground support configurations. Final catapult equipment will be powerful enough to accelerate all aircraft, including a fully loaded Grumman A2F, to 180 kt. in about 1,400 ft. Aim is to develop a catapult that can be operated without allowance for surface wind.

Blind Bolts™ become part of simplified wing rework saving $2.8 million!



Blind Bolts being installed in RF101C lower tapered skin covering main torque box after wing removal from rework jig. Hi-Shear Corp. portable power units (BP4000 electrically operated model shown) provide hydraulic power to the Blind Bolt Gun. Air operated model is non-sparking and safe for use near fueled aircraft or launch ready vehicles.

Because of its ability to fill misaligned or oversized holes, the all-purpose, Blind Bolt fastening system has become an essential part of a method developed at Hill A.F. Base at Ogden, Utah, to repair wings of RF101C fighter aircraft at depot level maintenance.

Since this unique repair method replaces only the tapered panels rather than entire wing structural assemblies, an estimated $2,815,921.00 was saved during first year of a continuing program. With similar conditions, this method is applicable to other type aircraft, missile and space vehicle structure.

At first, engineering analysis indicated that major repair of the damaged wing panels was not feasible. Because of the problem of aligning the hole patterns and varying tolerances between the original wing structure and the new factory panel, and yet retain the wing's original "set," the wing seemed unsalvagable. Complete replacement of the wing seemed necessary to fly the grounded aircraft again.

Fortunately, a repair method was developed by Hill engineers and shop technicians to transfer the exact hole locations of a damaged wing panel, by means of a drill blanket and potted drill bushing technique, to a new undrilled skin panel. The latter then was drilled and, with matching hole patterns, solidly fastened with Blind Bolts to the wing structure. When resighted, the reworked wing showed no evidence of distortion. Thus, the repair was accomplished for the price of a skin panel rather than that of an entire wing structure.

For repair or modification, usage of Blind Bolts and Blind Nuts minimize structural disassembly; for production, they are useful for tight structural areas, close-out panels and tubular members. For replacement purposes, self-locking Blind Bolts and Nuts match strength values of NAS bolts and nutplates. And, important to repair work, Blind Bolts are not grip sensitive.

INSTALLATION TOOLING



STANDARD DRIVING TOOLS are used in normally accessible areas. Photo shows hydraulically actuated BG1750 Gun.



EXTENDED DRIVING TOOLS extend 1⅞" further than standard tools for use in deep channels or to extend beyond adjacent obstructions.



OFFSET DRIVING TOOLS provide an extension up to 10" or more to reach into tightly congested areas. Use in repair work often saves removal of mechanical components to gain access in a tight spot.



HAND TOOLS to install Blind Bolts up through ⅜ dia. and Blind Nuts through ¼-28 in limited quantities or for field service where power equipment is not available.



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Describes how factories, airlines and government facilities have used Blind Bolts and Blind Nuts in new work or for repair. Also describes advantages, applications, strength data, installation techniques and tooling.

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Fairchild YC-123H, modified C-123 designed for rough, soft or short fields, lands in 14-in.-deep sand at Edwards AFB during Air Force's Rough Road Alpha tests for the YC-123H, C-123 and C-130. Modifications include braking chute, podded, underwing General Electric J85 turbojets and wide track flotation-type landing gear (AW Aug. 13, p. 84).

USAF Tests YC-123H on Soft Field





Cloud of dust surrounds the YC-123H as it uses reverse thrust to stop in sand, left. Wheels, above right, sink almost to hub. Company says aircraft can operate from fields which are either too soft or too rough for land vehicles. Below, YC-123H lifts off from mud and clay dry lake bed. Fairchild statistics claim aircraft's maximum payload is increased from 16,000 to 20,000 lb. and that with a 6,000-lb. payload it can take off over a 50-ft. obstacle in "substantially less" than 1,000 ft. Landing distance under the same conditions is said to be less than that of single-engine aircraft. Tests are being conducted in response to USAF requests for a 10-ton STOL tactical transport.



Antonov Scores Soviet Sports Authorities

Moscow—Russian aircraft designer O. K. Antonov has charged that top Soviet sports authorities may be getting ready to back out of the 1963 World Gliding Championships in Argentina because they are afraid of what may happen if their entries are beaten.

In another of his polemics against Russian bureaucrats, Antonov alleged that members of the Central Committee of the USSR's huge, government-controlled, semi-military DOSAAF sports organization would rather be "chided" for not permitting a Soviet team to compete than expose themselves to the unknown consequences of sponsoring a losing team.

Antonov, who is a member of the Presidium of Russia's All-Union Federation of Aviation Sport as well as a deputy to the USSR's Supreme Soviet, expressed his indignation in an article written for the newspaper Komsomolskaya Pravda.

The Russian industrialist's attack on DOSAAF (Voluntary Society for Assisting the Army, Air Force and Navy) declared:

"I would like to continue the discussion begun in the article 'Potholes in the Airways' and try, with the aid of the public, to save our aviation sport from yet another defeat before it is too late.

"In 1960, the A-15 sailplane—a craft designed for getting records—was built for DOSAAF glider pilots. Young designer-enthusiasts working in cooperation with personnel of the Antonov aircraft factory at Kiev put all their zeal, knowledge and love into the project," Antonov said.

"The A-15 glider was designed, built and thoroughly tested in a short period of time—one year—so as to ensure our gliding team's participation in the . . . world championships in 1960.

"However, when the Central Committee of the USSR's DOSAAF received the spanking-new gliders they decided that there wasn't sufficient time for pilots to master them. They apparently concluded that our glider pilots could not do well competitively in the A-15s.

"So DOSAAF's Central Committee refused to participate in the world championships that year. Meanwhile, only two days after this poorly-founded decision was made, M. Veretennikov, a member of the Soviet team, set a new world speed record of 111.3 km./hr. for the 100-km., closed triangular course. This beat the record established by an American.

"Soon afterward, yet another All-Union (Soviet) speed record was set for a 200-km. course.

"That same summer, A-15 gliders captured two more world and four All-Union records. And glider pilot Veretennikov, flying an A-15, took first place in competition in Rumania by collecting a perfect 5,000 points.

"Thus the flying and technical characteristics of the A-15 were demonstrated once again even during flights with light thermals.

"It was only because of insufficient experience in international meets, plus poor organization of team training and careless preparation of the team for competition (for example, the lack of a radio equipment specialist on the team), that we lost the team championship in the 1962 international gliding contests for socialist countries.

"Next February the World Gliding Championships will be held in Argentina. A-15 gliders have been fully prepared for the flights.

"But the directors of DOSAAF's Central Committee have started to waver again.

"They say: 'Look what might happen! This year our radio-controlled model airplane enthusiasts, our parachutists, and our sports plane pilots did considerably worse than they were capable of doing.'

"Yes, this is all true. But what has that got to do with our glider enthusiasts, who have demonstrated their 'fighting ability' by deeds?

"So what is the way out of this blind alley? Just what is to be done? In the future, contests will be held in Canada, France, India, Australia or some place else! In these places there will again be unfamiliar conditions! Again there will be dangers!

"Wouldn't it be better to sit quietly and snugly at home and not 'risk the nation's prestige,' as some DOSAAF officials like to say? This is a rather strange notion of prestige! Soviet sportsmen were not afraid to enter the Olympics at Helsinki for the first time —and they did well. Then later at Melbourne and Rome their participation resulted in a genuine triumph for the sports effort of the land of the Soviets.

"But, apparently, in the Central Committee of DOSAAF they reason like this: 'If you don't participate, you get chided a little and, perhaps, may even be praised for your prudence. However, if you participate and, God forbid, you don't come in first, what will happen . . .'

"And, by this reasoning, the fact that we are not accumulating experience in international competition (the USSR's team still has not been represented in the world championships, which have already been held seven times in the postwar period) can only be regarded as a good thing. It will be something that can be brought up as an excuse for not participating once more in 1965.

"The question arises: How long will our sport of gliding be run by people who do not love it ardently?"

Russian Withdrawal

O. K. Antonov disclosed that the real reason a Soviet team failed to participate in the 1960 World Gliding Championships in West Germany was because the USSR's top sports authorities did not think their pilots had time to "master" the new A-15 sailplanes, which had been built for the competition.

When the 1960 championships were held, the Russians said their non-participation was due to "inability to obtain visas in time."

They also protested the use of West German "military aircraft" (25 Do-27s on loan from the German Luftwaffe and army units) for towing purposes (AW July 18, 1960, p. 103).

Russia Boosts An-14 Power and Wingspan

Russia has put more power in its twin-engine An-14 "Pchelka" (Little Bee) light transport. The new AI-14RF radial engines are rated at 300 hp., compared with 260 hp. for the AI-14Rs previously employed in the Antonov craft (AW Jan. 8, p. 48).

Wingspan apparently has also been increased from 65 to 72 ft.

The "Pchelka" has undergone numerous modifications since it was unveiled in 1957. The many changes have greatly delayed its introduction into regular passenger, agricultural and other services.

Aeroflot says a seven-passenger version of the An-14 will have a 600-kg. (1,323-lb.) payload for distances up to 600 km. (373 mi.). For short hops up to 200 km. (124 mi.) the "Pchelka" can carry nine passengers and a 720-kg. (1,587-lb.) payload.

With maximum fuel load and a 550-kg. (1,212-lb.) payload, range can be increased to 720 km. (447 mi.).



THE FLIGHT OF THE HUMMINGBIRD

In the air for the Army a year from go-ahead

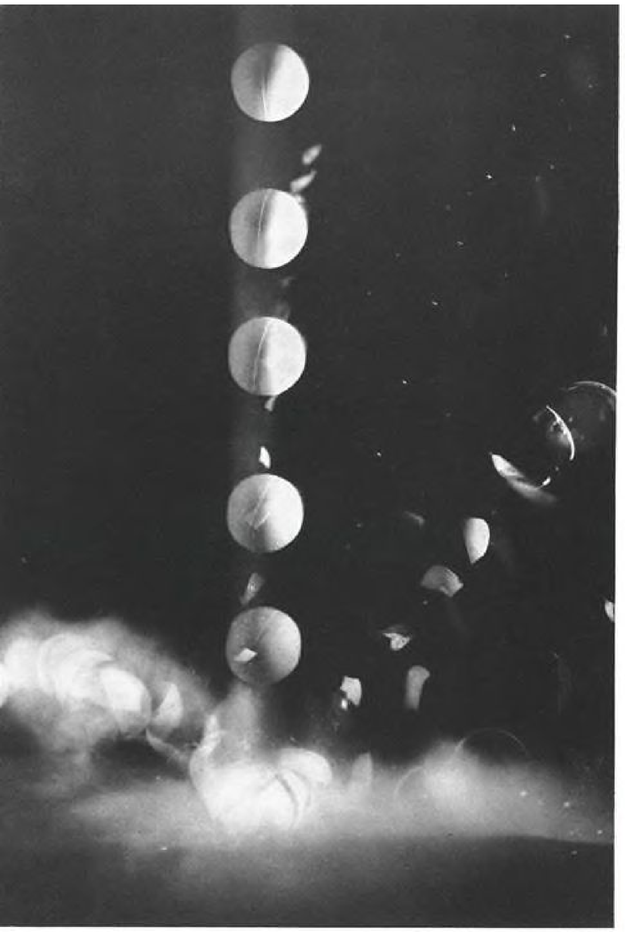
This is the new XV-4A (formerly the VZ-10) Hummingbird now being developed for the U.S. Army Materiel Command by Lockheed-Georgia. It has been flying since July 7, and is progressing successfully in its flight-test program.

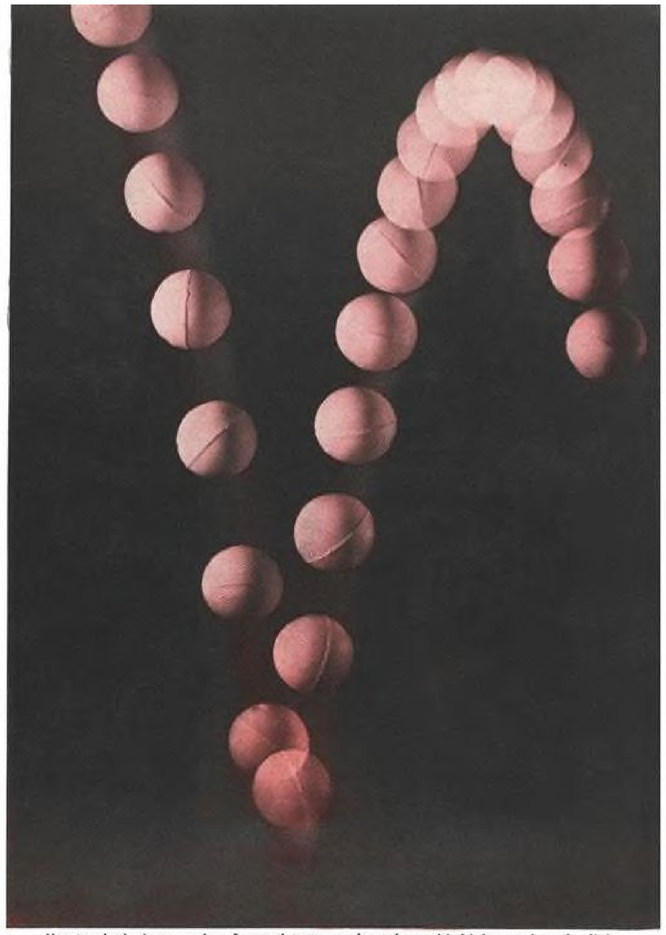
The Hummingbird, as the name suggests, will take off straight up, land straight down, hover, then dart away at speeds up to 500 mph. It combines — with simplicity — the characteristics of a helicopter and a high-speed jet. Mission: to work directly with the troops in performing surveillance and other missions.

The principle of the Hummingbird is a system of ejector mixing chambers in the fuselage, fed by high-velocity exhaust from twin jet engines. In vertical flight, gases are directed downward through bomb-bay-type doors. In conventional flight, these doors are closed and forward thrust is provided in the normal manner.

LOCKHEED-GEORGIA COMPANY

Marietta, Georgia • A Division of Lockheed Aircraft Corporation

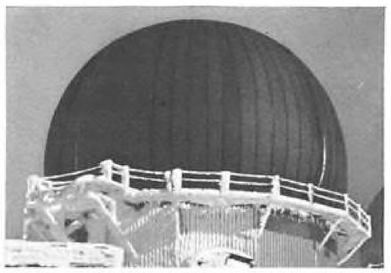




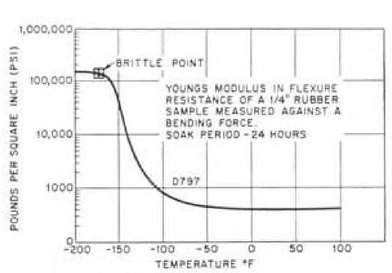
Unretouched photographs of actual test samples taken with high speed strobe light,

At -100°F all rubbers are disappointing except silicone rubber

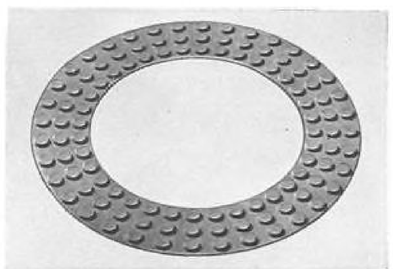
At 100°F below zero, other synthetic elastomers can hardly be tested, yet General Electric silicone rubber maintains excellent properties. For example, at −100°F, silicone rubber can offer elongation of 500%, tear resistance of 300 pi, and tensile strength of 3,000 psi (even better than at room temperature). As a matter of fact, G-E silicone rubber is continually useful at −130°F, and intermittently to −320°F!



Radome covers coated with G-E silicone rubber remain flexible at temperature extremes and provide long term protection for delicate radar. Silicone rubber coating protects against cracking at low temperatures, resists aging and corona.



Young's modulus in flexure test shows low temperature behavior of silicone rubber. Even after soak periods of 24 hours, silicone rubber is still useful below −150°F. Durometer and other properties show relatively little change from normal values.



Silicone rubber pad for liquid oxygen converter absorbs vibration in extreme temperature equipment. A series of impressions help assure uniform and predictable vibration deflection characteristics at temperatures from −65° to 300°F.

For further information on the low and high temperature properties of General Electric silicone rubber, write Section J1283, Silicone Products Dept., General Electric Company, Waterford, New York.

GENERAL ELECTRIC

AFOSR Grants

Air Force Office of Scientific Research grants and contracts recently awarded to universities and non-profit research institutions in the United States and Europe include the following:

GRANTS:

Johns Hopkins University, Baltimore 18, Md.—$65,378 for high resolution studies in the far infrared.

University of Washington, Seattle, Wash.—$30,763 for study of theory of molecular electronic states.

Univ. of Minnesota, Minneapolis 14, Minn.—$24,806 for study of complex formation, ion conjugation, and unusual valence states in acetronitrile.

Univ. of Minnesota, Minneapolis 14, Minn.—$12,928 for study of elimination from B-functional mercurie compounds.

Polytechnic Institute of Brooklyn, Brooklyn, N. Y.—$365,000 for study of fluid mechanical & dynamical problems emanating from hypervelocity flight.

Catholic Univ. of America, Washington 17, D. C.—$7,860 for research on flow separation.

California Inst. of Technology, Pasadena, Calif.—$21,954 for study of viscous effects and heat transfer in separated flows.

Univ. of Southern California, Los Angeles, Calif.—$70,612 for study of problems in rarefied gas dynamics.

Polytechnic Institute of Brooklyn, Brooklyn, N. Y.—$95,302 for study of high frequency rocket motor instability.

Columbia Univ., New York, N. Y.—$126,617 for hydromagnetic plasma research.

Univ. of Utah, Salt Lake City, Utah—$32,064 for study of ignition and burning of solid propellant.

Univ. of Michigan, Ann Arbor, Mich.—$12,666 for research on grammatical analysis.

Univ. of Illinois, Urbana, Ill.—$20,531 for basic study of the semantic and syntactic properties of many-valued and morphogrammatic systems of logic.

Indiana University Foundation Research, Bloomington, Ind.—$20,059 for information structures in linguistics.

Univ. of Montreal, P. O. Box 6128, Montreal, Canada—$38,850 for study of symbolic shorthand system for medical documentation-data phase.

New York Univ., New York, N. Y.—$25,111 for study of pattern analysis of planar geometric configurations.

Univ. of Montreal, Montreal Canada—$16,790 for study of a symbolic shorthand system for medical documentation.

Univ. of Chicago, Chicago, Ill.—$15,958 for investigation in the field of relational biology.

National Academy of Sciences, Washington, D. C.—$5,000, for the 14th international congress of zoology.

Yale Univ., New Haven, Conn.—$16,655 for the comparative study of echolocation in the terrecidae of Madagascar and other Old World insectivores.

Massachusetts Mental Health Research Corp., Boston, 15, Mass.—$62,541 for the investigation of personality attributes of good hypnotic subjects.

Northwestern Univ., Evanston, Ill.— $21,380 to study the simulation of communication and interaction.

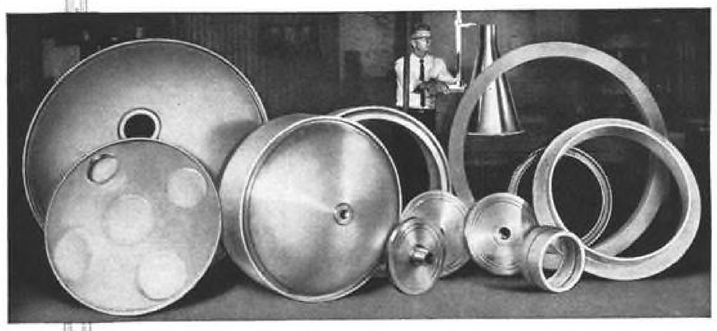
Univ. of Illinois, Urbana, Ill.—$16,347 to carry out research on negotiation and decision-making in complex organizations.

Tufts College, Medford, Mass.—$26,746 for a study of the effects of prolonged unusual stimulus conditions on perceptual discrimination and perceptual-motor performance.

Duke Univ., Durham, N. C.—$24,776 for a study of body and field perceptual dimension and altered sensory environments.

Harvard College, Cambridge, Mass.—$22,440 for study of cross-national measures of attitude change under conditions of modernization.

Univ. of California, Davis, Calif.—$6,482 for study of extrema of igenvalves of vibrating systems.



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These missile, rocket and jet engine components are typical of the many such parts being produced in Taylor Forge plants today.

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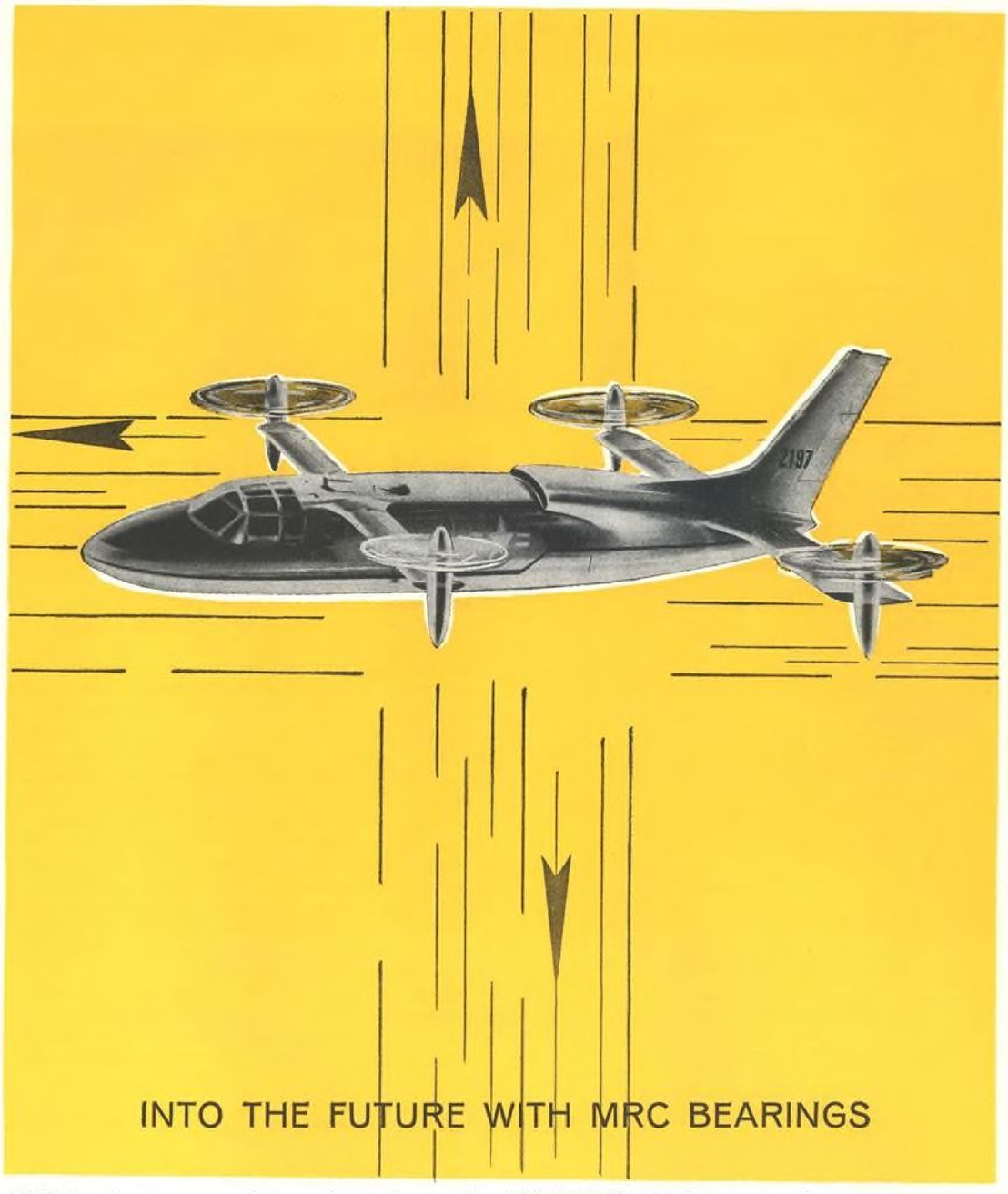
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MRC Bearings are used throughout the Curtiss-Wright X-19 which incorporates a new flight principle — high speed with VTOL capacity. Selected for their reliability and performance, MRC Bearings are used in the gear boxes, twin Lycoming T55 engines, the power transmission system, and the four tilting propellers mounted in nacelles at the wing tips. MRC has worked closely with the aircraft industry since its very beginnings and continues in the development of bearings for the future. **Marlin-Rockwell Corporation, Jamestown, New York.**

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CAB Accident Investigation Report

Missing Safety Wire Caused Electra Crash

On Sept. 17, 1961, at 0857 CDT, a Northwest Airlines, Inc., Lockheed Electra, N 137US, crashed shortly after takeoff from Runway 14R, at O'Hare International Airport, Chicago, Ill. All 32 passengers and the crew of five sustained fatal injuries. The aircraft was totally destroyed by impact and subsequent fire.

Flight 706 originated in Milwaukee, Wis., and was a regularly scheduled flight from Milwaukee to Miami, Fla., with intermediate stops at Chicago, Ill., Tampa, and Fort Lauderdale, Fla. While at O'Hare Airport the aircraft was routinely serviced and checked, and a scheduled crew change was made. At approximately 0855, while taxiing from the ramp, the flight was cleared for takeoff, and shortly thereafter the aircraft departed. Takeoff and initial climb appeared to be normal, but at approximately 200 ft. a shallow turn to the right continued into a gradually increasing bank of about 85 to 90 deg. While in the turn, the crew made a short, garbled transmission indicating alarm. During the latter part of the turn a gradual descent began and, two minutes after takeoff, the aircraft struck the ground.

The Board determines that the probable cause of this accident was a mechanical failure in the aileron primary control system due to an improper replacement of the aileron boost assembly, resulting in a loss of lateral control of the aircraft at an altitude too low to effect recovery.

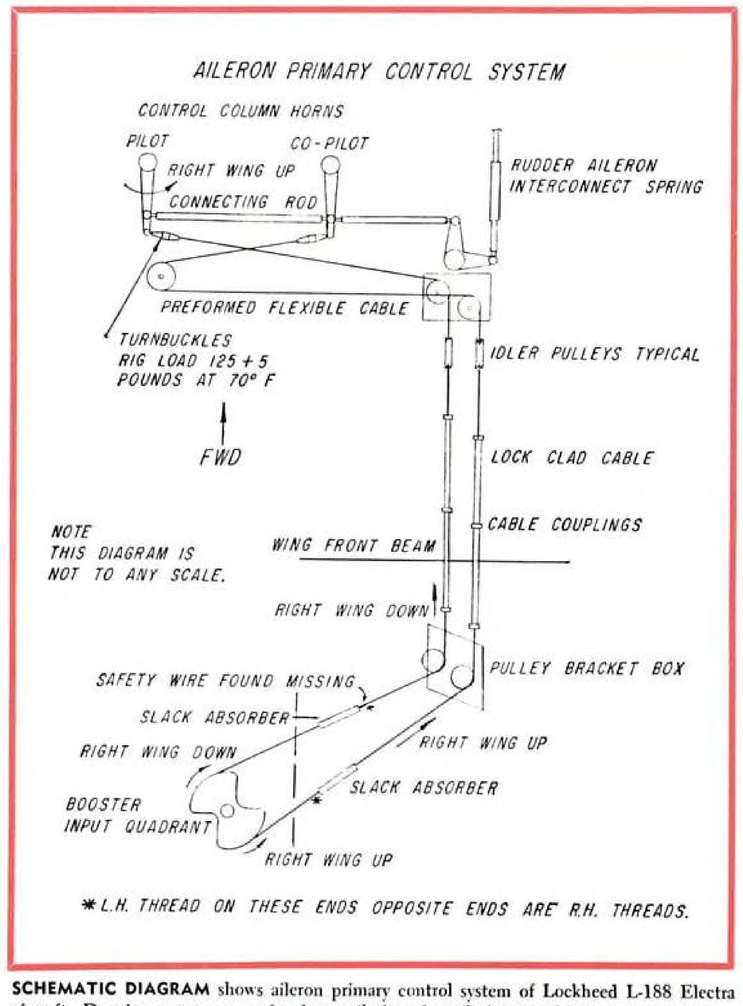
Investigation

Aircraft N 137US, a Northwest Airlines Lockheed Electra, was operated as Flight 711 from Miami to Milwaukee on Sept. 16, 1961, the day before the accident. After a layover in Milwaukee, the same crew which operated N 137US on Sept. 16 originated Flight 706 on the morning of Sept. 17 and flew the aircraft to O'Hare International Airport. Flight 706 was a regularly scheduled operation from Milwaukee to Miami, with intermediate stops at Chicago, Tampa, and Fort Lauderdale. While on the ground at O'Hare Airport the aircraft was given a turnaround check, routine servicing, and a walkaround inspection. A scheduled crew change was made, and the flight was dispatched with the gross weight and center of gravity within prescribed limits.

At approximately 0855,[1] the flight was cleared for takeoff on runway 14R. At this time the aircraft was taxiing on a westerly heading in the runup area adjacent to runway 14R. Flight 706 acknowledged the clearance, while continuing toward the runway, and made a running takeoff. No witnesses were found who observed the actual lift-off. N 137US was observed after lift-off, 3,000 to 4,000 ft. down the runway at an estimated altitude of 50-75 ft. and in a normal climb attitude.

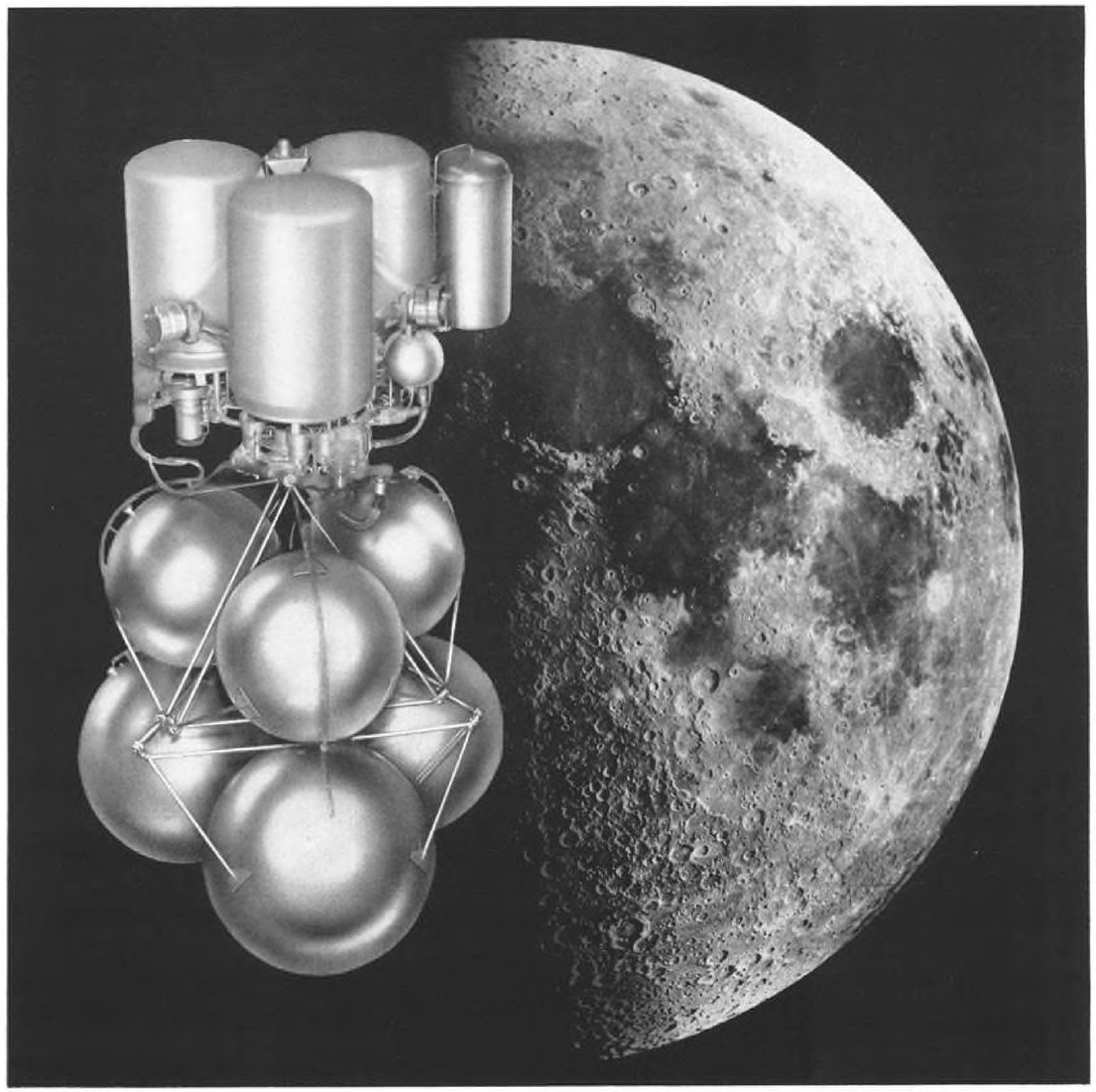
At the 8,000-ft. marker the altitude of the aircraft was estimated to have been approximately 100 ft., which is slightly lower altitude than Electra aircraft normally attain at this point during takeoff. Five witnesses noted a change in engine sound during this portion of the flight. Between the 8,000 and the 9,000-ft. runway marker the aircraft was observed to commence an apparently coordinated right turn with a slowly increasing rate of bank. When the bank angle was 30-45 deg., the crew made a short, garbled transmission. Immediately thereafter, at a bank angle of 50-60 deg., the aircraft began to lose altitude. The maximum altitude attained in the entire turn was 200 to 300 ft.

The right wing near the No. 4 engine struck powerlines adjacent to the Chicago Northwestern Railroad tracks, severing the lines at an angle of about 70 deg. from the horizontal, and causing a bright bluish flash. The aircraft then continued in a direction of about 271 deg. magnetic and, when in a bank of about 85 deg. and a nose-down attitude of about 10 deg., the right wing of the aircraft struck the railroad em-



SCHEMATIC DIAGRAM shows aileron primary control system of Lockheed L-188 Electra aircraft. Drawing, not to any scale, shows pilot's and copilot's control linkage arrangements. Note missing safety wire near booster input quadrant.

[1] All times herein are Central Daylight based on the 24-hr. clock.



A fuel cell for Apollo

This is a model of a fuel cell designed by Pratt & Whitney Aircraft—the company chosen to develop a fuel cell system for Apollo, America's first manned lunar craft. The Apollo spacecraft will be built for NASA by North American Aviation.

The hydrogen-oxygen cell will supply power for environmental conditioning, communication, instrumentation, and scientific equipment. In addition to generating electricity, the fuel cell will provide water for Apollo's three-man crew.

Pratt & Whitney Aircraft's fuel cell is far more efficient than conventional power systems. During tests, cells have demonstrated efficiencies of 70 to 80 per cent.

The fuel cell has a significant role in space. Moreover, it promises to be a significant power source on earth. Pratt & Whitney Aircraft is currently studying fuel cell power systems for such applications as remote-site power, vehicle propulsion, commercial power generation, and other industrial tasks.

Pratt & Whitney Aircraft
DIVISION OF UNITED AIRCRAFT CORP.
EAST HARTFORD, CONN.

bankment. Continuing to roll about its longitudinal axis, the aircraft cartwheeled, the nose crashing into the ground 380 ft. beyond the point of first impact, and landed right side up. It then slid tail first another 820 ft. The aircraft disintegrated throughout its path, and wreckage was strewn over an area 200 ft. wide and 1,200 ft. long. Evidence of ground fire was found at various points along this path.

Impact occurred on airport property about 3,800 ft. abeam and to the right of the end of runway 14R, about 500 ft. north of Irving Park Road. After passing beyond the railroad embankment the aircraft was lost to view by most of the eyewitnesses because of trees and other obstructions. Immediately thereafter a large mushroom of orange-red flame accompanied by heavy black smoke was seen. Time of impact was established as 0857. The aircraft was demolished by impact and fire. All occupants were fatally injured.

The weather at time of takeoff was: sky clear; visibility 6 mi.; smoke and haze; wind south at 8 kt.; temperature 59F; dewpoint 52F; altimeter 30.40.

Runway 14R is 11,600 ft. long. Airport elevation is 667 ft. msl. The Chicago Northwestern Railroad tracks are adjacent to the southwest boundary of the airport. These tracks are on a fill of 40% slope, 20 ft. above the general terrain toward the runway. Each of the two powerlines in front of the fill consists of three heavy wires carrying 38,000 v.

Members of the crew which operated N 137US on its flight just prior to the accident testified that no operational problems were encountered and that no mechanical discrepancies were noted during these flights. The Northwest Airlines crew chief who performed the turnaround check on N 137US after its arrival at O'Hare Airport, and who also accompanied the outgoing flight engineer during a walkaround inspection of the aircraft, testified that it was airworthy prior to its final flight. A review of company and Federal Aviation Agency records showed that all crew members involved were certificated and qualified to operate the Lockheed Electra. Dispatching of Flight 706 was found to have been normal and in accordance with company operating procedures.

Most witnesses indicated that the flaps were down to some degree at takeoff and that the landing gear was retracted after lift-off. All agreed that prior to impact with the powerlines there was no fire or smoke seen. Nothing was observed to separate or fall from the aircraft, no birds were seen in the flight path, and no abrupt pullup or violent maneuver prior to the steep bank was observed.

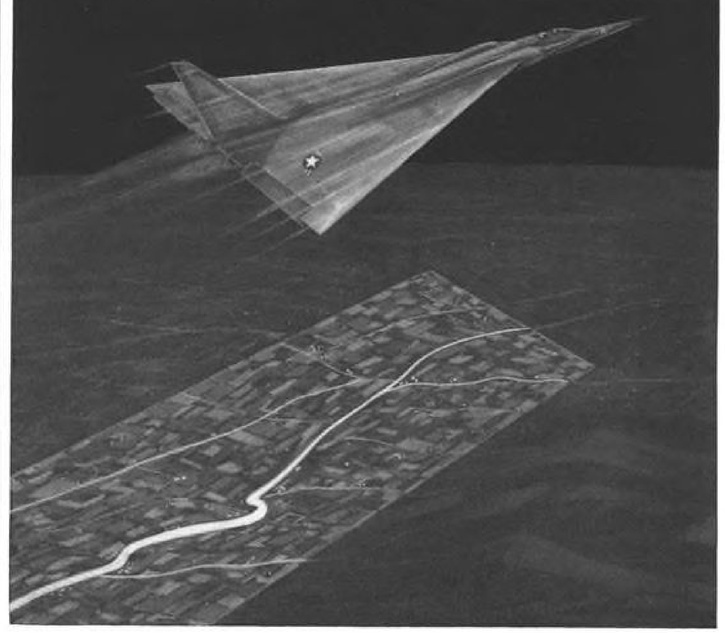
To assist in developing a flight profile based on actual operation of Electra aircraft, tower personnel, at the request of Board investigators, conducted a survey of 44 Electra takeoffs. These takeoffs were sampled at random and were all observed when using runway 14R. The survey disclosed that the average lift-off was made when these aircraft were approximately 4,000 ft. down the runway, and that when they reached the 8,000-ft. marker, their altitude and airspeed indications were about 280 ft. and 158 kt. respectively. The air-

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speed was based on 28 pilot reports given to the tower.

In addition, Lockheed Aircraft Corp., in response to the Board's request, provided a study of the flightpath based both on L-188 performance data and information disclosed during the investigation. Their study encompassed a ground envelope of reported flightpaths but, based on performance data, the inner boundary was considered as the only possible flightpath. Based on the Lockheed study, Board investigators prepared the estimated flightpath chart.

Parts of the flight recorder were found strewn along the entire wreckage path. Due to the forward location of the recorder in the fuselage, high impact loads had cracked and sheared the cast stainless steel magazine and fragmented the record foil contained therein. That part of the foil bearing the record of the final takeoff was not recovered, with the result that no useful information was obtained from the recorder.

Radio Message

Following acknowledgment of takeoff instructions, no further radio transmissions were made by the crew until the aircraft had gone into a steep bank of 30-45 deg. At this time the crew transmitted its last message. The transmission was 7 sec. long, delivered rapidly in a high-pitched voice, and was poor in signal quality. The control tower recording of this communication was studied by the Bell Telephone Laboratories and the Dictaphone Corp. As closely as could be determined it was, "we're in trouble (break) uh and all units holding this is Northwest alert. I still don't have release right turn in no control (intake of breath) (garbled phrase)." The first two words of the garbled phrase may have been "can you?" or "have you?" The garbled phrase was higher in pitch and more rapid than the preceding utterances.

All four engines and propellers had separated from the aircraft and were found along the wreckage path. Fuel and oil samples taken from refueling servicing units which had serviced the aircraft, and from the aircraft prior to takeoff, showed that the proper specifications for engine and propeller operation had been met. The powerplant accessories were examined and bench-tested where possible, but no evidence of operational distress was noted. There was no evidence of operational distress in the lubrication and scavenge systems of any engine, and the compressor and turbine bearings were adequately lubricated. All fuel pumps were in good condition. Complete powerplant assembly, as well as propeller slashes along the ground, revealed that the engines were all rotating at impact. The readings obtained from torquemeter, turbine inlet temperature, and phase detector indicators[2] were unreliable in definitely establishing engine power, as they did not correlate with each other or with the propeller blade angles at impact. However, these readings did confirm that the engines were operating. The propeller blade angle for all propellers was in a range compatible with the flight idle position, and was the most reliable indication of the operating characteristics of the engines at impact.

Investigation of that part of the electrical system which remained after impact and subsequent fire revealed no indication of loss of electrical power during flight. Examination of the rudder, elevator, and wing flap systems showed no signs of failure or malfunctions, and that upon impact the flaps were in takeoff position, elevator trim tab set at 10 deg. nose-up, and rudder tab at 0 deg. Actual position of the aileron trim tab could not be determined, but the aileron trim cockpit control was positioned at 0 deg. All landing gear was in the retracted position.

Some of the flight instruments were recovered but most were damaged to such an extent that no useful information could be determined. One instrument, the Captain's artificial horizon, indicated that it was receiving a signal of 90-100 deg. right bank at the time it ceased to function.

Boost Units

Although it could not be definitely determined whether the autopilot engagement switch was on or off, several arced leads were found in the autopilot circuitry indicating the presence of electrical energy at impact. However, the autopilot engagement pistons in all three control surface booster units were found in the "off" position. The autopilot was placarded "inoperative" by the carrier pending performance of a required modification.

The rudder and elevator boost units were found in the "engaged" position; the aileron boost unit was found in the "disengaged" position. However, because of the possibility of cables pulled due to break-up forces, it could not be determined to what position the boost unit controls had been actuated by the crew prior to impact. The aileron boost unit which had received external fire and over-all impact damage was given a complete disassembly and inspection at the Lockheed Aircraft Corp., Burbank, Calif., under Board supervision.

Measurements of the actuating piston, which had seized in the cylinder due to fire damage, represented a flight control movement of right wing down. After replacement of all fire damaged O rings, seals, and the cylinder, the unit was reassembled from the remaining original parts and operated in a satisfactory manner. The rudder and elevator boost units, which were not so extensively damaged, were also functionally tested and found capable of normal operation. No evidence was found in any of the boost units to indicate that a malfunction had occurred prior to impact. Hydraulic fluid samples taken from the boost units did not reveal any significant findings.

Components of the aileron primary control system, from the aileron boost unit to the ailerons, were damaged and broken in numerous places. Nevertheless, examination of this part of the aileron primary control system disclosed no evidence of any malfunction or failure prior to impact. However, impact marks made on the inboard closing rib of the right aileron indicated that the right aileron was deflected upward three degrees, corresponding to a flight control position of right wing down.

From the aileron boost unit's input quadrant to both control wheels, the aileron primary control system consists of two cables which run through a series of pulleys to the control wheels, forming a closed loop. The cable which connects to the pilot's control horn is in tension for a right wing down control movement and the cable which connects to the copilot's control horn is in tension for a left wing down movement.[3] These cables provide a signal input from the control wheels to the boost unit when the boost is engaged, and they also provide the physical link between the control wheels and the ailerons for manual operation when the boost in disengaged.

The pilot's cable run starts with a 153.-53-in. run of flexible cable routed athwartship to a pulley at Butt Line 34R, Water Line 128.5. From here, the cable consists of two consecutive 205-in. lengths of lockclad cables which run aft and down to a point just in front of a pulley bracket at Fuselage Station No. 651. A 39.25-in. flexible cable then joins the lockclad and passes through a 0.6-in. diameter guide hole in the front of the pulley bracket at Fuselage Station No. 651 and connects by a left-hand threaded stainless steel connector 4.2 in. long into the forward brass terminal block of a slack absorber unit. Proceeding from the aft brass terminal block of the slack absorber is a stainless steel, right-hand threaded connector attaching to a 42.01-in. length of flexible cable with a swaged ball fitting at the end which connects on the aileron boost input quadrant.

The copilot's cable is routed athwartship with a 200.34-in. length of flexible cable to a pulley at Butt Line 16.7L and then returned to the right side to a pulley at Butt Line 35R, Fuselage Station No. 127, and Water Line 132. From here aft, the run consists of lockclad cables identical with and parallel to the pilot's cable, and approximately an inch outboard. Just in front of the pulley bracket at Fuselage Station No.

[2] The relatively slow, progressive disintegration which occurred in this accident makes it impossible to assess the in-flight significance of instrument readings which might otherwise be reliable.

[3] These cables will hereinafter be referred to as the pilot's and copilot's cables, or as right wing down and left wing down cables, respectively.



Recorder Camera

Camera with 127-mm. lens set at f.11 and ½ sec. photographs tapes used in in-flight recorders on commercial aircraft. Developed by United Air Lines Engineer Evan Jensen, camera keeps running log of aircraft's altitude, heading and g-force.





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This simple announcement covers one of the greatest communications achievements in history. The Blaw-Knox antenna at Goldstone is catching a 0.00000000000000000001 watt signal from the Mariner II vehicle 37,000,000 miles out in space. Designed and built by Blaw-Knox for Cal Tech's Jet Propulsion Laboratory, the 85′ parabolic dish involved extremely accurate fabrication using heavy structural members. The 240-ton rotating element is capable of pointing within 0.01 degree of arc. □ Goldstone, White Alice and DEW Line exemplify the many types and sizes of antennas for radar, missile tracking, tropospheric scatter and space communications made by Blaw-Knox, the company with advanced concepts in antenna designs. Advanced Products Division, Blaw-Knox Company, 300 Sixth Ave., Pittsburgh 22, Pa.

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MOTOROLA
Military Electronics Division

SCOTTSDALE, Arizona, 8201 East McDowell Road
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Royal Navy Westland Wasp Makes First Flight

First flight of the Westland Wasp turbine-powered helicopter for British Royal Navy is shown on its first flight from Westland's Fairey Division airport at White Waltham, England. Helicopter is powered by a Bristol-Siddeley Nimbus Mk. 103 engine of 1,050 shp., torque-limited to 710 shp. Wasp is a naval version of the Westland Scout and features new four-wheel landing gear and folding tail for ship-board storage. Bulge on door is to accommodate a stretcher placed across the cabin section.

651, a 43.75-in. flexible cable connects to the lockclad and passes through a 0.6-in. diameter guide hole in the front of the pulley bracket approximately 1 in. to the right and ¼ in. below the pilot's flexible cable guide hole. After this, it joins a slack absorber unit with identical stainless steel fittings as on the pilot's side except that the forward one is right-hand threaded, and the rear, left-hand threaded. A 28.88-in. flexible cable with a swaged ball on the end connects the cable to the aileron boost input quadrant. Position of the copilot's control wheel at impact could not be determined, but the pilot's control wheel broke in a forward direction and was positioned about 90 deg. to the left, calling for almost full left wing down.

Safety Wire

Between the pilot's control column horn and the aileron boost input quadrant, all recovered cable connections were found to be normal except for the threaded connector of the slack absorber forward terminal block. This connector was found unsafetied and was backed out of the terminal block, showing five to seven threads for a 0.40-to 0.45-in. engagement.[4]

The forward connector should be safetied with steel wire exactly like the aft connector. Distinctive lines on the surface of the slack absorber's aft connector showed where safety wire had shielded these surfaces from fire and soot. In contrast, no such distinctive lines could be found on the forward connector in question. Laboratory examination by the National Bureau of Standards and the Federal Bureau of Investigation revealed no evidence of safety wire having been recently installed on this connector.

The copilot's slack absorber unit, the flexible cables on either end of it, and the rear section of the two 205-in. runs of lockclad cable were never recovered from the wreckage. Indentations were found about the guide hole of the still-intact Fuselage Station No. 651 pulley bracket. This guide hole, through which the copilot's 43.75-in. length of flexible cable passes, is 0.6-in. in diameter. The slack absorber terminal block is too large to pass through the guide hole in a forward direction, and the lockclad collar is too large to pass through the guide hole in an aft direction. These indentations about the guide hole indicate that some object passed through it in a forward direction.

In order to explore the possibility that wing flap interference with the aileron control surface may have been a cause of the accident, the Board requested Lockheed Aircraft Corp. to perform certain ground tests. With Board investigators participating, tests were conducted to measure the amount of interference between flaps and aileron (with simulated airloads applied to the flap, and the outboard flap jackscrew removed), and to determine the amount of pilot force required to overcome such interference with aileron boost both engaged and disengaged. With boost engaged it was found that the exertion to overcome the interference was similar to normal deflections. With boost disengaged, a force of about 550 in./lb., applied and measured at the control wheel, was required to force the aileron past the flaps. The force required was well within the capability of a pilot to exert.

Lockheed Aircraft Corp. performed another ground test, the results of which were made a part of the investigation. Because of a suspected failure in the system, this test was made to determine the ultimate load required to fail a portoin of the aileron boost input cable system. Loads were applied to the aileron primary control system and increased progressively to 2,000 lb., at which time the flexible cable itself failed in tension at a point between the pulley bracket assembly and the slack absorber. Examination revealed no failures, thread stripping or deformations of associated cable assembly brackets, pulleys, connectors, etc.

Tests Performed

It has long been accepted that a flexible cable, as used in the aileron primary control system, has a tendency to unscrew from a connector. The National Bureau of Standards, in 1941, conducted tests which showed not only that a cable would unscrew from a connector, but that it could exert enough torsional force to actually break the soft brass, cadmium-plated safety wire then in use by the aircraft industry. After breaking the safety wire, the connector would spin free of the turnbuckle. Nevertheless, in order to verify the existence or non-existence of this tendency in the L-188 aileron primary control system, the Lockheed Aircraft Corp. conducted certain tests, the results of which were also received into evidence. Using cable and slack absorber parts identical to those installed in the copilot's side of the system, with vibration applied to simulate flight conditions, and without safety wire installed, it was demonstrated

[4] The slack absorber is normally installed as a turnbuckle with both connectors engaged equally to a depth of 1.2 to 1.55 in. with no threads showing. Cables in the system are rigged to 125 (±5) lb. tension at 70 F.



VENUS CALLING: MESSAGE 1

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that the cable had a natural tendency to, and did, unscrew from its fitting.

Still another ground test performed at Lockheed Aircraft Corporation and witnessed by Board investigators was one which simulated failure of the left wing down aileron cable in an Electra aircraft. With hydraulic pressure applied, boost engaged, and ailerons in neutral, the cable, identical to the aileron cable missing from the wreckage of N 137US, was severed with a pair of cutters. The person holding the control wheel felt only a slight pulse when the cable was cut and was not otherwise aware of what had occurred. When the cable severed, an immediate signal was imparted to the boost input calling for right wing down. Measurements showed that the trailing edge of the aileron had moved six inches above its normally faired position. When the control wheel was then moved to the left wing down position, the slack in the left wing down cable caused the cable connectors to hang up on aircraft structure.

A review of the manufacturer's records showed that N 137US was manufactured June 14, 1960; that the Lockheed Electra Action Program, a major structural modification, was completed January 31, 1961, and that its final acceptance flight was performed June 21, 1961.

On June 22, 1961, the airplane was delivered without discrepancies to Northwest Airlines, Inc., and was placed into service on the same date.

Aileron Trouble

From June 27 to July 11, 1961, eight aileron control discrepancies were entered in the aircraft logs of N 137US. Most of these discrepancies reported: sluggish feel in aileron boost; delayed reaction in aileron boost; sticking or binding of aileron boost; boost pulses in aileron controls at all speeds; ailerons erratic at all speeds. Although two pilot writeups indicated the need for an in-flight check, examination of the records failed to disclose that an in-flight maintenance check was made. In one instance the pilot entered the remark ". . . OK on ground;" the corrective action entered in the log was, "checked aileron linkages & surfaces for clearance with flaps extended & found O.K. for further observation." In the other instance the pilot writeup was ". . . unable to feel on the ground—only in-flight condition;" the corrective action shown in the log was, "checked ail. sys. & boost package OK for further observation." Most of the corrective actions recorded indicated the performance of ground checks; one entry showed replacement of the boost valve and hydraulic filters; but one log carried only the barren entry, "noted." During this period of time the aircraft continued to be dispatched on a total of 29 flights.

On July 11, 1961, the aircraft was placed in the Northwest Airlines maintenance facility at Minneapolis, Minn., to undergo a layover check. Since the aileron control difficulty was still manifesting itself, it was decided to also replace the aileron boost assembly. Concerning the latter task, the then current company maintenance policies required that the Lockheed Electra maintenance manual, which prescribed the steps for the removal and replacement of the aileron boost assembly, be followed by those performing the work.

A Northwest Airlines maintenance manual required that red Unit Inoperative Tags, Forms OM-249, be attached to pertinent cockpit controls. The purpose of this requirement was to prevent operation of controls when such action is undesirable or dangerous during the performance of various maintenance operations, and to prevent release of an aircraft for dispatch when uncompleted work remains in an inconspicuous place. This directive also prescribed that upon completion of the task, provided it has been satisfactorily performed, an inspector will sign the tag and remove it from the aircraft. A quotation from this directive emphatically stated *"under NO circumstances shall the tags be removed from the aircraft before they are properly signed by an Inspector."* The directive further required that a record of the use of the red Unit Inoperative Tag be transcribed to a more permanent type of work control card to which the red tag must be stapled.

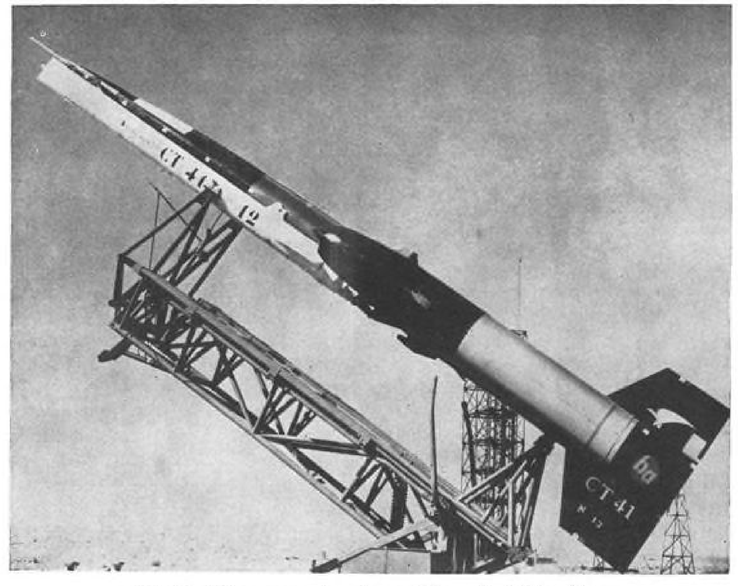
A separate section of the carrier's maintenance manual, specifically highlighting the possibility of incompleted work overlapping a shift change, required the use of the Unit Inoperative Tag when removing safety wire from turnbuckles in all control cable systems.

An interoffice memorandum dated June 21, 1957, signed by the Chief Mechanic and the Senior Supervising Inspector, constituted an important company policy in effect during July 1961. Paragraph 1A of this memorandum required that when a flight control is changed or removed and reinstalled on a "service" check, an inspector follow up on the installation and sign for it in the log book. Because an aileron boost assembly is a major component of a flight control, it is evident that this paragraph governed followup responsibility for the aileron boost unit change in question. However, paragraph 1D of the memorandum stated that, at the request of the Foreman or Crew Chief, the Inspector will inspect any unit replacements and sign for the inspection in the log book, and that the Foreman will be responsible for advising the Lead Inspector of any major units, not called out in paragraph 1A, which should be followed up by inspection. Most of the Northwest Airlines line maintenance and inspection officials who testified, indicated that the requirements of paragraph 1D constituted the governing policy which should have been followed during the aileron boost unit change on N 137US. Testimony at the public hearing further disclosed that in actual practice mechanics were also permitted to call for an inspection.

Boost Change

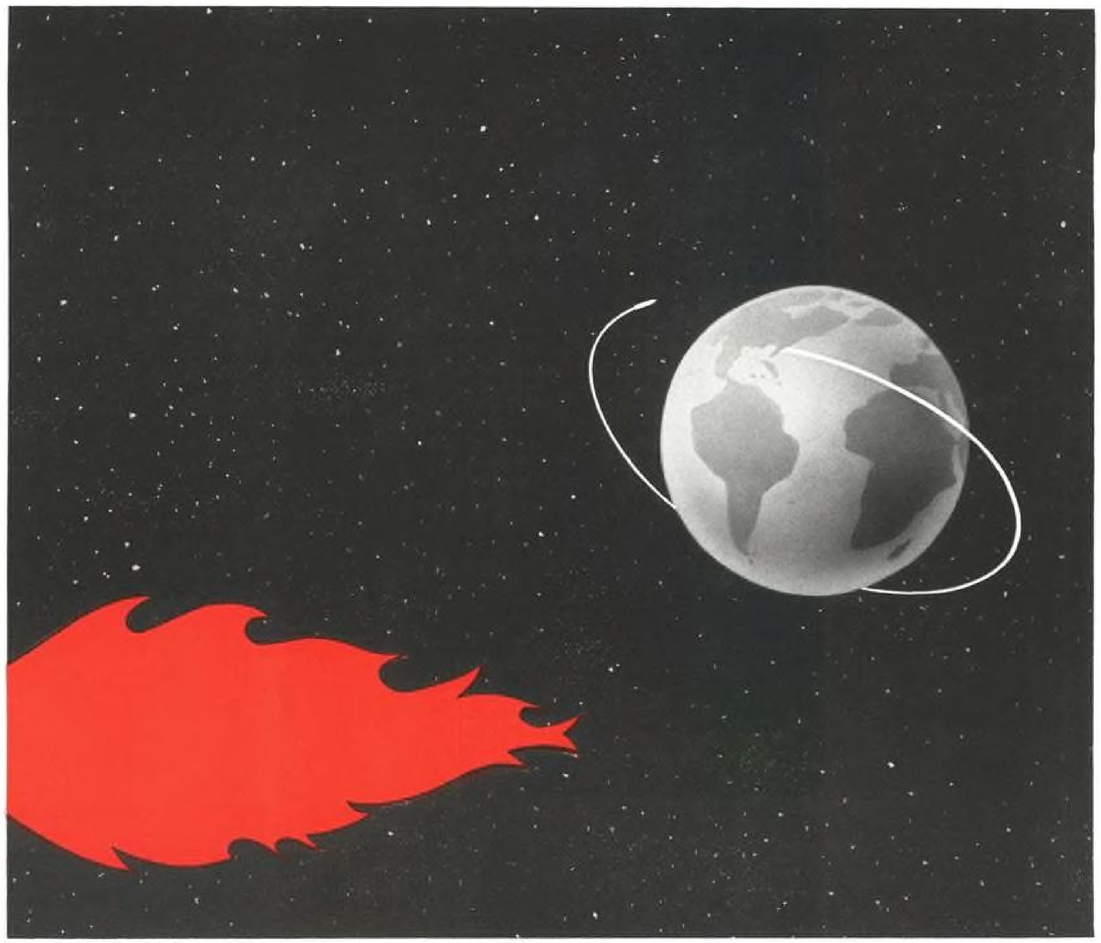
This particular aileron boost unit change on N 137US was the first such job to be performed on an Electra aircraft by the carrier's line maintenance personnel principally involved. The foreman who supervised the unit removal testified that he believed this was the first boost package change in which line maintenance was involved. During July, 1961, three shifts were operated throughout each 24-hr. period: Shift 1, from 6:30 a.m. until 2:30 p.m.; Shift 2, 2:30 p.m. until 10:30 p.m., and Shift 3, from 10:30 p.m. until 6:30 a.m.

Removal of the malfunctioning aileron boost unit was accomplished by two mechanics of Shift 2 on the night of July 11. One mechanic was occupied with other aircraft during most of the shift and worked on the unit removal only during his spare time; the other mechanic performed most of the removal work. Both testified that



Bell Demonstrates Nord Missile

Nord Aviation CT-41 supersonic target missile will be demonstrated to U.S. Navy by Bell Aerosystems Co. under a $1.7-million Navy contract. Bell will purchase six CT-41s from Nord in France and fly them at the Pacific Missile Range in California. Demonstration and evaluation flight will begin in April.



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they followed the manual prescribing the steps to be followed in removing the unit. However, upon further questioning, the mechanic who did most of the work admitted that he did not follow the manual exactly step by step. In accomplishing his task he removed the safety wires from the connectors at the forward ends of the pilot's and copilot's slack absorber units and unscrewed them to relieve cable tension, thereby facilitating the removal of the boost unit. This was done in accordance with the instructions contained in the Lockheed Electra maintenance manual. One mechanic stated that he definitely recalled having seen red Unit Inoperative Tags fastened around the control column and on the hydraulic pump switch, but neither mechanic remembered who had installed these tags. No inspectors were called to inspect the disassembly work as no inspection was necessary at this stage of the work. By the end of Shift 2 the aileron boost unit had been completely removed from the aircraft and placed on the floor of the hangar. That any information concerning the removal of safety wires and loosening of cable tension was passed on to the succeeding shift could not be conclusively determined from these two mechanics.

Installation of the new aileron boost unit was performed by two mechanics on Shift 3 during the night of July 11-12. Testimony established that neither mechanic had followed the manual step by step, referring to it only when a problem was encountered, and that neither had read the removal instructions to determine what components had been unsafetied, disconnected, or rendered inoperative in the removal of the boost unit. Step (10) of the Lockheed maintenance manual removal instructions states, "Loosen turnbuckles at cable slack absorbers near aileron booster assembly in aileron input control cable runs to provide enough slack in cables to permit removing input quadrant. Access to turnbuckles is at Station 654-673 through floor opening." When asked if they had read this part of the manual, they both answered in the negative. Both were also asked if they had read and complied with step (19) of the Lockheed reinstallation instructions which states, "Rig aileron input control cable system, aileron boost shift cable system, and aileron emergency cylinder disconnect cable. Refer to 27-2-0 and 27-5-12 (AA only) for rigging procedures." They both testified that they had not. As a result, neither of the two mechanics tightened the cable tension which had been slackened during removal, nor did they replace any safety wires which had been removed during the previous shift.

Although both mechanics testified that they checked each other's work after completion of the installation, neither one could recall having made a specific check to insure that the previously loosened cable connectors were properly threaded into the slack absorber terminal blocks, the cable tension checked, or the connectors resafetied.

The mechanics did not call for an inspector to check the installation at any stage of their work, and they could not remember having seen an inspector performing an inspection of the unit installation during their shift. After completing the installation and performing an operational check of the unit, both mechanics signed off the aileron boost assembly change as completed in the aircraft log. Neither mechanic could recall having removed any red Unit Inoperative Tags from the aircraft. Their crew chief, who also had not read the manual for this job, then made a cursory inspection of the work, performed an additional operational check of the controls and signed off the job as completed in the aircraft log. Although the crew chief believed that he had done so, he could not positively recall having requested an inspector to inspect the installation, and he could not remember having seen or removed any Unit Inoperative Tags. Testimony of the two mechanics and their chief indicated that the unit change was completed near the end of their shift and that they did not pass any information concerning the unit change to the next shift, Shift 1.

The Shift 2 Foreman testified that he went to the aircraft twice to check on the progress of the aileron boost removal, but that he did not actually check the work itself. He could not recall having directed the use of the manual in the removal task. He could not say whether or not red inoperative tags were used on the job as required. During the shift he called the lead inspector to check the taper pin on the input bellcrank of the new boost unit, which had been drawn from stock, and then sent the unit to the hydraulic shop for a change of taper pin. At shift change the Shift 2 Foreman verbally informed the Shift 3 Foreman about the completion of the unit removal and the taper pin change. The Shift 2 Crew Chief, who assigned the mechanics to the removal task, testified that he was told that red tags were used, but that he did not so direct or personally ascertain their use; that from his observation of the mechanics' work the manual was closely followed; that he did not observe the entire removal operation, and that much of his time was occupied with work on other aircraft.

The Shift 3 Foreman testified that he supervised the unit installation through the crew chief, visiting the aircraft three or four times to discuss such problems as were encountered but that at no time did he enter the cockpit, cabin or center section to check on the work itself. He did not recall seeing any red tags. Because the crew chief is authorized to do so, the foreman stated that he did not call for an inspector and did not order the crew chief to do so. He stated that at the end of the shift the aircraft was ready, and that the following shift was informed as to its availability for test flight.

The aileron boost change for N 137US was entered in the Inspection Activity Reports for both Shifts 2 and 3, but none of the inspectors of these shifts made any effort to determine if and when an inspection would be due. The Shift 1 Inspection Activity Report no longer carried the boost change entry, even though there were no entries on the previous Inspection Activity Reports indicating that the work had been inspected. No evidence was found to indicate that the status of the work was passed on to any Shift 1 Inspector. Although the Shift 1 Lead Inspector noted the entries concerning the aileron boost change on the previous shifts' Inspection Activity Reports, he could give no satisfactory explanation as to why he did not carry the entry over into his own shift activity report, nor could he positively recall having discussed the matter with anyone. All inspection personnel involved indicated that they had placed entire reliance upon the company policy which required line maintenance personnel to notify the Inspection Department of the need to inspect the aileron boost installation. The evidence shows that inspectors were never called, that inspectors did not on their own initiative investigate the status of the job, and that they did not make such an inspection.

On the morning of July 12 when Shift 1 reported for work, N 137US was rolled out of the hangar and prepared for a test flight. The aircraft log at this time reflected the following entries: the aileron booster assembly change signed off by the two Shift 3 mechanics and their crew chief, a layover check completed, a preflight completed, and past log entries examined. An inspector's signature did not appear on any part of the log. After reviewing the log, the Shift 1 Crew Chief then signed the "Released for Flight" block. He testified that when reviewing the log entries he assumed that the aileron boost change had been properly signed off and inspected. He also stated that the red tags had been removed from the cockpit and the pink cards, which serve as a permanent record of the use of the red tags, were on a desk near the front of the airplane. Although a search of aircraft records was made, no evidence of the use of these tags was ever found. The Shift 1 Crew Chief could not satisfactorily explain why he had released the aircraft for flight without the



Soviets Launch Large Hovercraft

Soviet hovercraft Neva, named after Russian river, has been launched by USSR Ministry of River Transport after design by Leningrad Institute of Water Transport. Craft has speed of about 40 mph. and carries 38 passengers. First flight occurred in September.

appearance of an inspector's signature opposite the aileron boost change entry on the log sheet.

The aircraft was flown on a test flight on July 12, 1961. After the test flight, a minor discrepancy concerning the aileron boost disconnect indicating light was entered in the aircraft log, but was signed off as satisfactory. No subsequent aileron system discrepancies appeared in the aircraft logs of N 137US.

Testimony received at the public hearing indicated that formal training of personnel in the maintenance of Lockheed Electra aircraft had been sporadic and that no training had been given in flight control systems. Formal training of the two mechanics who removed the aileron boost assembly consisted of three days of air conditioning for one, and five days of powerplants and propellers for the other. One of the two mechanics who installed the new boost unit had not received any formal training. Although an active on-the-job training program existed, with designated instructor personnel available for consultation concerning unfamiliar tasks, this program was not utilized during the aileron boost unit change despite the fact that this was the first time any of the Northwest personnel involved had ever performed such an operation.

Analysis and Conclusions

It was determined that the flight was properly dispatched, the flight crew was qualified, takeoff gross weight and center of gravity were within prescribed limits, and weather was not a factor.

The change in engine sounds heard by several witnesses during a portion of the flight is attributed to an intentional and routine power reduction following lift-off. Examination of the powerplants disclosed that all four engines were capable of normal operation at impact. The most reliable evidence which indicated that operating characteristics of the engines at impact was that the blades angles for all propellers were in a range compatible with flight idle. It appears reasonable to assume that the pilot, upon realizing that a crash was imminent, abruptly reduced power shortly before impact.

The possibility of flaps interfering with the ailerons was investigated as a possible causative factor. However, tests proved that physical interference between the flaps and the ailerons could have been overcome by pilot control forces. Investigative findings also indicated that the rudder, elevator, and aileron trim tabs were positioned at their proper setting at impact. It is therefore believed that none of these factors contributed to the cause of the accident.

The investigation disclosed that there was electrical power on the Priority A bus at impact. It was further found that the electrical load had been transferred from the No. 3 to the No. 4 alternator, the standby alternator which was carrying the load for this bus. The reason for such a transfer could not be determined. However, numerous indications were found that electrical power was available in both A and B buses up to the time of impact. Therefore, it is reasonable to conclude that a loss of electrical power was not a causative factor in this accident.

Electrical energy was present in certain electrical circuits within the autopilot at impact, showing that this equipment was energized at the time. Although the autopilot switch was placarded as "inoperative," it was not guarded and could have been inadvertently turned on. If turned on, the reaction of the aircraft would have been governed by the setting of the autopilot indices at the time of turn on. However, since the autopilot can be easily overpowered or readily turned off by the pilot, it is unrealistic to believe that accidental or intentional actuation of the autopilot switch contributed to the accident. It is also possible that the autopilot circuitry became energized during the initial stages of the aircraft's breakup.

Examination of the rudder, elevator, and aileron boost units disclosed that each of these units was capable of normal operation at impact. The rudder and elevator boost units were recovered with the disengage mechanism in the boost-engaged position, but the aileron boost unit was found in the booster-disengage position. Although this condition could have resulted from aircraft breakup forces, it does not appear probable, and the Board concludes that the aileron boost was disengaged by the crew at some time prior to impact.

Hydraulic power was used to retract the landing gear, and electrical energy to sustain hydraulic power was available up to impact. The fact that the rudder and elevator boost units were engaged and the aileron boost unit was disengaged, indicates that hydraulic pressure was available to operate all flight control boost units, and that the crew was not experiencing difficulty with either the rudder or elevator controls. However, these facts do indicate that the crew was having some type of aileron control difficulty and had disengaged the aileron boost unit in an attempt to solve the problem.

Shortly after takeoff the aircraft developed a rolling moment to the right which could not be controlled by the crew. Although the part of the crew's last transmission which stated, "I still don't have release right turn in no control" was uttered without a break, the Board believes that the first part, "I still don't have release" indicates an unsuccessful attempt by the crew to control the rolling moment manually by disconnecting the aileron boost, and that the second portion, "right turn no control" indicates a lack of control response.

The evidence indicates that the loss of aileron control experienced by the crew was the result of a disconnect in the aileron primary control system between the pilot's control wheel and the aileron boost input quadrant. Specifically, this disconnect occurred in the left wing down cable when the cable connector became completely unscrewed from the forward terminal block of the slack absorber. A discussion of this control system failure is given in succeeding paragraphs.

Measurements of the main actuating cylinder of the aileron boost unit represented a right wing down control movement. Marks made on the inboard closing rib of the right aileron indicated an aileron displacement corresponding to right wing down. However, the pilot's control wheel was positioned for a full left wing down aileron movement. These findings indicate that the pilot was attempting to recover from a right wing down condition, but that the ailerons were not responding.

A previous description of the aileron primary control system showed that between the pilot's and copilot's control wheels and the aileron boost input quadrant, two cables run through a series of pulleys to the boost input quadrant, forming a closed loop; that the pilot's cable is in tension for a right wing down movement and the copilot's cable is in tension for a left wing down movement; and that these cables respond to movement of the control wheels either in the boost-energies or the boost-disengaged condition. Furthermore, it has been established that if a disconnect or failure in either cable occurs, a loss in aileron control will result. It has also been shown that if a sudden disconnect or failure occurs in the copilot's cable, the rigging tension in the pilot's cable will displace the boost input quadrant, thereby imparting a signal to the aileron boost unit for a right wing down movement.

As previously indicated, examination of the aileron primary control system revealed that the right wing down cable connector which screws into the forward terminal block of the pilot's slack absorber unit was not secured with safety wire and was unscrewed to an engagement of only 0.40 to 0.45 in. (normal engagement, 1.2 to 1.45 in.). This condition can be attributed to either the natural tendency of an unsafetied cable to unwind or that this was the position to which the connector was unscrewed during the aileron boost unit change. The pilot's cable was still threaded through its pulley bracket guide hole, but the copilot's corresponding left wing down cable, connector, and slack absorber were missing and could not be found. In addition, the copilot's pulley bracket guide hole showed marks of a pronounced indentation, indicating that some object had passed through it in a forward direction. These marks closely matched the shoulder of a swaged cable connector.

System Failure

The pilot's and the copilot's cables run parallel to each other and pass through their respective guide holes in the pulley bracket. Each guide hole is 0.6 in. in diameter. The slack absorber terminal block is too large to be pulled forward through such a hole and the parted end of a flexible cable is not capable of making an indentation in the guide hole such as was found. The only object capable of making these marks, and which would also permit the missing copilot's cable to pass through the pulley bracket, was the connector on the aft end of the flexible cable which joins the forward terminal block of the slack absorber. Load tests have proved that failure in a cable and swaged connector system first occurs in the flexible cable itself, without any damage whatsoever to cable connectors and other components of the system. Other tests have proved also the natural tendency of a flexible cable to unscrew from its fitting when not secured to it by safety wire. This evidence indicates that the copilot's flexible cable connector completely disengaged from the slack absorber between the time the aircraft started its right turn and the time it crashed.

As previously mentioned, when the copilot's cable is suddenly separated the resulting tension on the right wing down cable imparts an immediate signal to the aileron boost unit for a right wing down control movement. These tests also disclosed that if the forces on the boost quadrant were released, the propensity of the system would be to return the ailerons to neutral in approximately seven seconds, provided no part of the system hangs up or binds. However, the tests involving cable separation further showed a tendency of the cable connectors between the forward flexible cables and the lockclad cables to bind with airfame structure. Because of the mechanical advantage of the system, only a small hang-up force would hold against inflight airloads and would prevent the ailerons boost unit from returning to the neutral position.

In this accident, it is believed that the left wing down cable did separate. With the left wing down cable separated it was not possible for the pilot to apply opposite aileron to bring the right wing up. Then, if the cable connector did hang up, the ailerons would not have returned to neutral, worsening an already unmanageable situation. Since witnesses observed the bank to the right to increase steadily, and since the right aileron was found in a position of right wing down, there is further reason to conclude that the cable stuck in the right wing down position somewhere within the aileron control system. Other recovery techniques such as use of rudder, asymmetrical power, and aileron tabs might have been effective in overcoming the steepening bank, had sufficient altitude been available.

The investigation disclosed that the aileron boost unit on N 137US was changed during two workshifts on July 11 and 12, 1961, approximately 65 days before the accident. A discussion of how this unit was changed and what effect the unit change had on the accident follows:

Since this aileron boost unit change was the first such task to be performed by the line maintenance personnel involved, it was important that the maintenance manual prescribing the steps to be followed in changing the unit be followed step by step. Despite its importance, however, the testimony revealed that this was not done. To facilitate removal, cable tension was lessened by removing safety wire and unscrewing the cable connectors at the forward end of the slack absorbers, as prescribed by the manual. However, when a shift change occurred between the removal and the reinstallation, the mechanics who accomplished the reinstallation performed the task without knowledge of the work accomplished on the unit during the previous shift, and they completely overlooked the extremely important cable rigging instructions prescribed by the manual. As a result, the connectors, unsafetied and unscrewed during the removal, were never tightened and resafetied after reinstallation. The use or non-use of red Unit Inoperative Tags by the maintenance personnel involved could not be clearly established by the testimony; but, if used, it is certainly clear that they were not used properly. The facts that no mechanic called for an inspection of the completed installation was made manifest by the testimony.

Evidence indicates that the amount of supervision devoted to this aileron booster assembly change fell considerably short of meeting the safety minimums desired and expected in a task of this nature. Testimony also established that, although the office of the foreman and the lead inspector were physically located adjacent to each other, there was a decided lack of coordination between maintenance supervisors and the Inspection Department. Moreover, no inspection was called for by the crew chief who, without studying the manual instructions, performed a cursory inspection of the completed installation and signed the job off as completed. Although several basic managerial controls existed at the time which would have assured the proper completion of this task, the testimony indicates that little attention was given to assure job continuity between shifts and to the use of Unit Inoperative Tags; and that company policy requiring an inspection of the completed installations was not complied with.

Follow-up Inspection

Although personnel of the Inspection Department were aware of the fact that the aileron boost unit was being changed, they failed to attach sufficient importance to the Inspection Activity Report entries to assure a timely inspection of the completed installation. Notwithstanding the fact that the boost change was carried on the Inspection Activity Reports throughout two successive workshifts, none of the inspectors on these shifts made any determination as to when the job would be completed. The Lead Inspector on Shift 1, the last shift involved, noted these entries on the two previous shifts' activity reports and saw no entry indicating that an inspection had been made, yet took no action to determine whether or not the installation had been inspected. The testimony indicates that all inspection personnel concerned believed that responsibility for a followup inspection notice rested upon line maintenance and not upon the Inspection Department. At the public hearing there appeared to be differences of opinion on the part of the carrier's maintenance and inspection personnel in their interpretation of the previously mentioned interoffice memorandum of June 21, 1957. These differences concerned whether it was the responsibility of line maintenance supervisors to give notice, or the Inspection Department to follow up, to insure that the aileron boost change was properly inspected upon completion.

The Board believes that this memorandum clearly placed the primary responsibility for followup inspection on the Inspection Department; and that the memorandum and the carrier's maintenance manual, taken together, also made it imperative that maintenance personnel secure an inspection of the completed installation. The Board therefore concludes from the testimony that maintenance and inspection personnel showed an ignorance or disregard of published directives and instructions.

A final management control which might have assured proper completion of the aileron boost change was not complied with when the Shift 1 Crew Chief released the aircraft for flight on July 12, 1961, without the appearance of an inspector's signature on the aircraft log. This Crew Chief had reviewed the log entries and had noted that the aileron boost work was signed off by the Shift 2 mechanics. Yet he could not give a satisfactory answer as to why he had released the aircraft for flight without an inspector's signature on the log.

The preponderance of evidence shows that the following chain of events led to, and had a direct bearing on, the destruction of N 137US on Sept. 17, 1961:

At, or shortly after, the aircraft began its turn to the right following takeoff from O'Hare Airport, a failure occurred in the aileron primary control system between the boost input quadrant and the control wheel. This failure was caused by a separation of the left wing down cable from the slack absorber on the copilot's side. Failure at this point made it impossible for the crew to decrease the steepening bank or effect a recovery by any means at such a low altitude. In connection with the failure experienced, it was established that two months prior to the accident, during an aileron boost unit change, the cable connectors to the slack absorber terminals were unsafetied and unscrewed, and that these connectors were never tightened and resafetied before the aircraft was released for flight. During the period July 12, 1961, until the accident, it is believed that there occurred a gradual unscrewing of the connector in question until it finally separated from the slack absorber following takeoff on the flight involved.

Mention has already been made of the fact that eight aileron flight control discrepancies were reported by pilots on the logs of N 137US from June 27 to July 11, 1961, the date the aileron booster unit was removed, and that during this time the aircraft was flown on a total of 29 scheduled flights. The aircraft logs recording the corrective actions taken indicate that little effort was made to analyze the cause of these discrepancies and to correct them. This type of operation reflects a casual attitude on the part of maintenance personnel toward a potentially hazardous condition, which was also evident in the replacement of the aileron boost assembly.

The training of Northwest Airlines line maintenance personnel on the Lockheed Electra appeared to have been sporadic and inadequate in scope, particularly with reference to flight control systems. Although the changing of this aileron boost unit provided an excellent opportunity for advantageous use of the existing on-the-job training program, this potential went unrealized.

Probable Cause

The Board determines that the probable cause of this accident was a mechanical failure in the aileron primary control system due to an improper replacement of the aileron boost assembly, resulting in a loss of lateral control of the aircraft at an altitude too low to effect recovery.

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ADVERTISERS IN THIS ISSUE

AVIATION WEEK, DECEMBER 24, 1962

AEROJET-GENERAL CORPORATION .....2nd Cover
AEROQUIP CORPORATION 47
AEROSPACE CORPORATION 3
AMP INCORPORATED 68
AMPEX CORPORATION 35
ANACONDA METAL HOSE DIVISION ANACONDA AMERICAN BRASS COMPANY.... 40
AVCO CORPORATION .....4th Cover

BENDIX RED BANK DIVISION, THE BENDIX CORPORATION 6
BLAW-KNOX COMPANY, ADVANCED PRODUCTS DIVISION 82-83
BOEING COMPANY, THE—AERO-SPACE DIVISION 66

CLIFTON PRECISION PRODUCTS COMPANY, INC. .....3rd Cover
CURTISS WRIGHT CORPORATION, ELECTRONICS DIVISION 80-81

DALMO VICTOR COMPANY.....60-61
DELCO RADIO DIVISION, GENERAL MOTORS CORPORATION 50
DOUGLAS AIRCRAFT COMPANY, INC., AIRCRAFT DIVISION 36-37

FAIRCHILD SEMICONDUCTOR, A DIVISION OF FAIRCHILD CAMERA & INSTRUMENT CORPORATION 10

GENERAL ELECTRIC COMPANY.....56-57
GENERAL ELECTRIC COMPANY, SILICONE PRODUCTS DEPARTMENT 74
GENERAL PRECISION, INC., LIBRASCOPE DIVISION 14

HRB-SINGER, INC. A SUBSIDIARY OF THE SINGER MFG. COMPANY..... 79
HI-SHEAR CORPORATION 70
HUGHES AIRCRART COMPANY..... 93

LAVELLE AIRCRAFT CORPORATION..... 55
LEAR SIEGLER SERVICE INC..... 93
LINDE DIVISION OF UNION CARBIDE CORPORATION 88
LITTON INDUSTRIES, INC.—LITTON SYSTEMS, INC., GUIDANCE & CONTROL SYSTEMS DIVISION 5
LOCKHEED AIRCRAFT CORPORATION..... 5
LOCKHEED-GEORGIA COMPANY A DIVISION OF LOCKHEED AIRCRAFT CORPORATION...72-73

MARLIN-ROCKWELL CORPORATION 76
MICROWAVE ELECTRONICS CORPORATION.... 86
MOTOROLA, INC., MILITARY ELECTRONICS DIVISION 84

ROHR CORPORATION 48-49

SOUTHWEST AIRMOTIVE COMPANY..... 4
SUNDSTRAND AVIATION • DENVER A DIVISION OF SUNDSTRAND CORPORATION..... 7

TAYLOR FORGE & PIPE WORKS..... 75
TEXAS INSTRUMENTS INCORPORATED, APPARATUS DIVISION 12

UNITED AIRCRAFT CORPORATION, HAMILTON STANDARD DIVISION 54
UNITED AIRCRAFT CORPORATION, PRATT & WHITNEY DIVISION 58, 78
UNITED CONTROL CORPORATION..... 44
UNITED TECHNOLOGY CORPORATION, A SUBSIDIARY OF UNITED AIRCRAFT CORPORATION 63

VICKERS INCORPORATED DIVISION OF THE SPERRY RAND CORPORATION..... 8

CLASSIFIED ADVERTISING

F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES 92
EQUIPMENT (Used or Surplus New) For Sale 92

ADVERTISERS INDEX

Machinery & Steel Div..... 92
National Aeronautical & Space Administration..... 92
Sundstrand Aviation 92

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LETTERS

Missing Satellite

Recent Department of Defense directives make the gathering of news of outer space activities an extremely tenuous matter at best. You are, therefore, to be congratulated on the thoroughness and quality of your coverage of this most significant field.

In spite of these efforts, however, there appears to be no information currently available concerning the space vehicle bearing the international designation 1962 Alpha phi.

I would appreciate any information you or your readers might have concerning this vehicle, its orbital parameters, launch date, launch vehicle, and country of origin.

Thank you.

Louis D. Braida
White Plains, N. Y.

(United Nations satellite registry and the National Aeronautics and Space Administration's satellite situation report both omit 1962 Alpha phi. Presumably it was a Soviet attempt to launch a spacecraft on a Venus fly-by mission. It was probably a backup to the unsuccessful Soviet Venus probe launched Sept. 1. This was one of six failures announced by NASA Administrator James E. Webb. Since Alpha chi is identified as an object launched by the U.S. on Sept. 17, the missing Alpha phi apparently was launched between Sept. 1 and Sept. 17.—Ed.)

Human Element

In AW Oct. 29 (p. 118) Capt. Heth afforded us his professional views concerning the recent airline pilot "misconducts," and in AW Nov. 19 (p. 154) Flight Engineer Widdicombe contributed further support in his "Candid Camera Caper" letter. This internal endorsement of the much-maligned pilot by their own types is a source of much gratification to those of us "who do not have a working knowledge of what transpires behind the closed cockpit door" but who, nevertheless, are vitally concerned—the airline passenger.

There is no doubt the recent photo fiasco of alleged front-office parties made great newspaper copy and caused much chuckling and dig-in-the-ribs "I knew it all along" comments. Many of my non-flying, headline-reading friends have leeringly asked me how I enjoy inverted flight on three engines while all that ribaldry is going on in the cockpit. It is at this point that I become an unpaid public relations man for ALPA, and not only sell my own confidence in the people who fly me around but try to make the point that calculated negligence by the guys looking through the windshield gets them the same fate it would us. This basic fact seems to have escaped most of the "investigators."

Since the advent of this so-called "exposé" I have heard much comment from my fellow air travelers, but none of it indicative of any loss of confidence in today's flight crews. Neither do I see any missing faces because some portion of the passenger community has run off screaming to other forms of

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transportation. Other than some male-type sniping at embarrassed hostesses, we still continue to relax in our seats with no thought that the professional efficiency of the flight crew is being compromised. We recognize that the airline flight crews are going through a labor transition, but neither side could ever win us over by attempting to malign the others' devotion to duty via the dirty-pool route.

There used to be the day when the mundane passenger could wander up to the front end while in flight and exchange pleasantries while trying to absorb what all the activity was about during a routine cruise. Capt. Heth and Mr. Widdicombe, from the inside, have reconfirmed what most passengers have always thought, despite the fact that recent circumstances require the door to be locked.

As regards the actual fact of pilot-hostess relationships, it appears obvious that all that has been proven is that the front-end fellows are human after all; we wouldn't want any other kind.

Edward T. Sherman
Eastern Area Representative
Aerojet-General Corp.
Jackson Heights, N. Y.

With all the recent revelations of in-cockpit shenanigans aboard the airlines, one can't help but wonder if the CAB will ever give "stewardess error" as the major factor in an aircraft accident.

John Andrews
Hawk Model Co.
Chicago, Ill.

Family Plan

Let me loudly second the suggestion of Bill Blake (AW Dec. 3, p. 134) for the airlines to come up with a low cost family plan. As a fairly heavy user (300,000 mi. in 10 years) I have not been on full flights 5% of the time; accurate statistics are, of course, available.

Since a great preponderance of family travel is for convenience and not to meet a particular hour of arrival, my suggestion is:

1. A family ticket to cost full fare for Dad and Mother (i.e. about 6½¢ a mile each) and children at 2¢ a mile each. (This brings the total cost quite close to gasoline, tires, motel, food, special repairs to the car for a trip, and some allowance for a day saved for a family of three or four kids.)

2. The family ticket would be for a certain day, but not necessarily a particular flight. Thus maybe Dad and one kid would go out on the first flight and Mother and the others on a later flight. Priority would move up so that the family is united by evening.

The above would get the family together at nightfall 500 to 600 mi. away (or more) after a restful hour or two flight instead of dodging traffic for 10 hr. In some cases they would be at the beach by 10 a.m., and always half the family would be there by then.

Alan Pope
Albuquerque, N. M.

Halaby Scored

There seems little doubt that Mr. Halaby (Federal Aviation Agency) should resign after letting the airlines draw him into their labor controversy (flight engineers). Especially with his action in providing substandard and inadequately trained personnel in the cockpit of today's fast and complicated aircraft. . .

You know, one inadequately or substandard trained crew member on today's fast aircraft has a tendency to reduce the efficiency and proficiency of all crew members as the two properly trained will be diverted from their duties to determine that an inadequately trained crew member is doing his duties properly. It seems a shame that he could not have conducted himself in the same courageous and determined manner that Mr. Quesada did. His primary interest was always safety. He never bowed to the interest of any pressure groups. His basic interest was the safety of the airline traveling public.

I hope his successor has the same motivating desire to increase safety at all costs as did Mr. Quesada.

Gerald H. Kirk
Newark, N. J.

Non-Pro Pilot

Certainly the air traffic system scares the non-professional pilot (AW Oct. 15, p. 119). When airliner flight decks full of professionals are snowed under by reports and requirements of the system; when the full wrath of the FAA (or worse, a jet-propelled liner or fighter) descends on the luckless non-pro pilot, who misunderstands an instruction given at many words per minute in "controller-ese," the system is frightening.

An airplane is the shortest time between two points, unless your destination isn't close to the airport or you get caught in a stack of airliners on IFR milling about in clear weather. By the time the general aviation pilot has battled through the ATC-controlled air traffic, the hurricanes of jet blast on the ground and the problems of ground transportation, he is ready to forget the whole idea of flying.

Let's face it. Non-professional flying is being relegated and regulated out of the metropolitan areas by closed down airports and "jet age" control systems. If you can't fly more than 25 hr. a month you just can't keep up with "progess."

J. N. Shaw
Ex-non-professional Pilot
San Diego, Calif.



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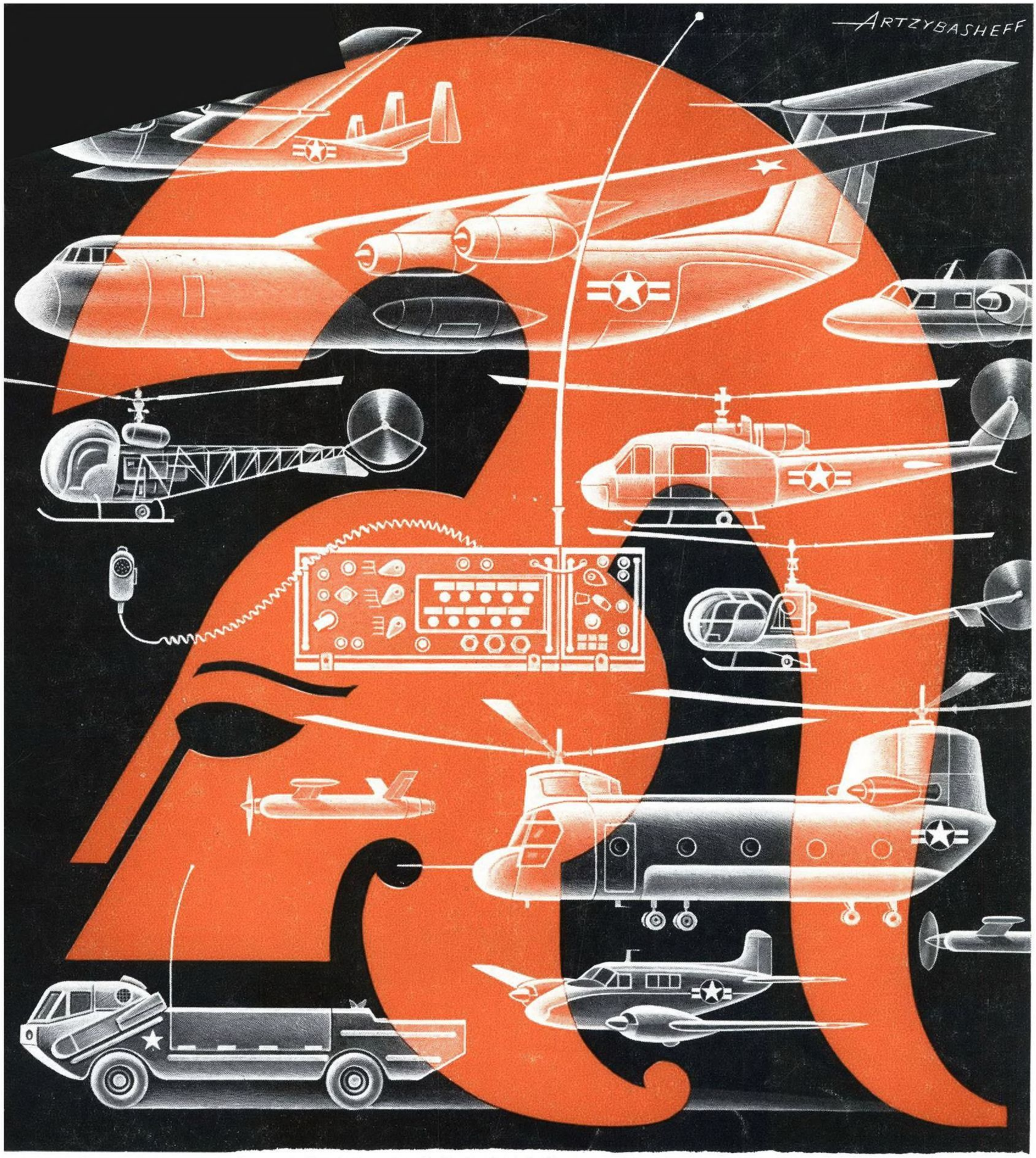
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