Aviation Week & Space Technology

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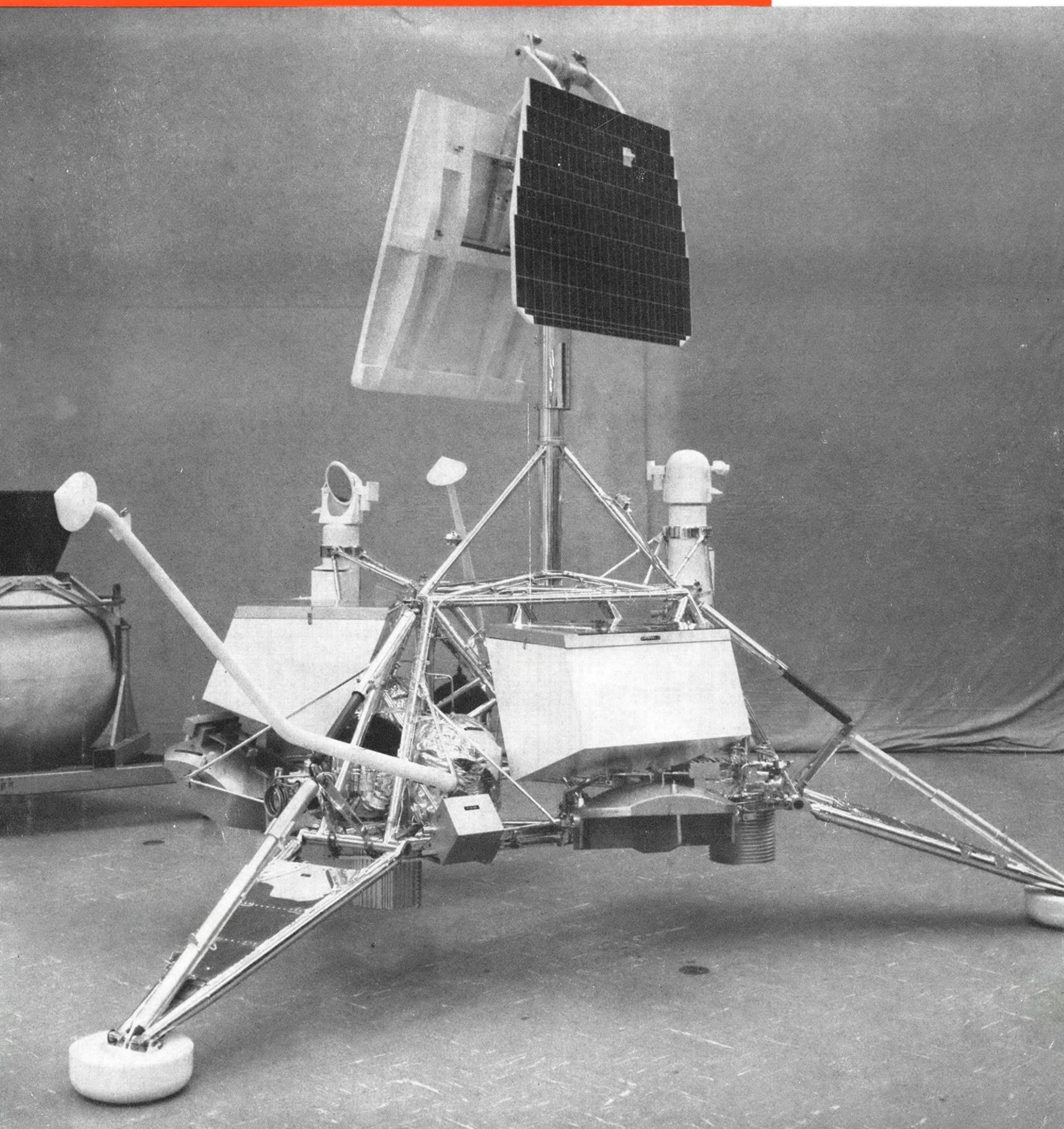
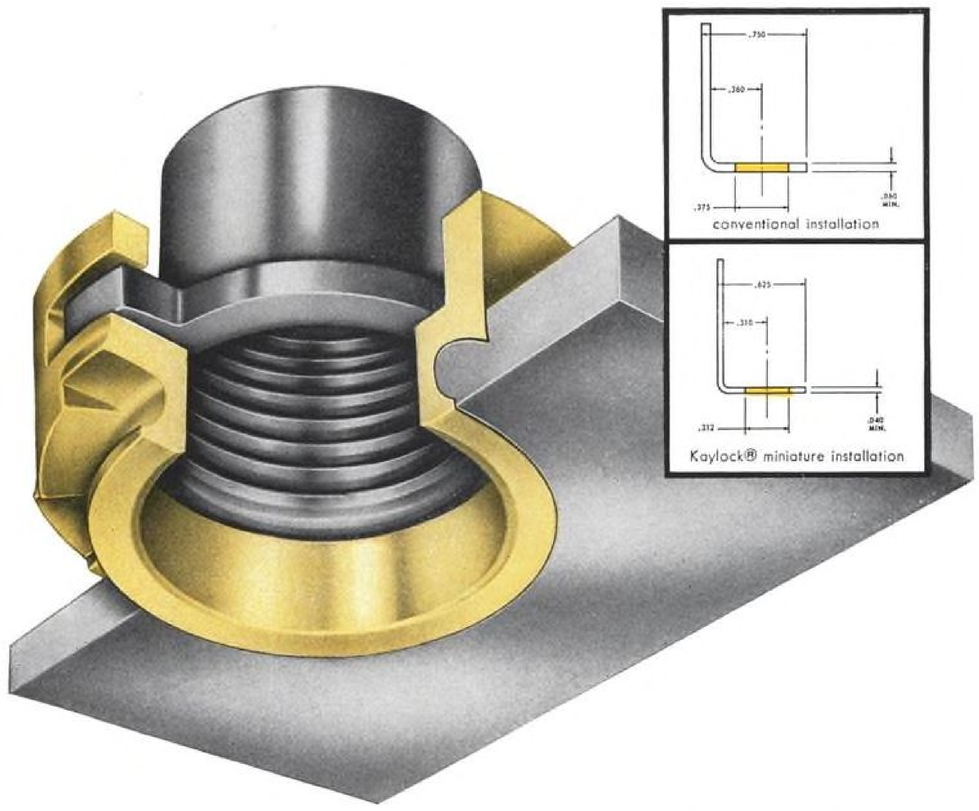
October 8, 1962

Space Science Needs, Scope Are Expanding

Hughes Surveyor Lander Mockup





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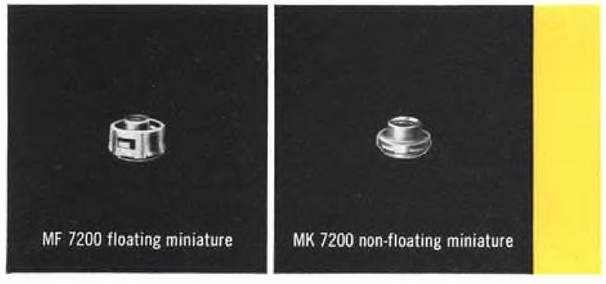

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AEROSPACE CALENDAR

Oct. 9-11—Ninth Annual Air Force Science and Engineering Symposium, Brooks AFB, San Antonio, Tex. Sponsors: Air Force Systems Command; Office of Aerospace Research.

Oct. 9-11—National Airports Conference, American Assn. of Airport Executives, University of Oklahoma, Norman, Okla.

Oct. 10-12—Ions in Flames & Rocket Exhausts Conference, American Rocket Society, Palm Springs, Calif.

Oct. 10-12—20th Annual Aerospace Electronics Exposition/Report, Aerospace Electrical Society, Pan Pacific Auditorium, Los Angeles, Calif.

Oct. 12-13—Symposium on Photography of Electronic Display, Shoreham Hotel, Washington, D.C. Sponsors: Society of Photographic Scientists & Engineers, National Bureau of Standards.

Oct. 15-17—Fall Meeting, International Scientific Radio Union & Institute of Radio Engineers, Ottawa, Canada.

Oct. 15-17—ASW Meeting, Somerset Hotel, Boston, Mass. Sponsors: IAS; U. S. Navy. (Classified Secret.)

Oct. 15-18—International Symposium on Space Phenomena and Measurement, Statler-Hilton, Detroit, Mich. Ninth Annual Meeting: IRE, NASA, AEC.

Oct. 15-18—17th Annual Instrument-Automation Conference & Exhibit, Instrument Society of America, Coliseum and Hotel New Yorker, New York, N. Y.

Oct. 16-17—Symposium on Inertial Guidance Test, Holloman AFB, N.M. Spon-

(Continued on page 7)

AVIATION WEEK and Space Technology

October 8, 1962
Vol. 77, No. 15

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AEROSPACE CALENDAR

(Continued from page 5)

sor: AF Missile Development Center.

Oct. 16-18—Rochester Institute of Technology's Seminar on Noise in Electronic Systems, Midtown Tower Hotel, Rochester, N. Y.

Oct. 18-19—Second National Conference on Planning & Designing Urban Helicopter Facilities. Institute of Aerospace Sciences Bldg., Los Angeles, Calif. Sponsor: Los Angeles Chamber of Commerce.

Oct. 18-19—Sixth Annual Display, Aerospace Electrical Society, San Diego, Calif.

Oct. 22-23—Joint Meeting, Canadian Aeronautical Institute—Institute of the Aerospace Sciences, King Edward Sheraton Hotel, Toronto, Canada.

Oct. 22-24—East Coast Conference on Aerospace and Navigational Electronics, Institute of Radio Engineers, Emerson Hotel, Baltimore, Md.

Oct. 22-24—Annual Meeting, National Aeronautic Assn., Statler-Hilton Hotel, Washington, D. C.

Oct. 24-26—Annual Meeting & Exposition, Society for Experimental Stress Analysis, Hotel Schroeder, Milwaukee, Wis.

Oct. 25-27—1962 Electron Devices Meeting, Institute of Radio Engineers, Sheraton Park Hotel, Washington, D. C.

Oct. 26-27—17th Midwest Quality Control Conference, American Society for Quality Control, Denver Hilton Hotel, Denver.

Oct. 29—Fourth Annual Western Technical Conference, American Institute of Electrical Engineers, Biltmore Hotel, Los Angeles, Calif.

Oct. 29-30—Aerospace Fluid Power Conference, Pick-Fort Shelby Hotel, Detroit, Mich. Sponsor: Aerospace Division, Vickers, Inc.

Oct. 29-30—Meeting on Large Rockets, Institute of the Aerospace Sciences, El Dorado Inn, Sacramento, Calif.

Oct. 29-31—Symposium on Dynamics of Manned Lifting Planetary Entry, Philadelphia, Pa. Attendance limited; for information: Sinclaire M. Scala, General Chairman, Room M7023A, General Electric Co., MSVD, Valley Forge Space Technology Center, Box 8555, Philadelphia 1, Pa. Co-sponsor: AFOSR.

Oct. 29-Nov. 2—World Metal Show & National Metal Congress, American Society for Metals, Coliseum and Hotel Biltmore, New York, N. Y.

Oct. 29-Nov. 2—International Symposium, "Basic Environmental Problems of Man in Space." UNESCO House, Paris, France. Sponsors: International Astronautical Federation; International Academy of Astronautics.

Oct. 30—Supersonic Commercial Transport Metals Symposium, Metallurgical Society, Statler-Hilton Hotel, New York, N. Y.

Oct. 30-31—National Conference on Spaceborne Computer Engineering, IRE, Disneyland Hotel, Anaheim, Calif.

Oct. 30-Nov. 1—Eighth Tri-Service Conference, Armour Research Foundation, Chicago, Ill. Sponsors: U. S. Army, Navy and Air Force.

Nov. 1—Annual Meeting, General Aviation Safety Committee, National Safety Council, Conrad Hilton Hotel, Chicago, Ill.

(Continued on page 9)

AEROSPACE CALENDAR

(*Continued from page 7*)

Nov. 1-2—Sixth National Conference, Product Engineering and Production, Institute of Radio Engineers, Jack Tar Hotel, San Francisco, Calif.

Nov. 2-3—Advanced Technology Symposium, New Mexico Section/American Society of Mechanical Engineers, University of New Mexico, Albuquerque, N. M., in cooperation with AFSWC-Kirtland AFB.

Nov. 4-7—14th Annual Conference on Engineering in Biology and Medicine, Conrad Hilton Hotel, Chicago, Ill. Sponsors: Institute of Radio Engineers; American Institute of Electrical Engineers; Instrument Society of America.

Nov. 5-7—Symposium on Protection Against Radiation Hazards in Space, Gatlinburg, Tenn. Co-sponsors: Oak Ridge National Laboratory; NASA Manned Spacecraft Center; American Nuclear Society.

Nov. 5-7—Northeast Electronics Research and Engineering Meeting, Institute of Radio Engineers, Commonwealth Armory & Somerset Hotel, Boston, Mass.

Nov. 5-16—16th Air Transport Management Institute, School of Business Administration, The American University, Washington, D. C.

Nov. 7-8—Symposium on Lasers and Applications, Antenna Laboratory, Department of Electrical Engineering, Ohio State University, Columbus, Ohio.

Nov. 7-9—International Air Cargo Forum, Dinkler-Plaza Hotel, Atlanta, Ga. Sponsors: Institute of the Aerospace Sciences; Society of Automotive Engineers.

Nov. 12—Wings Club Annual Dinner, Americana Hotel, New York, N. Y.

Nov. 12-15—International Air Transport Assn.'s Sixth Public Relations Conference, Shoreham Hotel, Washington, D. C.

Nov. 13-14—Retardation and Recovery Symposium, Imperial Motel, Dayton, Ohio. Sponsor: Aeronautical Systems Division's Flight Accessories Laboratory.

Nov. 13-18—17th Annual Meeting and Space Flight Exposition, American Rocket Society, Pan Pacific Auditorium, Los Angeles, Calif.

Nov. 19-20—Mid-America Electronics Conference, Institute of Radio Engineers, Hotel Continental, Kansas City, Mo.

Nov. 26-27—Western States Section Meeting, The Combustion Institute, Aerojet-General Corp., Sacramento, Calif.

Nov. 27-29—40th Meeting, Aviation Distributors and Manufacturers Assn., The Kenilworth, Miami Beach, Fla.

Nov. 28-30—1962 Ultrasonics Symposium, Institute of Radio Engineers, Columbia University, New York, N. Y.

Dec. 10-12—Conference on VTOL Aircraft, New York Academy of Sciences, Henry Hudson Hotel, New York, N. Y.

Dec. 17-18—Symposium: Structural Dynamics Under High Impulse Loading, Wright-Patterson AFB, Ohio. Co-sponsors: Air Force Office of Scientific Research (Mechanics Division); Aeronautical Systems Division.

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

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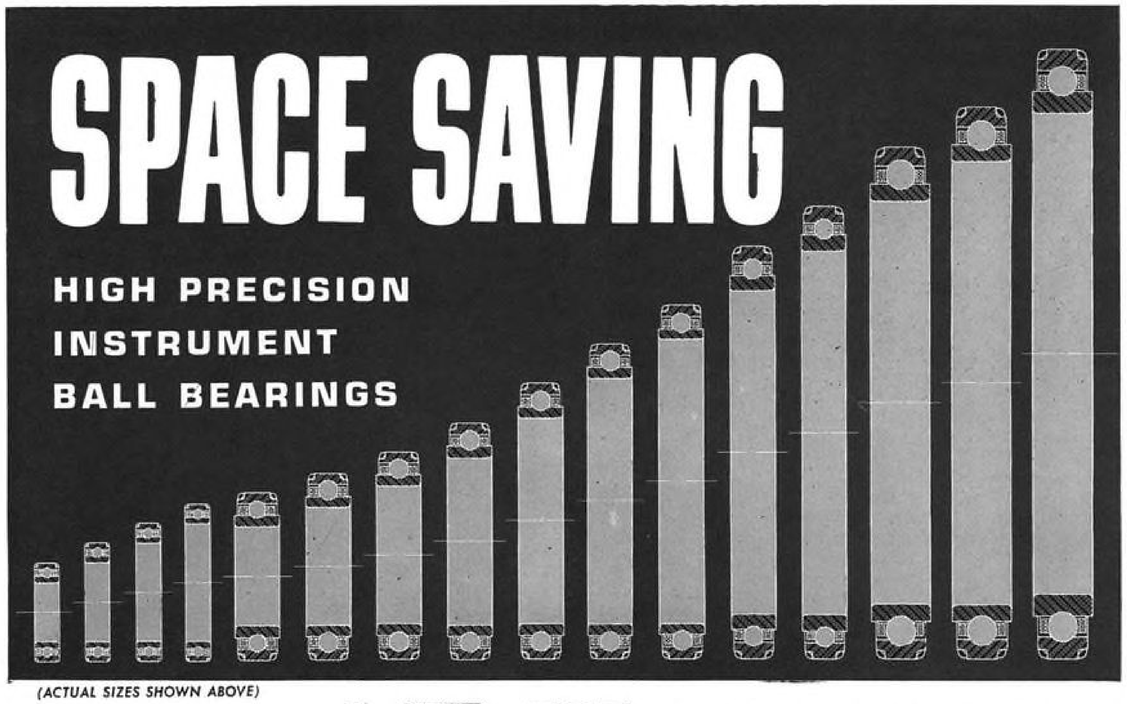

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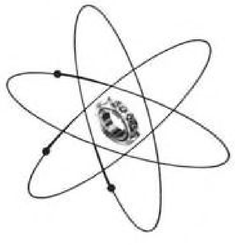

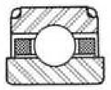

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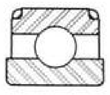
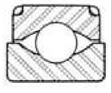
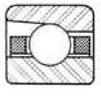


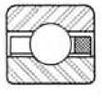
TCF, TCA patented SBB construction permits utilizing full ball complement without resorting to loading slots or counterbore; for heavy loads and relatively low speeds. Type TCA is same as Type TCF, except alternate balls are undersize to function as ball spacers; for moderate loads and speeds.



TWF, TWA patented SBB construction, internally similar to Types TCF and TCA, except rings employ unique integral shield design, which with close clearance annulus and grease lubrication functions virtually as seal. Type TWF with full ball complement, and Type TWA with alternate balls slightly undersize.



TAR Angular contact design with one-piece reinforced phenolic retainer, for combination radial and high thrust loads. Also available as Type TAS with one-piece stamped stainless steel retainer.



TKR Conventional Conrad design with one-piece snap-type reinforced phenolic retainer — capacity less than type TCR patented SBB construction, but adequate for many instrument applications at lower cost. Also available with Teflon slug ball spacers as type TKL, or with spring separators as type TKP.

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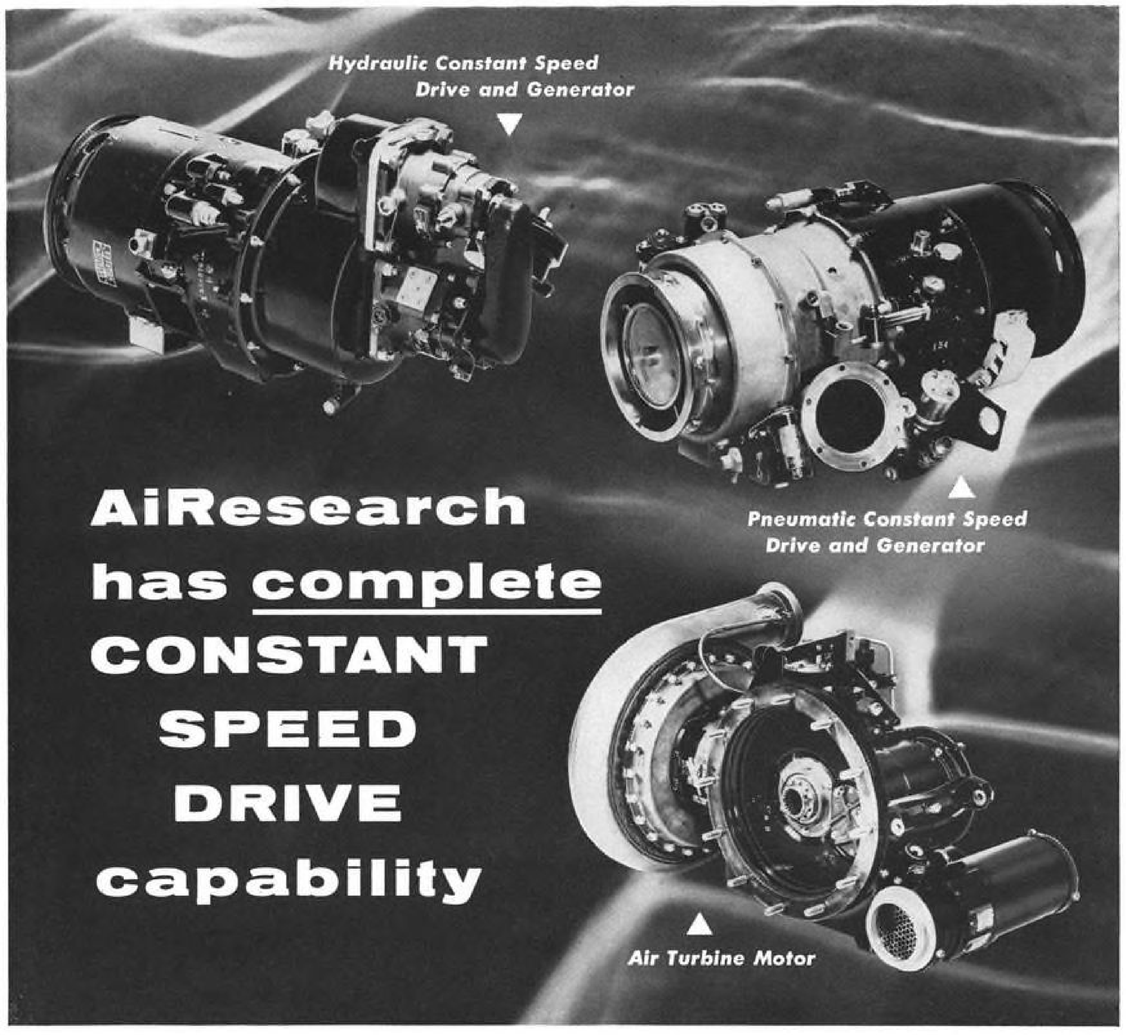

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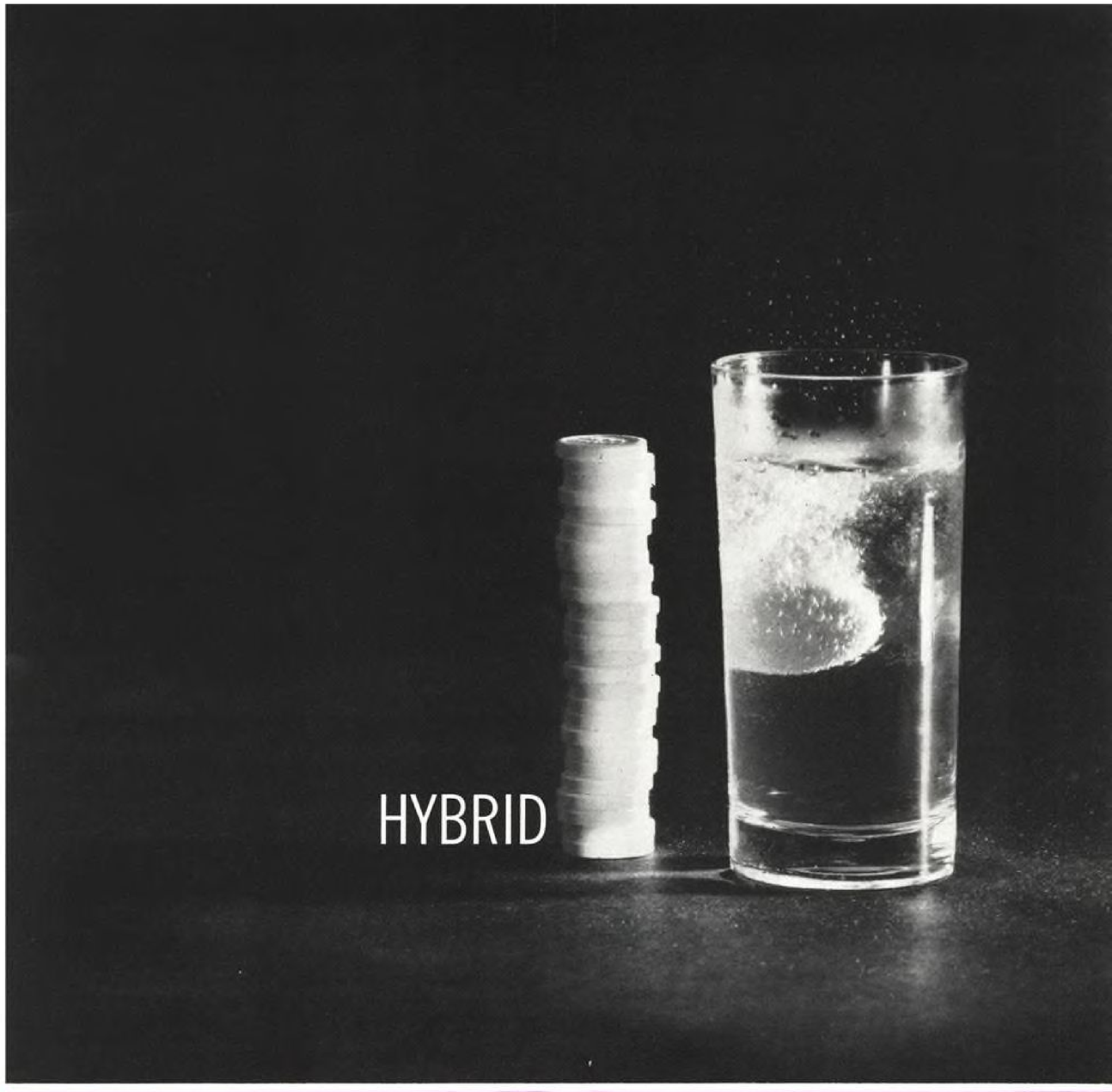

SELTZER TABLETS. GLASS OF WATER. UNMIXED, YOU HAVE AN INERT SOLID, AN INERT LIQUID. MIX THEM, YOU HAVE IMMEDIATE REACTION. WHAT DOES THIS SIMPLE THERAPEUTIC SYSTEM HAVE IN COMMON WITH UTC ROCKET PROPULSION DEVELOPMENT? UNITED TECHNOLOGY CORPORATION IS WELL ALONG WITH A DEVELOPMENTAL HYBRID ROCKET MOTOR, IN WHICH A LIQUID OXIDIZER IS BROUGHT INTO CONTACT WITH SOLID FUEL. THE RESULT IS A WHOLLY NEW KIND OF PROPULSION SYSTEM, COMBINING TRADITIONAL SOLID PROPELLANT RELIABILITY WITH THE HIGH PERFORMANCE FIGURES CHARACTERISTIC OF LIQUID ENGINES. UTC'S HYBRID OFFERS UNLIMITED START-AND-STOP CAPABILITY, AND HIGHER SPECIFIC IMPULSE THAN ANY OTHER NON-CRYOGENIC SYSTEM. APPLICATIONS: HUGE BOOSTERS, SOFT LUNAR LANDINGS, ORBITAL CHANGES OF SPACECRAFT, CONTROLLABLE BALLISTIC MISSILES. ANOTHER STATE-OF-THE-ART ROCKET DEVELOPMENT BY UTC.

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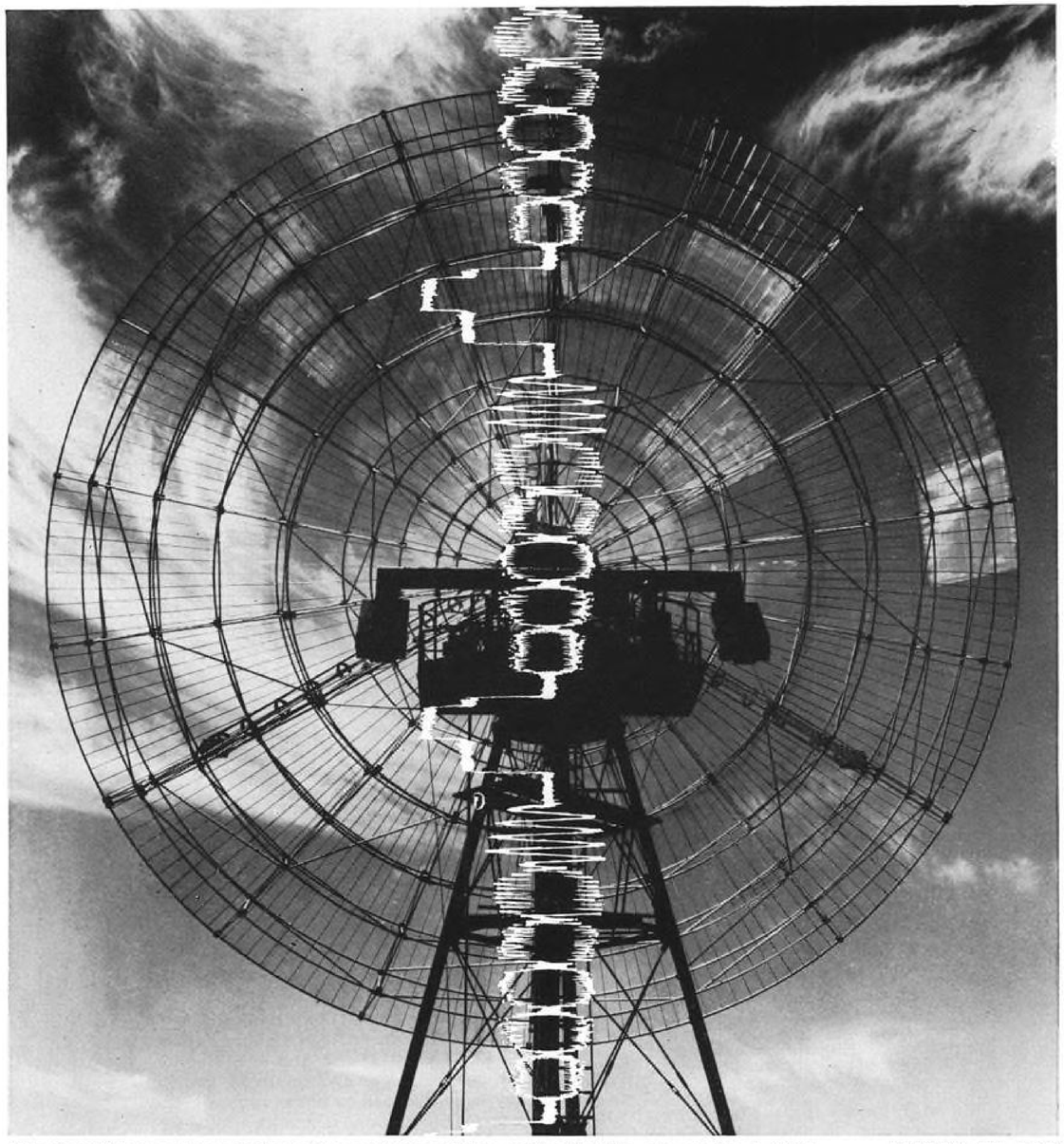

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Aviation Week & Space Technology

Volume 77
Number 15

October 8, 1962

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CONTENTS

COVER: Engineering mockup of the Surveyor lunar soft-landing spacecraft, has been fabricated at Culver City, Calif., by the systems contractor, Hughes Aircraft Co. Seven spacecraft will be built by Hughes as part of National Aeronautics and Space Administration's unmanned lunar exploration program. For further details and photographs, see p. 76.

PICTURE CREDITS

Cover—Jim Dell, Hughes Aircraft Co.; 26, 27—Wide World; 32—Space-General Corp.; 43—Sov Foto; 54—Aviation Week; 55—NASA (left), U. S. Navy (right); 57, 66—NASA; 67—NASA (top), U. S. Navy (bottom); 76—Jet Propulsion Laboratory (top), Hughes Aircraft Co. (bottom); 80, 82—Jet Propulsion Laboratory; 83—Aerojet General; 87—U. S. Navy; 88—USAF; 92—Ron Appelbe; 102, 103—Kaman Aircraft; 110—General Electric.

EDITORIAL

Sputnik to Schirra

The space age celebrated its fifth birthday last week. The interval between the first orbit of the Soviet Sputnik 1 and the flawless 9-hr. flight of Cdr. Walter Schirra, Jr., in his Sigma 7 Mercury capsule was just a day short of five years. During that period space technology has made astonishing progress, although it is still in its infancy technically as well as chronologically. Nine men have survived space flight, seven of them orbital ventures. Telstar is carrying intercontinental television programs, Tiros is mapping the world's weather, Lunik has photographed the dark side of the moon, Mariner is extending man's field of knowledge to Venus and scores of space probes of many nationalities have added immeasurably to man's knowledge of his universe (see p. 54).

How many of even the rosiest space prophets' pre-Sputnik predictions have already come true! How much of the supposedly "practical realistic" critics' pessimism has been proved false once science and industry were unleashed on space technology! And how close the moon looks now with Soviet and U.S. metal already impacted on it and two powerful nations pushing full throttle to land their own men on its surface within this decade.

Soviet Bioastronautic Lead

Man in space is still the key to mastery of space, although a broad program of scientific exploration is necessary to provide a firm technical foundation for man's long-term use of space. The Soviet program has been oriented from its inception toward adding space to man's useful environment. The United States' program, in contrast, was conceived of as primarily a pure science venture with man entering it as a somewhat reluctant afterthought. Thus it is not surprising that while this country has studded its space technology with a wide variety of unmanned satellite achievements such as Tiros, Telstar and Samos, the Soviets still enjoy a substantial lead in their manned space achievements, and in the sciences necessary to support this effort, such as bioastronautics. The Soviet superiority in rocket boosters, enabling them to put manned space capsules at least twice as heavy as Mercury into orbit, has been freely acknowledged by U. S. experts. But the Soviet lead in bioastronautics is probably even greater than in boosters and the U.S. shows little inclination to close this gap.

Therefore, their concern with the problems of weightlessness in a space environment even after the successful 3½-day flight of Maj. Nikolayev in Vostok 3 and the three-day orbit of Lt. Col. Popovich in Vostok 4 is of real significance (see p. 38). Recent papers delivered by Vassily Parin and V. I. Yazdovsky in Leyden, Holland, and Varna, Bulgaria, make it clear that the year-long interval between the flight of Maj. Titov in Vostok 2 and the launching of Vostok 3 was caused not only by the necessity of solving the vestibular disturbance problem experienced by Titov but also by the need to broaden the whole scope of their bioastronautics program, including new methodology and instrumentation to gather data on the problems that lie ahead for prolonged functioning of man in space.

The methods, including both physical training of the Soviet cosmonauts and practice in training their vestibular systems to cope with the disorientation effects of weightlessness, that proved successful for Cosmonauts Nikolayev and Popovich were truly ingenious. It must have been quite a sight to see these tough fighter pilots executing ballet pirouettes for vestibular system exercise in preparation for their flights.

It is also significant that both Vostok 3 and 4 carried a wide variety of biologicial specimens in addition to the cosmonauts and that the two men were required to perform experimental work in bioastronautics in space for the first time.

The Soviet priority on man in space may have several implications, but its military significance is obvious. Even Soviet official commentators are no longer reluctant to make this clear.

Cdr. Schirra's superb flight in Sigma 7 was a good measure of how well the U.S. man-in-space program progressed once it received some official support and solid funding. The Mercury program has built a tremendous foundation for future U.S. manned space efforts but it has been handicapped by its late start and the booster limitations of the man-rated Atlas, although that vehicle has logged a remarkable reliability record in the Mercury program.

U.S.-Soviet Efforts Contrasted

One yardstick by which the relative progress of the U.S. and USSR manned space programs may be measured is the fact that at the end of the Mercury program next year its final 24-hr. mission will only equal the performance over a year ago of Maj. Titov in Vostok 2.

We still trail in this race and will continue to do so for another several years. But this is hardly the time to develop faint hearts or soft funding for our own manned programs. It is the time to press on at maximum possible pace, to cut as many bureaucratic corners as possible, and to utilize our technology to its fullest. Then, slowly at first, but faster as the finish looms closer, we may overhaul the Soviets not only in the race to the moon but also in the broader goal of controlling space for peaceful purposes and denying it to anybody who wants to use it to impose his will on all the world.

—Robert Hotz

WHO'S WHERE

In the Front Office

William L. Maxson, Jr., president, Maxson Electronics Corp., New York, N.Y., succeeding **Joseph A. Frabutt**, resigned.

John C. Barnes, vice president-engineering, Hycon Mfg. Co., Monrovia, Calif.

Dr. Ernst H. Krause, a vice president, Aerospace Corp., and general manager of the newly established San Bernardino (Calif.) Operations.

Lloyd L. Kelly, executive vice president, Link Division of General Precision, Inc., Binghamton, N.Y., and **Dr. John M. Hunt**, senior vice president-technical director.

Wesley A. Peterson, vice president, Land-Air, Inc., a subsidiary of Dynalectron Corp., and general manager of Land-Air's Instrument and Electronics Division, San Leandro, Calif.

Dr. F. H. Bratton, vice president-research, G. T. Schjeldahl Co., Northfield, Minn.

George C. Stewart, vice president-Eastern representative, Air Logistics Corp., Pasadena, Calif., with offices in Washington, D.C.

A. H. Sonnenschein, vice president, Federal Scientific Corp., New York, N.Y.

Arthur E. Thake, vice president-manufacturing, Consolidated Vacuum Corp., Rochester, N.Y.

Air Commodore Cyril John Roderic Salmon, Senior Air Staff Officer, R.A.F. Maintenance Command, with acting rank of Air Vice-Marshal.

Karl W. Dahlem, assistant vice president of public relations, American Airlines, Inc. Also elected assistant vice presidents: **Scott C. Whitney** for state and community affairs (New York), and **George A. Warde** for base maintenance (Tulsa).

Walter S. Boone, Jr., executive vice president, Scope, Inc., Falls Church, Va.

G. J. Hunt, vice president-sales, Cinch Manufacturing Co., Chicago, Ill.

Lawrence J. Straw, corporate vice president-marketing, American Electronics, Inc., Fullerton, Calif.

Robert J. Trivison, vice president, Crescent Engineering & Research Co., El Monte, Calif.

Honors and Elections

Rep. Oren Harris (D.-Ark.), Chairman of the House Committee on Interstate and Foreign Commerce, has been named recipient of the Air Traffic Control Assn.'s Medallion Award for legislative leadership in air safety in recognition of his co-authorship of the Federal Aviation Act of 1958.

Robert H. Widmer, vice president-research and engineering of General Dynamics/Fort Worth, has received the American Society of Mechanical Engineers' Spirit of St. Louis Medal for 1962 in recognition of his role in the design and development of the B-58 Hustler bomber.

Albert J. Kullas, director of engineering for Martin Co.'s Denver Division, has been appointed chairman of the National Aeronautics and Space Administration's Research Advisory Committee on Missile and Space Vehicle Structures.

(Continued on page 118)

INDUSTRY OBSERVER

► Full-scale model of Aerojet-General Corp.'s propulsion system for the Apollo service module is being test-fired in runs up to 50-sec. duration in a series of sea-level tests at Azusa, Calif. Purpose is to determine performance and material properties, including thrust chamber ablation characteristics. Projected to have a reliability factor of 0.9999, the engine is approximately 12 ft. long and is designed to develop approximately 22,000 lb. thrust at altitude. Nozzle will have an unusually large exit plane diameter and gimbaling action of ±10 deg. Titan 2 propellants will be used, as well as a modified Titan 2-type injector.

► **Japanese government is planning to establish a space development agency, probably in Fiscal 1964. Kappa-8 sounding rocket recently was launched successfully at Kagoshima Space Flight Center, at southern tip of Japan. Yugoslavia already has purchased the Kappa-8 from Japan, and other countries have expressed interest.**

► During recent Army and Tactical Air Command Swift Strike 2 maneuvers in the Carolinas it frequently required 24 hr. to obtain, process and distribute aerial reconnaissance photographs showing deployment of fast-moving forces, a situation which shocked some Pentagon observers. Maneuvers were intended to demonstrate mobility and fluid-situation fighting.

► **Japanese Defense Agency six-man mission is in the United States for discussions with Hughes Aircraft, General Electric and Litton, the three finalists in a competition for the Base Air Defense Ground Environment (Badge) system, Japanese equivalent of the U.S. Sage system. Contractor probably will be selected early next month. Each U.S. company is teamed with a Japanese avionics firm for the project.**

► Weather Bureau officials are interested in a Navy proposal for a system of surveillance satellites in a medium-altitude equatorial orbit which could provide television pictures of large portions of the earth's oceans. Coverage would show weather conditions and disposition of shipping.

► **Air Force may substantially increase the funding for its satellite inspector (Saint) program, perhaps doubling the funds originally earmarked for the program during the current fiscal year. Additional money is expected to cover more extensive satellite systems testing and some non-contractual changes made in the program since its inception.**

► Lawrence Radiation Laboratory at the University of California has completed a preliminary inquiry in the rocket industry and is expected to issue a request, probably this month, for a proposal for a single- or two-stage booster. It will be built of existing hardware and will carry a 100-lb. payload to an altitude of about 250 mi. for nuclear radiation measurements.

► **National Aeronautics and Space Administration probably would be receptive to training Japanese space pilots should a program develop in that country for readying astronauts for future roles in space exploration.**

► USAF Special Weapons Center at Kirtland AFB, N.M., is planning an analytical study program to predict accurately the effects of satellite nuclear auxiliary power (Snap) system radiation on the operational lifetime of a satellite avionics payload. Prediction of radiation flux is to include energy, angular distribution, build-up, hardening, scattering and secondary sources of radiation in spacecraft using nuclear power.

► **Air Force is expected to select a contractor next week for its multi-million-dollar airborne geodetic mapping system, USQ-28 (AW Aug. 20, p. 23). Leading contenders for the contract are Aeronutronic Division of Ford Motor Co., General Precision, Minneapolis-Honeywell and Nortronics.**

► USAF will soon launch a Discoverer satellite from Vandenberg AFB, Calif., equipped with special experiments to measure degradation of solar cells in the intensified radiation belt created by the July 9 high-altitude nuclear explosion (AW Oct. 1, p. 24).

Washington Roundup

Soviet Nuclear Aircraft

Soviet Russia's nuclear-powered aircraft program has been reoriented from an experimental program based near Moscow to development of an anti-submarine warfare system, with work being done in the Dolan nuclear research complex near Semipalatinsk. Goal of the new program is an anti-Polaris submarine weapon system with sufficient range to reach Polaris cruising areas, enough payload capability to carry large electronic detection gear and nuclear depth bombs, and endurance that would allow it to stay on station as long as possible.

Large, delta-winged Bounder bomber is still being used in the nuclear research program, but a new version of this aircraft has appeared in the Soviet Union with new and larger jet engines than those displayed at the Tushino air show in July of last year (AW July 17, p. 31). New engines are estimated to be in the 35,000 to 40,000-lb. thrust class and should give the Bounder Mach 2-plus performance.

Science Board Changes

Defense Secretary Robert McNamara has ordered that the Air Force Scientific Advisory Board—which now has approximately 175 members—be cut about in half and be made responsive to his requirements as well as to USAF's. Air Force Secretary Eugene Zuckert has agreed. This is due to be announced at the board's fall general meeting at Brooks AFB, San Antonio, Tex., on Oct. 25-27.

Theme of that meeting is military man in space. The tentative agenda includes a 40-min. talk on Defense Department's five-year space plan by John Rubel, deputy director of defense research and engineering, and discussion groups on topics including unique military manned spacecraft missions and Soviet military space capability for the next decade.

Watch for Air Force to reverse its decision to buy Vertol 107 turbine-powered helicopters for its SOR-190 long-range utility helicopter requirement (AW June 11, p. 28) and switch to the Sikorsky HSS-2. Decision will not be announced until after the November elections. Problems on delivery schedules and price caused the change in vehicles for the missile site and Texas radar tower support mission.

Internal TFX Struggle

Intramural fight appears to be brewing in the Office of the Secretary of Defense over the bi-service TFX tactical fighter as the time for selection of a single development and production source draws near. Defense Research and Engineering officials feel they have guided the determinations of TFX requirements in such a way that the weapon system will be technically sound and that there will be only about a 15% difference between the USAF and Navy versions (see p. 37). They want the project initiated as soon as possible.

But the program review offices under Assistant Secretary of Defense (Comptroller) Charles J. Hitch are arguing that the cost-effectiveness balance of the TFX does not warrant development of such a sophisticated aircraft and the allied parts of the weapon system. Most of the cost-effectiveness review is performed under Deputy Assistant Secretary (Programing) Hugh McCullough in the directorates for systems planning and systems analysis. In the latter, headed by Alain Enthoven, a team of Dr. Dieter H. Schwebs, Victor K. Heyman, Dr. Jacob A. Stockfisch and John E. Keller perform what amounts to technical reviews of DDR&E's technical reviews.

TFX is not the only issue. The Enthoven team has gone directly to the services and to contractors to obtain information on a variety of aircraft and allied programs. The services have taken advantage of this to try to change what they consider unfavorable recommendations coming from DDR&E.

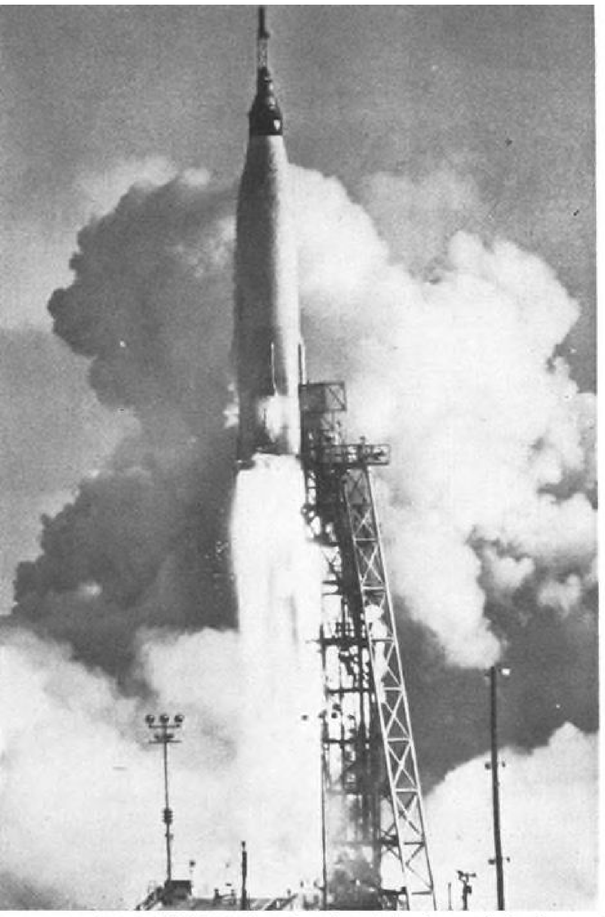
Solid Political Issue

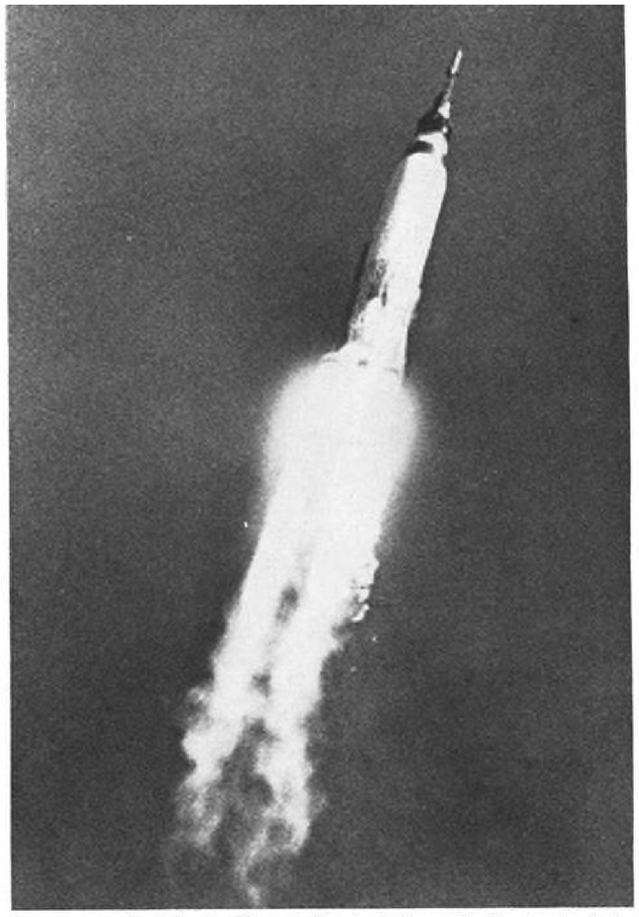
President Kennedy has promised Rep. David S. King, Utah Democrat who is fighting for the Senate seat held by Republican Wallace F. Bennett, that he will look into whether money appropriated for large solid rockets can be awarded as contracts before November elections (AW Oct. 1, p. 16). King also said last week in a press release that he "sewed up a final commitment" for an award to Thiokol (see p. 30) "in a personal visit with President Kennedy," which he said was the third he has had relating to missile and space work.

U. S. Strike Command has been asked to study Army proposals for radical increases in tactical air programs and an Air Force review of these proposals before Secretary McNamara gives them a final going over. Army's Tactical Air Support Requirements Board, headed by Lt. Gen. Hamilton Howze, offered five plans for streamlining Army air forces, based on varying priorities. The most expensive would boost the cost of Army's five-year aviation package from the current $1.6 billion to $5.4 billion.

Air Force's counterpart board, headed by Lt. Gen. Gabriel P. Disosway, took exception to Army's use of such tactical transport aircraft as the de Havilland AC-1 Caribou and its turboprop follow-on (see p. 30), and the Grumman AO-1 Mohawk reconnaissance aircraft (see p. 37), saying USAF should operate them. It also took milder exception to what it called over-emphasis on helicopters to the detriment of VTOL and STOL aircraft.

—Washington Staff





MA-8 LIFTS OFF from launch pad in photo at left. Center, Atlas arcs over the Atlantic. Vapor trail extends from Atlas booster in photo at right. The six-orbit flight lasting 9 hr. 14 min., was termed flawless by NASA officials.

Flawless MA-8 Flight Advances Mercury to Day-Long Mission Next Year

Cape Canaveral—Flawless, six-orbit Mercury Atlas-8 flight by Navy Cdr. Walter M. Schirra will allow the Mercury program to move directly to its final objective—a 24-hr. mission—with only minor changes necessary in the basic capsule.

Cdr. Schirra and his Sigma-7 capsule were launched at 8:15:11 a.m. EDT from the Atlantic Missile Range in the smoothest countdown yet conducted for a manned flight. He landed 9 hr. 14 min. later, after traveling 160,000 mi., at 5:29 p.m. (EDT), 330 mi. northeast of Midway Island in the Pacific, five miles from the center of the primary six-orbit recovery zone. His flight was the longest U.S. manned space mission, and was conducted primarily as an engineering test flight designed to assess systems operations and conservation of consumables. Apogee was 176 mi., perigee 100 mi., period 88.9 min., and inclination 32.5 deg.

From an engineering standpoint, Cdr. Schirra experienced none of the systems problems reported by Marine Lt. Col. John H. Glenn in MA-6, and Lt. Cdr. Scott Carpenter in MA-7, particularly in excess usage of reaction control fuel. Schirra had 80% of his fuel remaining when he began his re-entry maneuver.

Immediately after Schirra was picked out of the water by the aircraft carrier Kearsarge, Mercury Operations Director Walter C. Williams said the flight was "perfect . . . there were no spacecraft difficulties whatever . . . there were no psychological difficulties." Williams said success of the flight will move Mercury to the day-long mission. This means the second six-orbit flight will be canceled (AW Oct. 1, p. 22).

MA-8 Coverage

Aviation Week & Space Technology's coverage of the Mercury Atlas-8 mission was provided by Space Technology Editor George Alexander at Cape Canaveral and West Coast Editor Irving Stone in Honolulu.

Primary change in the one-day capsule will be removal of the 75-lb. periscope. Weight of the periscope will be replaced by environmental oxygen, reaction control fuel, and suit coolant water . (See box p. 29.)

Schirra was able to end his orbital mission with a large amount of fuel remaining because he spent a considerable portion of his flight drifting, that is, using only limited or no positive control of his attitude.

Drifting flight, a major experiment of the MA-8 mission, was accomplished in two phases; limited and full. He spent 118 min. in full drift and 18 min. in limited drift.

Limited drift began at about 11:25 a.m. EDT, shortly after Cdr. Schirra entered his third orbit. During his first two orbits, the pilot had exercised all four modes of the attitude control system—automatic, fly-by-wire, rate stabilization and manual proportional.

In limited drift, the automatic mode of the control system was locked out and the Mercury capsule was allowed to swing around any of its three axes, within the 30-deg. limit of the automatic system's gyros. Had the capsule started to exceed this 30-deg. limit, the pilot could have brought the capsule back to its correct attitude by using any one of the three modes actuated by his control stick, or by reverting to the automatic method.

When no severe rates along any axis were noted during limited drift, Schirra went into full drift during the fourth and fifth orbits and shut down a number of systems to conserve electrical power.

The systems shut down were the automatic stabilization and control system (ASCS), which was turned off completely and its gyros caged; the alternating current bus, and the C- and S-band beacons. For long periods during the fourth and fifth orbits, the Sigma-7 spacecraft was beyond reach of tracking stations in the South Atlantic and the mid-Pacific and so telemetry systems were not used, conserving electric power.

Full drift flight was not permitted during the transitions from third to fourth and from fourth to fifth orbits, because of the possibility that the flight might have had to be terminated and the capsule would have had to be in the right attitude for firing of the retrorockets. Coming up on the end of the third and fourth orbits, therefore, Schirra re-instated the control system, pitched his capsule up 34 deg. above the local horizontal and prepared to initiate the retro and re-entry sequence, should it have been commanded by the Mercury Control Center.

When he received authority to proceed on to the fourth and fifth orbits, Schirra again shut down the ASCS control mode and the other systems described above and reverted to full drifting flight once more. Prior to shutdown, the pilot had planned to induce the capsule into a slow tumble along the pitch axis and to study the possible physiological effects of the slow tumbling motion.

Purpose of the drifting flight experiment was to conserve hydrogen peroxide fuel of the control system, so that it would last throughout the six-orbit flight, and to determine what moments of inertia might cause attitude changes in a freely drifting body. Mercury program officials were interested in the rate and direction of these moments and their possible effect on the pilot's capability to execute programed tasks.

Had an emergency situation arisen during full drift flight, Schirra would have had to use one of the three stick-actuated control modes, because of the warm-up time required by the gyros in the automatic system.

Schirra was credited for the economical management of the control system's fuel supplies. Preflight requirements established by Mercury program officials called for a minimum of 45% hydrogen peroxide remaining in the control system's tanks at the end of three orbits before an affirmative decision could be granted to try for six. At the beginning of the retrofire sequence, the requirement was 35% of fuel remaining.

Nearly four hours after lift-off, Schirra had used only about 10% of his control fuel and had approximately 80% left in the two independent tanks as he began re-entry.

The fly-by-wire mode of the control system was modified by the addition of a panel switch, which—when thrown—locked out the high 24-lb. thrust jets. This permitted the pilot then to use the one-pound thrusters without fear of repeating Scott Carpenter's experience during the MA-7 flight of accidentally triggering both the high and low thrusters simultaneously. Carpenter depleted his fuel during his flight (AW May 28, p. 26).

Because of difficulties experienced by Carpenter with the yaw reference system, the MA-8 pilot was called upon to test his ability to determine yaw position through a reticle on the window and to correlate these observations with panel instruments.

On the sunlit side of the earth, Schirra selected a recognizable terrain feature, then yawed his spacecraft. By looking out the capsule window and by using the periscope, he then attempted to bring Sigma-7 back to its original attitude.

On the night side of the earth, Schirra was to have used a star or star field as his reference point. Carpenter reported difficulties in aligning his capsule along the yaw axis, especially as light diminished.

In other experiments, Schirra was to look for the ignition of three high-intensity flares while his craft passed over Woomera, Australia, and the lighting of 3-million candlepower electric lamps while flying over Durban, South Africa. Because of broken clouds and

Martin Has Nova Study

Washington—Martin Marietta Corp. has received a $300,321 contract to conduct the two-part study of Nova launch vehicle facilities (AW Sept. 24, p. 34). Fifteen companies submitted bids in the competition.

First part of the study will develop preliminary information on facilities required for the most promising Nova configurations, and will be due Dec. 14. Second part, to be due next May, will make a detailed analysis of each promising launch concept.

rain over Woomera, the pilot reported he saw the three flares as a single block of light in the first-orbit experiment. As he passed over Durban during his fifth orbit, cloud cover prevented him from seeing the lamps. Schirra reported that he did see the lights of Perth, Australia, as the people there turned on their lights for him as they did for Glenn.

Two officers on the Indian Ocean tracking ship, Coastal Sentry, reported a visual sighting of the Sigma-7 spacecraft as it passed over the vessel at approximately 12:57 p.m. on a bearing of 270 deg. from the ship. The sighting, the officers said, correlated with tracking plots. They said the spacecraft appeared brighter than Venus.

The MA-8 pilot also carried a handheld 35-mm. camera similar to the one used by Glenn last February and attempted to take photographs of mountains, fault zones, volcanic fields, meteor impacts, glaciers and other terrestrial features of interest to NASA's Goddard Space Flight Center.

The pilot carried food in both paste and cube form and ate during the third and fifth orbits. Food paste consisted of a mixture of beef and vegetables and peaches and applesauce in tubes. Cube food consisted of chopped almonds, compressed fruit and nut bars, fruit cake and ginger bread. Six pounds of water, contained in two flat bottles with extendable tubes, also was carried in the spacecraft.

MA-8 also served as an orbiting testbed for an experiment with various advanced heat-protective materials. The material shingles were provided by Avco Corp., NASA's Langley Research Center, McDonnell Aircraft Corp., Emerson Electric, Chance Vought Corp. and General Electric.

Goddard Space Flight Center installed two emulsion packs, each weighing about one pound, on either side of Schirra's couch to study radiation in space at the altitudes flown by Sigma-7. Of particular interest to Goddard was the energy spectrum of low-energy cosmic ray particles, high-energy gamma rays and rare particles.

Only one hold was encountered in Schirra's countdown and this was occasioned neither by the McDonnell capsule nor the Atlas boosters, but by a tracking radar at Grand Canary Island station. The delay lasted only 15 min.

The pilot was awakened at 2:40 a.m. (all times given here are EDT), ate breakfast at 3:10 a.m. and underwent a preflight physical examination by Flight Surgeon Capt. Howard K. Minners, USAF physician. By 4:25 a.m., the pilot had his bio-sensors attached and had donned his suit. Schirra left hangar S at 5:04 a.m., arrived at Complex 14 at 5:23 and entered the capsule at 5:47. Hatch-sealing procedures began at 6:20 and were completed by 6:30.

During Schirra's first orbit, Mercury Control Center said he transmitted a blood pressure reading almost immediately after capsule separation and turnaround. At 9:05 a.m. EDT the center said it had lost body temperature measurements and was watching Schirra's over-all condition and suit temperature closely for signs of overheating. One source said that the measurements were lost just prior to launch.

Like Carpenter before him, Schirra had a problem with the suit's inlet temperature control. This is a dial numbered from 1 to 8, and the number selected controls the amount of water passed over a heat exchanger—the higher the number the more the water and the cooler the suit.

One observer said Carpenter ran up and down the scale rapidly in attempting to adjust suit inlet temperature, but that this method risked freezing the water on the exchanger. Schirra was understood to move along the scale more slowly, going from a setting of 3.5 up to 8.0 in half steps. He finally settled around 6.5 to 7.0, and the temperature was declared to be no longer a problem at around 11:05 a.m. Ground controllers briefly considered ending the mission after one orbit.

Highest suit temperature was reported to be about 88F and it settled out at around 74F after the early part of the flight.

After the flight, Dr. Minners reported that Schirra's heartbeat ranged from 60 to 120 beats per min. over the course of the entire flight, but averaged in the mid-60's most of the time. Breathing ran from 15 to 20 inhalations per minute and blood pressure was normal.

During the first orbit, which was completed at 9:52 a.m. EDT, Schirra exercised all attitude control system modes. Toward the end of his first orbit, he pitched his capsule down 75 deg. to see the flare experiment conducted at Woomera, Australia.

During his second orbit, Schirra said that he "too saw fireflies," and that by banging the side of his spacecraft, he was able to cause their appearance. Coupled with Carpenter's similar experiment, Schirra's experience gives credence to the theory that the particles originate on the capsule itself.

Sigma-7 entered its third orbit at 11:23 a.m. Toward the end of this orbit, Schirra went into limited drift flight. When told by fellow Astronaut Virgil "Gus" Grissom that he had tentative approval from Mercury control to go for six orbits, the pilot responded: "Hallelujah."

Fourth orbit, beginning at 12:55 p.m., and the fifth, beginning at 2:31 p.m., were spent in full drifting flight. There was some motion around each axis. One NASA spokesman said the capsule passed over Southern California in a nose-down attitude, but that the motions around each axis appeared to be random and revealed no clear-cut pattern. Performance of General Dynamics/Astronautics Atlas booster was smooth and well within tolerance limits. Booster engine cut-off was about 2 sec. early and sustainer engine cut-off about 10 sec. late to compensate for the shorter booster burning time. Orbital injection velocity was 17,560 mph., about 20 mph. faster than planned, but again well within limits.

A new, high-frequency (HF) antenna was installed on the base of the retrorocket pack to improve communications with ground-based stations. Mercury program officials were pleased with its operation.

The antenna, basically a dipole, consisted of two separate flat strips of beryllium, curled first along its longitudinal axis to form a tube. It was then straightened out and curled up like a roll of paper. After separation of capsule and booster, the strips snapped out to their full 13 ft. 8 in. lengths, and then curled into a tubular shape.

Problems were reported at various times in the communications between the MA-8 spacecraft and different ground stations, but these were attributed to atmospheric conditions and not to any equipment malfunction either aboard the capsule or in ground stations.

The decision to go beyond three orbits was based primarily on the fact that 30 min. earlier, the pilot still had 90% of his reaction control fuel remaining. At 2:09 p.m., still in drifting flight, his fuel was still at 90%.

During his fourth orbit, which was completed at 2:16 p.m., the Sigma 7 spacecraft was rotating slowly. Schirra told Hawaii the island area was "very beautiful."

Cdr. Schirra told Flight Director Christopher C. Kraft he was enjoying his flight, and Kraft advised the pilot where to look to attempt to spot the Echo satellite.

On the fifth orbit, Schirra was scheduled to take cloud cover photographs for a 20-min. period, and to eat semi-solid peaches squeezed from a tube. The MA-8 pilot began his sixth and final orbit at 3:44 p.m.

Final 89-min. orbit was spent going over the re-entry checklist, most critical item of which was orienting the capsule at the 34-deg. re-entry angle for the retrofire maneuver. Cdr. Schirra fired his retrorockets at 5:07 p.m. Although Mercury control said there was a 2-sec. delay in this maneuver, the Sigma 7 capsule came in precisely on target, within five miles of the prime recovery force flagship, the carrier Kearsarge, which was steaming with its destroyer force about 330 mi. northeast of Midway.

Pacific tracking ship Watertown tracked the capsule through re-entry to landing. First visual sighting of the capsule came at 5:26 p.m., and it landed in sight of the Kearsarge two minutes later.

On landing, Cdr. Schirra said he was in fine shape, and he elected to remain in his capsule until it was hoisted by aircraft winch to the Kearsarge's deck at 6:09 p.m. Capsule escape hatch was blown at 6:13 p.m., and Schirra came out after being inside his spacecraft 12 hr. 26 min.

The MA-8 pilot received congratulatory telephone calls from President Kennedy and Vice President Johnson. The Vice President invited him to his Texas ranch in November to hunt. The New Jersey congressional delegation said Cdr. Schirra will be honored at a homecoming in Oradell on Oct. 15.

Approximate times and geographic positions projected for Pacific retrorocket firings were: orbit four—contingency at T+5 hr. 44 min.; three degrees north latitude, 140 deg. east longitude. Contingency orbit five—at T+7 hr. 18 min.; 15 deg. north, 135 deg. east. Orbit six—at T+8 hr. 51 min.; 23 deg. north 130 deg. east. Impact in each case was programed for 20 to 21 min. later.

Fourth orbit retro firing would have been due north of New Guinea and southwest of the Carolines. Fifth orbit firing would have been due north of Biak and due east of Manila. Sixth orbit firing was south of Kyushu and northwest of Guam.

Task force 130 was deployed in two areas off Midway Island. The Kearsarge, with destroyers Philip, Renshaw and O'Bannon were stationed for recovery on fifth or sixth orbit. Kearsarge was 275 mi. northeast of Midway. The three destroyers and four Air Force aircraft—three C-130s of the 6593rd Test Squadron of the Hickam-based 6594 Recovery Control (Discoverer) Samos capsules) Group and one SC-54 of the 76th Air Rescue Squadron, Hickam AFB, with para-rescue jumping team aboard—were positioned to conform to an ellipse 200 mi. long and 44 mi. wide with the Kearsarge at the center. Lengthwise axis of the ellipse coincided with the first to fifth orbital flight paths and then shifted to coincide with the sixth orbit flight path when Schirra was cleared to go for six.

Destroyers Epperson, Radford and Walker, together with the same type aircraft, patrolled similar ellipse along the fourth orbit flight path until the signal was given to go for five. Aircraft then shifted to fifth orbit path. Two SA-16 and one SC-54 of the 76th ARS were on Midway airfield as backup, along with a para-rescue jump team. Pacific Air Rescue Center under Col. Walter F. Derck, stationed with TF130 Commander Rear Adm. Charles A. Buchanan in Kunia Tunell, Oahu, directed contingency air rescue operations.

Rose Knot, the Pacific command ship, was 800 mi. north of Guam, between the fifth and sixth orbital paths. Pacific Missile Range Ships filled the communications gap between the Rose Knot and Kokee, Kauai. USNS Huntsville was under the fifth orbital path and USNS Watertown, the sixth orbital path, with USAS American Mariner at the apex of the triangle slightly downrange.

Non-astronaut NASA capsule communicators on board the Huntsville and Watertown monitored communications from Schirra. Astronaut Grissom at Kokee, Kauai anticipated being able to communicate with Schirra from retrofiring until he landed.

Three specially instrumented WV-2 aircraft of the Pacific Missile Range were used to extend Kokee's range. The PMR aircraft were equipped to receive UHF from the capsule, translate it into HF and relay it to the Naval Communications Station in Oahu. From there communications traveled by Hawaiian Telephone Co. lines to Kokee. Grissom's communications to the capsule followed a reverse path.

Interstellar Missions

Cincinnati, Ohio—Interstellar mission times of less than 50 years now appear theoretically possible with multi-staged vehicles and either fission or fusion propulsion systems.

But practical engineering problems, described in the third symposium on Advanced Propulsion Concepts here, may limit the capability of these very-long-range vehicles.

A typical radiator might have an area of 1 sq. mi., radiating from both sides, according to D. F. Spencer and L. D. Jaffe of Jet Propulsion Laboratory. Extremely high levels of magnetic field strength—on the order of several hundred thousand gauss—might be required to confine the plasma produced for power. Waste power, the losses in the system because of its inefficiency, would be enormous.

Major engineering problems remain in all advanced space propulsion systems, according to Spencer and Jaffe. Detailed development of systems using electrical propulsion is currently waiting for the extension of research into major areas where the problem list is still long and the answers are not in sight.

Mercury Atlas-9 Capsule Changes

Cape Canaveral—Mercury Atlas-9 mission capsule, scheduled for a full 24-hr. orbit flight early next year, is expected to weigh about 4,200 lb.—65 lb. less than the weight of the Mercury capsules flown so far. Weight could grow with the addition of scientific experiments, however.

Primary capsule changes involve removal of the periscope and the use of a reticle on the capsule window for yaw reference. Consumables to be added to the MA-9 vehicle are: Four pounds of environmental oxygen; 15-lb. reserve reaction control fuel tank; manual switch to interconnect the automatic and manual reaction control fuel tanks; electrical power batteries and one pound of lithium hydroxide to the carbon dioxide removal system in the environmental control system.

So that the capsule will be within range of at least one tracking station and one command station on every orbit, the Pacific Command Ship Rose Knot will be moved from the western Pacific station it held for the Mercury Atlas-8 mission to a point just off the western coast of South America. It is possible that additional stations may be given a capability to command retrofire. Five stations and the Rose Knot now have this capability.

Decision to move directly to a 24-hr. mission has been based on the preliminary results of Cdr. Walter M. Schirra's performance in MA-8. Mercury Flight Director Christopher C. Kraft called MA-8 "the finest [flight] we've had yet." He praised the pilot's performance, saying Schirra flew the capsule "just like an airplane."

Prime pilot candidate for the next Mercury mission is USAF Maj. Gordon Cooper (AW Oct. 1, p. 22). He would spend a considerable part of the one-day mission in drifting or limited drift flight. Use of these techniques apparently will eliminate the fuel depletion problems experienced in MA-6 and MA-7 missions.

New Study Contracts Awarded In MMRBM Program Definition

Washington — Defense Department has selected single contractors for the mobile medium-range ballistic missile (MMRBM) program definition phase for propulsion, re-entry vehicle and transporter-launcher, and is expected to name a single contractor soon for the integration, assembly and checkout role.

Thiokol Chemical Corp. won the propulsion award, Aeronutronic the re-entry vehicle phase, and Goodyear Aircraft Corp. the transporter-launcher. Hughes and Northrop are contenders for the integration role.

Earlier, General Precision, Inc., had been selected as a single source for program definition phase on the guidance and control system. The only portion of the MMRBM program in which two contractors will be used for program definition is the command and control subsystem, where contracts go to Hughes and a team consisting of Martin and Sylvania.

The Phase 2 development contracts are expected to go to the same companies, if a decision is made to proceed with the MMRBM, except for command and control. There, a single contractor will be selected following the initial phase, expected to be completed within six months.

The ultimate fate of the MMRBM is still uncertain, partly because European nations within the North Atlantic Treaty Organization for whom the weapon is intended are reluctant to base it within their borders or finance its development and production. But the winning contractors for this program definition phase will have the advantage for obtaining development funds if the Defense Department decides to carry the MMRBM to completion.

Industry observers also noted that the award to Aeronutronic for re-entry studies pushed the firm farther into a field largely dominated by the Avco Corp. and General Electric Co. Fairchild Stratos Corp. of Hagerstown, Md., an area suffering from high unemployment, and the Ford Instrument Co. Division of Sperry Rand will be associated with Aeronutronic in the re-entry studies.

Last week's awards were announced after DOD had narrowed the field to two proposals. Losing contractors were Rocketdyne Division, for propulsion; Avco, for re-entry, and AMF for transporter-launcher.

VJ-101D Testbed Trials

Testbed model of the West German VJ-101D VTOL interceptor concept has been undergoing tethered flight trials at Messerschmitt's Manching flight test facility since July, according to Lt. Gen. Josef Kammhuber, retiring inspector general of the West German air force. Kammhuber said a first prototype of the VJ-101D could be available within two years.

There are indications, however, that Lt. Gen. Werner Panitzki, Kammhuber's successor in the top air force post, will take a serious look at the program, possibly canceling the interceptor project, which has been programed as a late 1960s replacement for the Lockheed F-104G, because of the logistics problems that would be involved in support of any large numbers of the aircraft. Work on a less-sophisticated VTOL close-support replacement for the Fiat G.91 is expected to continue.

First Civil Sabreliner Delivery Set in March

Pittsburgh, Pa.—First delivery of a civilian version of the North American Aviation T-39 Sabreliner twin-jet, six-place military transport, aimed for the business flying market, will be made next March to Remmert-Werner, Inc., of St. Louis, named last week by North American as its first distributor.

The airframe manufacturer stated at the National Business Aircraft Assn.'s 15th annual convention here that the 500-mph. Sabreliner will sell for $795,000 in bare-hull configuration and can be ferried to a modification center for installation of cabin furnishings and equipment. Fully-furnished and equipped for all-weather operation, it will sell for $900,000 to $980,000.

Remmert-Werner named AiResearch, Los Angeles, as its West Coast representative to handle civil Sabreliner sales and customizing.

William Remmert, president of the distributor, said he already has seven or eight prospective customers for the Sabreliner executive model. A deposit of $25,000 will be required to establish priority for delivery.

In other NBAA activity, there was a clear trend that the largest share of business airplanes sold over the next 5-10 years will be turboprop-powered, although a market also exists for pure-jet aircraft in the Aero Commander 1121 class. It also appears there will be a sizeable volume of conversions of piston-powered airplanes in the Beech 18 class to turboprop engines as the new powerplants become available.

Caribou 2 Engine

Washington—General Electric T64 turboprop engine has been chosen by the Army to power its de Havilland AC-2 Caribou twin-engine short-takeoff-and-landing transport.

The Caribou 2, which will have a five-ton payload capability (AW July 23, p. 26), will be the successor to the AC-1, powered by Pratt & Whitney R2000 engines, which is now in Army service in Southeast Asia and the continental U. S. No contracts for the aircraft or engines have yet been negotiated.

A firm indication of future turboprop conversions was evident in the first display of the turboprop-powered de Havilland Dove, being developed by Riley Aeronautics of Ft. Lauderdale, Fla. First flight is scheduled next March, and Riley says there are a half-dozen firm orders for the new Dove.

The airplane will be powered by two Turbomeca Astazou 2 engines with 530 eshp. It will be pressurized and will sell for $375,000 fully-equipped with a 6-to-10 place interior and electronics, including radar.

Avco Corp. to Supply Minuteman Mark 2

Washington—Avco Corp. Lycoming Division has been awarded a $39,566,000 contract for production of improved first generation re-entry vehicles for the Air Force Minuteman intercontinental ballistic missile.

Development of the Mark 2 re-entry body was conducted at the Avco Research and Advanced Development Division under a previously unannounced contract which amounted to more than $29 million.

Production of the Mark 2 will be at the Lycoming plant in Stratford, Conn.

A second generation Minuteman re-entry vehicle competition is now in progress, with proposals due at the Ballistic Systems Division next week.

Naval Air Chief

Washington—Vice Adm. William A. Schoech, who at present is commander of the U.S. Seventh Fleet in the Pacific, will relieve Vice Adm. Robert B. Pirie as deputy chief of naval operations for air in November, as predicted in Aviation Week (Aug. 20, p. 25).

Rear Adm. Thomas H. Moorer will become Seventh Fleet commander Oct. 13 with the rank of vice admiral. Until recently, he was director of the Navy's Long-Range Directives Group in the Office of the Chief of Naval Operations.

Explorer 14 Sends Valuable Radiation Data

By George Alexander

Cape Canaveral—Explorer 14 (S-3A) energetic particles satellite launched last week was returning excellent data which is expected to provide new information on the profile of the earth's magnetic field, the interplanetary magnetosphere and geomagnetically trapped radiation.

Although not designed specifically for measuring the intensity of the artificial radiation caused by the July 9 U. S. high-altitude nuclear detonation (AW Oct. 1, p. 24), Explorer 14 contains instruments which can detect and measure high-energy particles like those which have intensified the Van Allen radiation belt as a result of that blast.

The 89-lb., octagonal-shaped satellite was successfully launched by a Douglas Delta three-stage vehicle at 5:12 p.m. (EST) Oct. 2 from here at an angular inclination to the equator of 33 deg. The flight was the twelfth consecutive success for the Delta (AW Sept. 24, p. 41), and marked the first use of the uprated 168,000-lb.-thrust Rocketdyne DM-21 engine in the Delta.

Launch trajectory was comparatively flat to achieve the desired eccentric orbit of 53,000 mi. apogee and 185 stat. mi. perigee. First ephemeris was determined by NASA to be 61,000 mi. apogee and 175 mi. perigee. Planned orbital period of Explorer 14 was 31 hr. and the actual was 36 hr. 6 min.

Five of the six experiments carried on board Explorer 14 were contained within the 5-in. deep, 29-in. wide octagonal section of the satellite:

• **Proton Analyzer,** developed by NASA's Ames Research Center. This unit, measuring 3 x 4 x 2 in. is to determine the spectrum and flux of low-energy protons beyond 24,000 mi. Energy range to be monitored was from 2 to 2,000 electron volts, within ±5%.

• **Trapped Particle Radiation,** developed by the State University of Iowa, to measure cosmic rays and different particle radiations throughout the satellite's orbital path. Iowa State experiment uses four Geiger counters. One, similar to that flown on Explorers 7 and 12, was omnidirectional and measured impinging protons above 20 mev. (million electron volts) and electrons above 1.6 mev. The other three counters are of the thin-window type; one contained a magnet to trap low energy electrons at 2,000 ev. and above. Two of the tubes were to detect protons at 50,000 ev. and above, and the third at 4 mev. and above. Aside from the low-energy electron tube, the other Geiger counters are to sample electrons at 25,000 ev. and above.

• **Cosmic Ray,** developed by NASA's Goddard Space Flight Center. This unit, consisting of a double scintillation telescope, a single-crystal cadmium sulphide detector and two connected pancake-type Geiger counters, is to measure, respectively, total cosmic ray flux, proton flux above 700 mev. and the low-energy portion of the alpha particle spectrum; low-energy gamma rays, protons from 1 mev. and incident particles from 10,000 ev. to 20 mev.; and proton flux above 75 mev., electrons above 800 ev. and cosmic ray flux above 75 mev.

• **Ion-Electron Detector,** developed by Goddard. This device is to measure particle fluxes, types and energies as a function of direction, time and position within, above and below the Van Allen radiation belt. Range of the ion detector is 10,000 ev. to 1 mev., of the electron detector from 1,000 to 10,000 ev., and of the total energy detector from 3,000 ev. to 1 mev. for protons and from 100 to 1,000 ev. for electrons.

• **Solar Cell Damage,** an experiment developed by Goddard. This experiment was designed to compare the deterioration of P-on-N and N-on-P solar cells when exposed directly to radiation (AW Sept. 17, p. 32). Two strips of P-on-N and two of N-on-P cells, 10 cells to each strip, were mounted on a wall of the octagonal section of the satellite. One strip of each cell type was protected by sliding 3-mil shields, while the other strip was unprotected.

Goddard hopes to compare the radiation-induced degradation of both cell types, with and without protection.

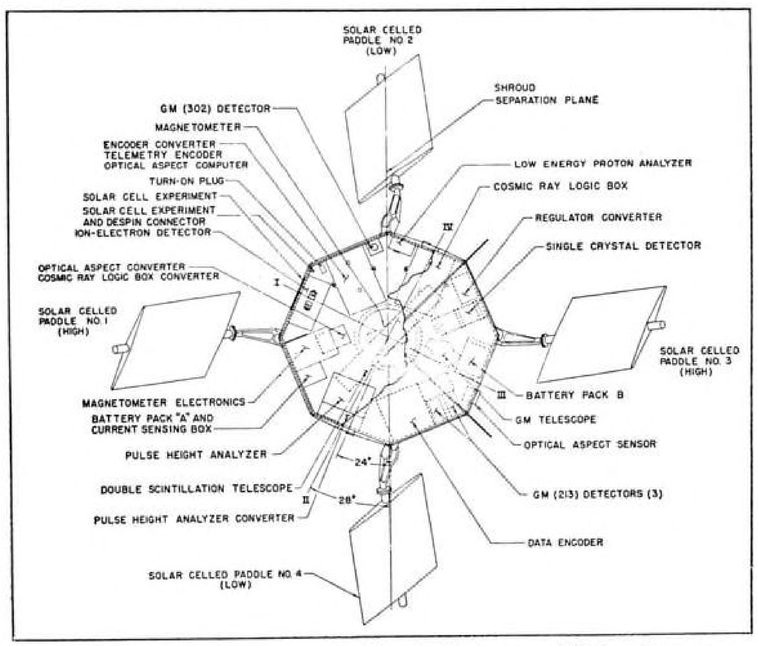
• **Magnetic field,** an experiment developed by the University of New Hampshire to measure the magnitude and direction of the interplanetary magnetic field between 20,000 mi. altitude and apogee, and the limit of the geomagnetic field at an altitude of 40,000 mi. The magnetometer is mounted at the end of a 34-in. shaft protruding from the center of the octagonal section.

Launch window for Explorer 14 was approximately one hour and was dictated both by solar heating restrictions and lighting conditions at time of apogee. To reduce solar heating of the experiments and electronics aboard the satellite, the vehicle was launched on a trajectory at a right angle to the earth sun-line.

The resultant orbital plot prevented the sun from striking the payload during third stage spin-up and coast at an angle greater than 30 deg.

By launching between 5 and 6 p.m. (EST), Goddard was able to limit the time that the spacecraft was within the earth's shadow during its long climb to apogee from a possible 4.5 hr. to roughly 2.5 hr.

Explorer 14 is equipped with four solar paddles which were expanded as the protective payload fairing was jettisoned shortly after second stage firing.



EXPLORER 14 (S-3A) experiments are detailed. Satellite's expected lifetime is two years.

Early Inflatable Micrometeoroid Paraglider Re-entry Tests Planned

By Irving Stone

Los Angeles—Two of the three inflatable micrometeoroid paragliders (IMP) being developed by Space-General Corp., El Monte, Calif., for NASA's Langley Research Center, are programed to be the first vehicles of this type to undergo earth re-entry trials when they are flight-tested early next year.

Paraglider prototype model (AW June 4, p. 37) will undergo structural and environmental tests late this year to establish compatibility with space and re-entry regimes.

Program aims to demonstrate, in addition to re-entry glide characteristics, the capability of the vehicle's capacitance-type micrometeoroid sensors, and measurement of the flux and penetration properties of micrometeoroids.

Inflated IMP configuration is approximately 13 ft. long, and about 20 ft. wide at the aft end. It includes a tubular curved nose (apex) 20 in. in diameter, and two tubular leading edge booms and a center or keel boom, each 20 in. in diameter at the forward ends (where they join the nose) and tapering to 8 in. in diameter at the aft ends.

Vertical, tubular section approximately 12 ft. long and 12 in. in diameter is suspended from the keel boom, and is steadied with cables from the leading edge booms. Material for IMP's inflatable portions is approximately 0.025 in. thick, is made of glass fiber coated with silicone resin, and is designed to take pressures of 14 psig. (plus a safety factor of 3), and temperatures up to 1,150F for about 10 sec.

Membranes or sails, which extend from the leading edge booms to the keel boom, present an area of approximately 112 sq. ft. Sail material, similar to that used in inflatable sections, is about 0.008 in. thick.

Paraglider payload is carried at the bottom of the vertical shroud. Re-entry portion of the payload contains a nitrogen pressurizing bottle, camera for observing paraglider deployment and re-entry orientation, beacon to permit tracking while IMP is in space and during its glide to ground, and a valving system to maintain a constant pressure differential of 14 psig. between the inflated sections and ambient pressure during re-entry, and a reduced pressure of 5 psig. thereafter.

Payload also includes a nose cone, jettisoned before paraglider re-entry, which contains power supplies, programmer, instrumentation, and telemetry.

Weight of recoverable portion of payload (exclusive of the jettisonable nose cone and its contents) is 45 lb. and weight of the paraglider proper also is 45 lb., giving a wing (sail) loading of 0.8 psf. during re-entry.

IMP sail's top and bottom surfaces are covered, each to the extent of about 100 sq. ft., with capacitance-type micrometeoroid sensors, which consist of five alternate layers of aluminum and Mylar. Layers are electrically connected so that both micrometeoroid impact and depth of penetration is recorded and telemetered to the ground.

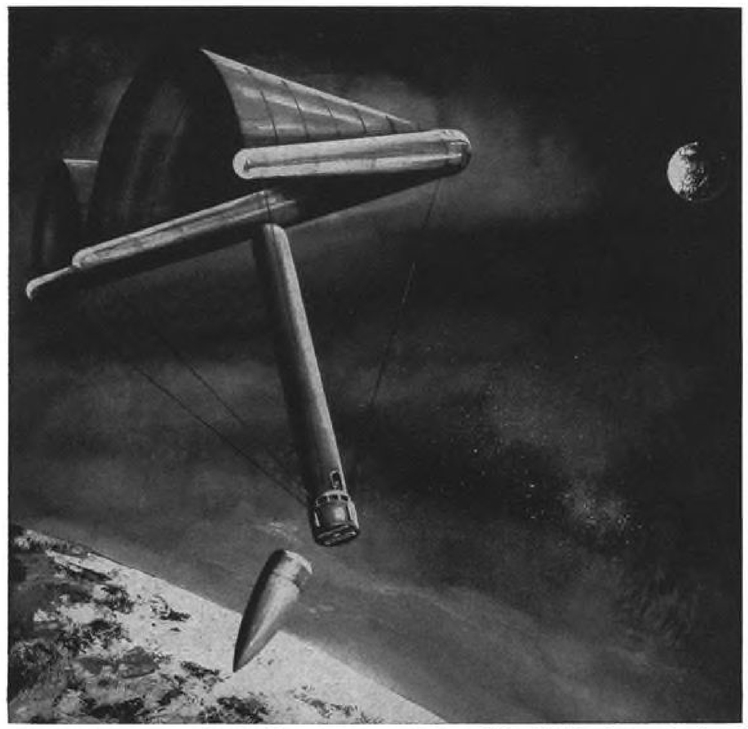
When packed, IMP fits in a glass-cloth canister 13 in. in diameter and approximately 33 in. long. The canister, which is bonded to the glider nose, serves the dual purpose of containing the folded paraglider and acting as a heat shield during re-entry.

Paraglider is inflated in two steps—first a low-pressure forming stage, followed by inflation to the full 14 psig. A control valve maintains this pressure at altitude, and a relief valve pumps excess pressure during re-entry.

Glider is trimmed to perform a spiral maneuver following re-entry into the atmosphere.

IMP is carried into space by a Space-General Aerobee 150 rocket. Following sustainer burnout, the vehicle is despun. At approximately 250,000 ft., a retro-rocket separates the sustainer from the forward section of the rocket, immediately after firing of a shaped charge separation system. In the separation, the sustainer pulls a 27-in. outer skin extension into which the paraglider canister has fitted. As the sustainer falls away, it pulls a lanyard which opens the aft-facing canister, allowing the paraglider to free itself. Following this, the inflation sequence is begun.

The glider ascends to a maximum altitude of approximately 700,000 ft. and remains in space above 400,000 ft. for a total of five minutes. At 400,000 ft., on the descending part of the trajectory, the nose cone is jettisoned by shaped-charge action and IMP is ready for re-entry. Since the vehicle is not attitude-controlled, it is designed to attain its hypersonic trim (aerodynamic stability) condition prior to achieving maximum air and temperature loads. The re-entry condition occurs at a speed of approximately 5,500 fps.



ARTIST'S VERSION of inflatable micrometeoroid paraglider (IMP), being developed by Space-General Corp. for NASA, shows nose cone containing power supplies, programmer, instrumentation, and telemetry being jettisoned just before paraglider begins re-entry. Sketch shows configuration of tubular structural members and sails, the latter being covered, top and bottom, with the micrometeoroid sensors.

DOD Prepares Conflict-of-Interest Code

By Philip J. Klass

Washington—Basic principles for a conflict-of-interest conduct code which will be applied to organizations engaged in Defense Department-sponsored research and development programs are taking shape in the Pentagon. Current emphasis is on converting these principles into unequivocal legal language to permit them to be applied routinely by contracting officers.

The formulation of such a code by various government agencies was directed by the President, based on recommendations in the Report on Government Contracting for Research and Development, prepared by a committee headed by Budget Bureau Director David Bell (AW May 7, p. 33).

Most difficult portion of the problem for Defense Department is to define conflict-of-interest as it applies to companies that serve as technical advisers or help prepare system specifications during the initial program definition phase, and then want to compete later for hardware production contracts.

Two basic principles are guiding DOD in preparing its code:

- **No company** should be tempted to slant the technical advice it gives in the hope of gaining a competitive advantage in subsequent procurements.
- **No company** should be allowed to gain unfair competitive advantage as a result of its role as technical adviser or contractor for the early program definition phase.

The hardware exclusion clause in the recently awarded contract to International Telephone & Telegraph Corp., for services as a technical adviser to the Defense Communications Agency on the military communication satellite system (AW Sept. 24, p. 39), is an example of current Pentagon thinking, but it is not necessarily a model for the future code. Already DOD officials recognize "grey areas" in the ITT contract which may pose future problems.

Here is how the current Defense Department conflict-of-interest principles might apply under several types of common situations:

If a contract is awarded to a single company to develop specifications for a new weapon or support system as a technical adviser to a military service, giving the firm the opportunity to slant the specifications toward techniques in which it specializes, then that company should be banned from competitive bidding for subsequent development-production contracts.

However, if the specifications are to be prepared as a program definition phase, with the expectation that the follow-on development and production will be given to the same company without holding a competition, then there is no conflict in allowing the company to prepare the specifications.

Where the program definition phase is to be followed by an open competition for development and production, and where two or more companies have program definition contracts, there would be no exclusion from subsequent phase bidding, providing that all program definition contractor reports are made available to other prospective bidders for the next phase. Since the Phase 2 specifications are likely to incorporate the best ideas of the several Phase 1 programs, and these are made known to all bidders, no single program definition contractor obtains an unfair advantage.

Space Technology Laboratories, under contract to the Defense Communications Agency, conducted a study to determine what characteristics are desirable in a communication satellite system to make it suitable for military use. If this had been the only such study conducted, and if the STL recommendations were to become the requirements for the new military communication satellite system, then STL would be banned from bidding for the upcoming satellite development contracts.

But there have been a number of similar studies, including those made by the Institute of Defense Analysis, the Air Force and others. All of these reports will aid DCA as it formulates the over-all specifications and the STL views are not expected to dominate. For this reason, STL will be allowed to bid for the upcoming satellite programs.

However, the procedures followed in one of the USAF's existing military space programs probably would be banned if it were being awarded today. The Air Force awarded a contract to a single company to develop the operational requirements and specifications for the space system. These were used in the subsequent hardware development competition which was won by the same contractor.

More recently, one of the USAF's development centers needed to prepare the specification for a major support system but felt it lacked the technical manpower to do so. It therefore requested two companies to assist by drawing up specifications for the system on which the two firms would subsequently be invited, along with others, to submit bids. When word of this reached the Pentagon, the center was advised that this was an intolerable conflict-of-interest situation.

The contract awarded to ITT for its military communication satellite role excludes the company from bidding on "any of the hardware directly associated with the satellite or with ground equipment directly related to the satellite" for a five-year period. This clause applies to any companies which ITT might acquire during this period. However, it does not apply to any products which ITT already had developed at the time the contract was signed.

One thorny question could arise if ITT attempts to sell its recently developed mobile communication satellite ground terminals (AW Sept. 17, p. 98) for use with the new military communication satellite system. Although the latter would have to operate at different frequencies than the present design, it is a moot point whether the existing mobile terminal modified to handle the new frequencies is a product developed at the time of contract execution or a newly developed one and therefore excluded by the contract.

Government-financed study contracts pose another problem. For example, if a company is given a government contract to study the feasibility of using lasers for space communications, where the study is based on its own know-how and a search of the open literature, then it need not be banned later from bidding on a program to develop a laser communication system.

However, if the company contract calls for it to visit all firms working on lasers under government contract, with full access to all details of their work, then the company is acting as an agent of the government and should be banned from exploiting such knowledge in a subsequent competition.

Current estimates are that it will probably be two to four months before DOD has prepared a final draft of its conflict-of-interest code.

Military Comsat Plans

Washington—Requests for proposal on the medium-altitude military communication satellite are expected to go out to industry no earlier than Nov. 1, and the RFP for the synchronous-altitude communication satellite probably will not be released until early next year.

Companies expected to bid on the medium-altitude satellite include Philco, Radio Corp. of America and Space Technology Laboratories. Contenders for the synchronous orbit satellite are expected to include Bendix, General Electric, General Telephone & Electronics, Hughes Aircraft, Lockheed and STL. There is speculation that Bendix and Lockheed also may bid for the medium-altitude satellite.

Canadian-U.S. Alouette Satellite Shows Perfect Early Performance

Los Angeles—All equipment and scientific experiments aboard the Canadian satellite Alouette, orbiting the earth every 105.4 min. in a near-polar orbit, were operating perfectly through the middle of last week, according to a spokesman for Canada's Defense Research Telecommunications Establishment.

Joint Canadian-National Aeronautics and Space Administration satellite, designated S-27 (AW Oct. 1, p. 26), was launched from Pt. Arguello, Calif., at 11:05 p.m. PDT Friday, Sept. 28 after a brief delay into an orbit inclined 80.48 deg. from the equator. Perigee is 616.9 stat. mi., apogee 639.8 mi.

NASA described the orbit as one of the best ever achieved by its satellites. The Air Force Thor Agena B booster combination placed Alouette into an orbit very closely approximating the one intended.

Alouette's principal role is that of a topside sounder—to measure the electron density of the ionosphere from above the peak level of ionization over the polar and auroral zones of North America throughout its anticipated maximum lifetime of one year.

By late last week, Canadian scientists expected to determine whether the satellite's solar cells had suffered any degradation in performance as a result of exposure to high-energy electrons released by the July 9 high-altitude nuclear explosion over Johnston Island (AW Oct. 1, p. 24).

Alouette's apogee is well below the altitude of the belt's peak, but is only 50 mi. below the apogees of the Transit 4B and TRAAC satellites, whose solar cells experienced a sudden sharp deterioration after the July 9 blast.

Companion NASA topside sounding experiment, S-48, which is scheduled to go into an orbit identical to that of S-27, is being delayed to give engineers a chance to change its solar cells to the more radiation-resistant N-on-P type.

Initial soundings from the Alouette satellite as it passed over Ottawa indicated, as expected, that the ionosphere is an excellent reflector of radio waves broadcast from above as well as below it. The satellite was radiating radio signals swept in frequency between 1.6 and 11.5 mc.

Depending on ionospheric conditions, some of the higher frequencies were penetrating the ionosphere and being picked up by the satellite after bouncing off the ground. During its first pass over Ottawa, the critical frequency, below which no signals could penetrate the ionosphere, was 5.5 mc.

Sounding stations throughout Canada and elsewhere were probing the underside of the ionosphere simultaneously with topside soundings and tapes of return signals are being forwarded for processing by the Defense Research Telecommunications Establishment in Ottawa.

In one exercise conducted from an Ottawa station as the satellite passed overhead, the satellite sounder's results correlated exactly with bottomside sounding, indicating peak ionization at that time and location to be about 300 km.

DOD Penalty Sought For Security Misuse

Washington—House Government Operations Committee, in its latest report on government secrecy, urged the Defense Department to establish penalties for officials who place a security classification on documents for other than security reasons.

"Until the generalizations about the public's right to know are backed up by specific rules and regulations—until set penalties are established for abuse of the classification system," the committee said, "fine promises and friendly phrases cannot dispel the fear that information which has no effect on the nation's security is being hidden by secrecy stamps."

The committee praised Defense Secretary Robert S. McNamara's statement, "when in doubt, underclassify," but said it "has little effect when there is absolutely no penalty to prevent secrecy from being used to ensure individual job security rather than national military security. . . . A security system which carries no penalties for using secrecy stamps to hide errors in judgments, waste, inefficiency or worse is a perversion of true security."

The committee also decried "the lack of an effective procedure for appeals against abuse of the information classification system." The committee said President Kennedy's decision to handle this by "the incidental assignment" of the job "to a busy assistant" does not fill the need. Lee C. White is the President's assistant special counsel so assigned.

White wrote Chairman John E. Moss (D.-Calif.) of the House Special Government Information Subcommittee on Sept. 12 that he has received no complaints about executive secrecy, and added, "any such complaints that may be received will be handled as expeditiously and fairly as possible."

"Until a responsible individual in the White House is charged with the primary duty of receiving and acting upon complaints against abuse of the classification system—until a fully operating appeals system is set up and widely publicized," the committee said, "the most important safety valve in the information security system is completely useless."

The committee's recommendations stemmed from its information subcommittee's study of Executive Order 10501 issued Nov. 5, 1953, and designed to safeguard information considered vital to U.S. security. The subcommittee's report did not concern itself with the Defense Department's Mar. 23 directive cloaking military space activities in secrecy. Rep. Moss has shown little inclination to do anything more than ask McNamara to provide a declassified version of that directive (AW May 21, p. 26).

In discussing government secrecy generally, the committee said over the years "there has been significant progress toward resolution of the conflict between the necessity for a fully informed public in a democratic society and the importance of protecting defense information to help preserve that society. There has been a gradual recognition of the fact that the ideal information security system is one which defines very carefully those secrets which are imperative to the nation's defense and then protects them as carefully as possible."

First Minuteman Shot From Vandenberg Fails

Vandenberg AFB—First Minuteman ICBM to be launched here was destroyed by a range safety officer after a 59-sec. flight in which the solid-fuel missile attained an altitude of about 75,000 ft. First stage separation was programed to occur at 96,000 ft.

The Sept. 28 launch came after a 7 hr. and 30 min. countdown in which no technical delays were necessary. According to Brig. Gen. Samuel Phillips, deputy commander, Minuteman, USAF Ballistic Systems Division, the ICBM's track was perfect until it "suddenly went awry" at about the time second stage ignition should have taken place. Target area was north of Eniwetok Atoll in the Central Pacific about 4,000 naut. mi. away.

Air Force late last week could not identify the precise cause of the malfunction. A SAC crew, supervised by Air Force Systems Command and contractor personnel, conducted the launch from an operational prototype silo here.

Counter-Insurgency Aircraft Plans Studied

By Larry Booda

Washington—Flurry of proposals from industry to meet current and future requirements for counter-insurgency (COIN) close support aircraft has descended on the Air Force, Army and the Navy, acting for the Marine Corps. Most are for short takeoff and landing (STOL) aircraft powered by one or two turboprop engines.

Air Force and Army are examining the possibilities of modifying existing aircraft for use in the immediate future. All three services are studying concepts and proposals for new aircraft that will fill the need in the more distant future.

Gen. Maxwell Taylor, who became chairman of the Joint Chiefs of Staff on Oct. 1, is known to favor a concept wherein the counter-insurgency aircraft would perform its mission at low altitudes while protected by an umbrella of air superiority fighters. He has the backing of the Administration.

The near future counter-insurgency aircraft would be a modern replacement for the Douglas B-26 and AD series of attack planes used for close support during the Korean war. Emphasis would be on simplicity, reliability and load-carrying ability. Takeoff and landing speed of 40 to 42 kt. would be necessary for operation from rough airstrips, while the maneuvering range would be between 75 kt. and 200-300 kt.

The counter-insurgency aircraft would fill the lower end of the speed and altitude spectrum represented by the TFX tactical fighter, which will have Mach 2.5 speed and 70,000-ft.-plus altitude capabilities, and the VAX lower speed, higher load-carrying attack aircraft.

But a counter-insurgency fighter based on some existing design is wanted as soon as possible. Air Force recently submitted a proposal to develop a new counter-insurgency aircraft based on a Republic Aviation Corp. design. Deputy Secretary of Defense Roswell Gilpatric disapproved the request on the grounds that an in-production aircraft that will require little modification is needed for the near future. This indicates that Defense Department wants clearer definitions of requirements before any specific project for an all-new aircraft is approved.

The TFX, which is to be developed in separate versions for the Air Force and the Navy, is expected to be operational in the two services in 1967 and 1969, respectively. The TFX is now in the final stages of a second rework of proposals by General Dynamics/Ft. Worth and Boeing-Wichita (AW Sept. 17, p. 25). Disparities between Air Force and Navy needs are now described as having been trimmed to where there is about 15% difference.

The VAX requirements have not yet been approved and are not expected to be until about six months after the TFX source selection is made. Since the VAX will be less complex than the TFX, its development time will be shorter—about four years. As proposed by the Navy, the VAX would be a Mach 1.8 aircraft which would be a replacement for the current Douglas A4D series.

If the high-low aircraft combination concept is adopted it would spell the end of the VAX, inasmuch as it comes between a future counter-insurgency aircraft and the TFX.

As the TFX is now conceived, it will weigh 60,000 lb. in the Air Force version and 55,000 lb. in the Navy version. Both will carry 20,000 lb. of stores and will be able to take off in 3,000 ft. and clear a 50-ft. obstacle. The Navy version will have its own long-range, air-to-air missile system embodying the idea of the Eagle-Missileer missile-subsonic fighter which the Navy was forced to cancel early last year. Hughes Aircraft Co. is developing the missile.

The VAX is designed to weigh about 30,000 lb. and be powered by two turbofan engines. It would carry 10,000 lb. of stores and would be able to take off in 1,500 ft. over a 50-ft. obstacle. The supersonic capability would give pilots some projection against fighter opposition. Engineers say that little difference in power would be required to change the speed ability from Mach 1.2 to Mach 1.8.

If Defense Department decides to fill the counter-insurgency need immediately with an in-being aircraft, there are two leading contenders. One is the Grumman AO-1 Mohawk twin-turboprop, two-place reconnaissance aircraft which is now in the Army inventory. The other is a modification of the North American T-28 equipped with a turboprop engine, called the RS-28 (AW Oct. 1, p. 21).

The Mohawk was originally designed as an STOL aircraft. One model is fitted with side-looking radar for battlefield reconnaissance in all kinds of weather. The other is configured to perform a photographic mission. It is powered by two Lycoming T53-L-3 engines developing 1,050 hp. each. As a counter-insurgency aircraft, it would be fitted with conventional weapons.

The RS-28 (reconnaissance-strike) model proposed by North American would be powered by a 2,450-hp. Lycoming T55 engine. The airframe would be either the Air Force T-28A or the Navy T-28B, many of which have already been modified to the T-28D to perform the counter-insurgency mission in South Vietnam.

Both Air Force and Army are actively evaluating these and other aircraft. At Eglin AFB, Fla., the Tactical Air Command's Special Air Warfare Center is flying the AO-1 and the T-28D. The Army's newly formed Combat Developments Command is flying them at Ft. Rucker, Ala. and in conjunction with troops at the Special Warfare School, Ft. Bragg, N. C.

The present opinion of defense officials is that a twin-engined aircraft will perform the mission better. They cite the better STOL performance with two engines directing air flow over the wings at high angles of attack and the ability to return to base in the event of the failure of one engine.

The Navy is not actively asking for future counter-insurgency proposals in behalf of the Marine Corps, although the Marines are looking into possibilities themselves. The Marines expect to participate in procurement of any interim counter-insurgency aircraft.

Some Army and Marine officers believe that the aircraft used for counter-insurgency in the future should be scaled down in size. One source suggests a twin-engine aircraft with each engine developing 550 hp. The contention is that such an aircraft would be available in greater numbers for covering a greater number of targets, would be light enough to allow less pilot skill than a heavier aircraft, and would still embody most of qualities of heavier aircraft.

Defense Department defines counter-insurgency as all military, political, economic, psychological and sociological activities directed toward preventing and suppressing resistance groups whose actions range in degree of violence and scope from subversive political activity to violent actions by large guerrilla elements to overthrow a duly established government.

Undisclosed Payload

Air Force successfully launched a Thor-Agena booster combination with an undisclosed payload from Vandenberg AFB at 4:40 PDT on Saturday, Sept. 29, the fourteenth unidentified Thor-Agena shot from that base since the Department of Defense Space Secrecy Directive (AW May 21 p. 26) went into effect last spring. In addition to the Thor-Agena shots, Air Force has launched five Blue Scouts and eight Atlas-Agenas from nearby Pt. Arguello, since the directive according to Aviation Week count.

Weightlessness Effects Worrying Soviets

By Cecil Brownlow

Varna, Bulgaria—Soviet bioastronautics experts still fear that the effects of weightlessness over prolonged periods may seriously hamper man's ability to work effectively in space or respond to ground commands for action.

Despite the recent successful multi-day orbits of the manned Vostok 3 and 4 vehicles (AW Aug. 20, p. 26), in which Maj. Andrian Nikolayev and Lt. Col. Pavel Popovich apparently completed their assigned tasks without a major problem, concern over the possible potential effects of long duration in a weightless environment were expressed here at the 13th International Astronautical Congress by both Russian scientists and Cosmonaut Maj. Gherman Titov.

Report prepared by Soviet Army Col. Vladimir I. Yazdovsky, a leading figure in the Vostok bioastronautics program and an associate of the Academy of Medical Sciences of the USSR, indicated that the Russians may be leaning toward the theory held by some U.S. neurologists that a prolonged absence of pressure on the brain could lead to a form of mental instability and perhaps a breakdown in the body's cellular structure.

Yazdovsky's report said a "special experimental study of this problem of great significance" is now under way within the Soviet Union in an effort to determine the deteriorating effects on man, if any, of long-duration periods of weightlessness.

In response to questions, a colleague of the absent Yazdovsky who read the latter's report at the conference said that there is no scientific evidence available to date to confirm definitely the hypothesis. However, Soviet scientists fear that a "certain amount of atrophy" may become evident after an astronaut has been subjected to a prolonged period of weightlessness, particularly upon his re-entry into the earth's atmosphere.

He later estimated that this might occur in flights over one week, with a possible breaking down of the molecular or cellular distribution within the astronaut's body.

To help combat this, he said, Russian bioastronautics specialists are recommending "all sorts of exercises during a prolonged flight."

Upon their return, he added, Nikolayev and Popovich showed no signs of any "physiological disruptions at the molecular and cellular levels . . . and it is difficult to foresee how long a flight [would be necessary] . . . before this began, but generally . . . the more short-lived a cell life, the earlier it breaks down in weightlessness."

Maj. Titov, who suffered periods of dizziness during his 17½ orbits around the earth in August, 1961 (AW Mar. 12, p. 114), told delegates to the Congress that Nikolayev and Popovich were sent through a special training program prior to their flights. The program was designed to strengthen their vestibulary systems, and neither suffered from a feeling of nausea during their respective periods of 94 hr. 25 min., and 71 hr. in space, Titov said. Training presumably consisted primarily of a series of physical exercises.

Titov added, however, that Soviet scientists are not yet willing to draw any firm conclusions as to the effects of weightlessness on man for periods extending beyond 24 hr. He said:

"For 24 consecutive hours, the problems of studying weightlessness are concluded, but weightlessness is still a main factor [in manned space flight considerations] and, if we can't create an artificial weight, it is impossible to say when this problem . . . can be solved."

Titov said that while the Vostok capsule has a design orbit potential of 10 days, it was decided to keep Nikolayev in space for a maximum of four days to investigate the effects of weightlessness within this relatively limited framework of time.

Nikolayev and Popovich, he said, freed themselves from the bands of their life-support couches and worked for brief periods in a free state. During these times, Titov said, the two cosmonauts operated the Vostok's manual control system, made entries in their log books and completed other tasks.

The two men reported that they detected a "slight difference between their feeling when freely moving about and when strapped in. . . . Nikolayev, for example, felt very light," Titov noted. The two cosmonauts also recommended that in future flights some type of support be installed as an anchoring point for the crew member when he is not on his couch.

Titov also said that he had remained strapped to the Vostok 2 couch during all of his 25 hr. in orbit. This contradicted a statement attributed to him which appeared in Pravda shortly after the flight in which it was stated that he was not restrained throughout the flight (AW Sept. 4, 1961, p. 34).

Concern over weightlessness also runs counter to a statement made at the time by Soviet Bioscientist Roman Beyevsky who said then that Titov's flight proved that prolonged weightlessness has no effect upon man's work capacity, body functions or nervous system.

Another Titov remark contradicted an earlier Moscow statement that cabin temperature during the Vostok 2 flight ranged from 20-22C (AW Aug. 14, 1961, p. 32). Titov said here that he could regulate his cabin temperature and since "I am from Siberia, I chose 12C temperature [during orbit]. Before landing, I regulated it at 18C."

Generally, Yazdovsky said, he does not believe prolonged periods of weightlessness will have any long-range effects upon an astronaut at the basic physiological level. "However, on such matters as tissue regeneration, blood structure, etc., we are not clear."

He theorized that the dizziness and nausea encountered by Titov at periods during his flight resulted from an imbalance in the afferent nervous system and that no pathological changes were recorded from either Nikolayev or Popovich during the orbits of Vostok 3 and 4. He added that their working level remained high throughout the flight, including the periods when they released the bands from their life-support couches and moved in a free state.

Titov, in his unscheduled appearance at the Congress, said that except for widening studies on the problems of weightlessness, each Soviet space flight has a mission profile that overlaps but does not repeat earlier experiments.

In this regard, he was critical of the first two three-orbit Mercury flights, saying that he could not understand why the U.S. insisted upon repeating experiments after one had been successfully completed rather than taking a step forward or at least in another direction.

He also presented the following brief stepping-stone objectives of the manned Soviet space flights to date:

- **Vostok 1**—Study of the "life conditions" of a cosmonaut during launch, flight and landing; verification of the possibility of human life in a state of weightlessness; study of conditions needed to establish radio communications between a satellite and the earth.
- **Vostok 2**—Examination of the influences of a long period in orbit upon organisms; study of the effects of weightlessness on such a flight; verification of the functioning of the capsule's biological systems; operation in space for the first time of the Vostok's manual control unit.
- **Vostoks 3 and 4**—Study of group flight and rendezvous techniques (AW Oct. 1, p. 17); lengthy manipulation of the manual control system, including its operation by the cosmonaut while suspended in a free state; a broadened examination of the effects of weightlessness in all its aspects.

Commenting on the Vostok package, the Soviet cosmonaut said provision has been made for safe ejection of the space pilot during an emergency on the launch pad as well as after launch. "We have had no need to use it thus far," he said, but "we have studied these systems on space ships with animals aboard, and they worked wonderfully." These tests apparently included the successful ejections from orbit of the dogs Strelka and Belka (AW Aug. 29, 1960, p. 28).

V. I. Moroz, of Moscow's Sternberg Astronomical Institute, summarized data obtained from recent infrared spectroscopy studies of Venus conducted at the institute and the Crimean Astrophysical Observatory in a report which also alluded to "space ship flights to Venus planned for the nearest future." The report said the studies conducted last fall and this summer have led to these conclusions:

- **Venus cloud layer** consists of dust particles. Possibility of the existence of ice particles in the layer, as predicted by some, is "excluded" because the crystals "should give a depression near 1.5 microns whose absence undoubtedly follows from our recent observations."
- **Radiation** in the relatively far infrared region, possibly beginning from three microns, is intensely absorbed by an "unknown substance" which masks the CO_2 bands over the cloud cover and causes the strong "greenhouse effect" below the cloud layer.
- **Greenhouse effect,** in turn, leads to a high temperature on the planet's surface, to a large depth of the lower atmosphere and relatively large pressures near the surface. Moroz estimated the high temperature at the planet's surface at 600K on the night side and 700-907K on the day side.

After the report had been presented for Moroz by V. K. Prokofyev, of the Crimean Astrophysical Observatory, the U. S. Weather Bureau's S. Fred Singer said studies he has made suggest the theory that the greenhouse effect is produced by heat friction may well be correct. Prokofyev said he discounted this particular theory but failed to give the reasons behind his stand.

Singer's own paper on the Tiros and Nimbus weather satellite programs aroused particular interest among the Russian and East European delegates. They prolonged the session with a number of questions pertaining to the satellites' performance, capability of their cameras—"Can Tiros pick up a ship at sea?"—other equipment aboard and data readout techniques.

Singer, in describing the system's capability, said that film from Tiros 5 in August showed the existence of 10 tropical storms around the world. Five of these, he said, were first discovered by Tiros. For the future, Singer said, the Weather Bureau plans to adapt Tiros to:

- **Assist in a joint** U. S.-Canadian ice watching program beginning next year, paying particular attention to the movements and actions of large floes in the Gulf of St. Lawrence. He estimated that such a project will represent a $1.5-million annual saving over conventional methods.
- **Detect forest fires** by the addition of microwave equipment which can probe through cloud and smoke covers to determine the location and nature of the fires. Singer said the annual loss caused by forest fires in the U. S. is between $50 million and $300 million, with another $140 million going toward the cost of fighting them. Most of this damage, he added, comes from the 3% of the fires that are not detected in their early stages when they would be easily controllable. He said Tiros will attempt to present a comprehensive picture of these fire patterns.
- **Aid in the fight** against locusts in Africa and Asia, possibly by picking out and photographing the locust clouds themselves and plotting their progress. If this is not possible, more accurate forecasts of the wind patterns which carry the locust swarms can at least provide an adequate warning of their approach.

Meanwhile, at the International Astronautical Federation plenary sessions, there appeared at least a glimmer of hope that the Soviet Union eventually may be willing to provide other nations with advanced information on some of its future satellites, including planned trajectories and monitoring frequencies.

Asger Lunbak, president of the Danish Astronautical Society, proposed that such information from all launching nations "appears to be urgent." He added that such monitoring activities in other countries "may in some cases be of great value for the launching nations themselves."

Leonid I. Sedov, former IAF president and head of the Interplanetary Communications Commission at the Soviet Academy of Sciences, agreed that the IAF should encourage cooperation in this field, and the matter was subsequently passed on to the agency's executive bureau for study or action.

IAF Picks France

Varna, Bulgaria—International Astronautical Federation will hold its 14th Annual Congress next year in France, with Paris and Cannes under consideration as possible sites. A firm date for the meeting has not been set.

French bid was accepted after Argentina, where the meeting originally was to be held, withdrew its invitation, explaining that the facilities and time needed to organize the Congress properly were not available.

The 1964 Congress is scheduled for Warsaw in the fall, a week after the International Council of the Aeronautical Sciences holds its annual meeting there, so that delegates can attend both the IAS and IAF sessions.

Edmund Brun of France was elected IAF president for the coming year during the conference here. Vice presidents are Leonid I. Sedov of Russia, Martin Summerfield of the U. S., Michael Lunc of Poland and Nicolas Boneff of Bulgaria.

USAF Studies Anti-Satellite Systems

All available U. S. ballistic missiles and boosters and spacecraft to be available in the immediate future are being examined by Air Force in a broad study of potential anti-satellite defensive weapons under Advanced Development Objective 40 (ADO-40).

If this effort, under the cognizance of Air Force Systems Command's Space Systems Division, continues according to schedule, it is probable that initial demonstration firings will be made by next summer from Johnston Island in the Pacific Ocean against U. S. satellite targets.

Missiles being seriously considered in the anti-satellite study include Army's Nike Zeus, Air Force's Thor IRBM, Minuteman ICBM and Skybolt air-to-surface missile, and Navy's Polaris submarine-launched IRBM. If included in the program, Skybolt would use its present launch mode from a B-52 mother plane to take advantage of an initial launch altitude of about 50,000 ft. Polaris probably would be surface-launched.

Air Force is proposing to fire the two-man NASA Gemini spacecraft as early as 1964 to gain experience in space before the Dyna-Soar boost glider is available, provided the vehicles can be secured without disrupting NASA's own Gemini schedule. McDonnell Aircraft, prime Gemini spacecraft contractor, is known to have suggested to Air Force's Space Systems Division a military version of Gemini, called Blue Gemini, which might be suitable for defensive military roles in space.

Assisting SSD in the study program are Aerospace Corp., Rand Corp., USAF's Aeronautical Systems Division and other government agencies.

Transfer of Centaur, M-1 to Lewis To Advance Hydrogen Research

By Edward H. Kolcum

Washington—Revitalized Atlas Centaur launch vehicle development program has been transferred from the reluctant management of Marshall Space Flight Center to Lewis Research Center, the facility largely responsible for the early research and technology on which hydrogen propulsion for space is based.

National Aeronautics and Space Administration has reaffirmed after a series of top-level reviews that Centaur is the keystone of the entire hydrogen engine development program and has obtained the highest national DX materials and production priority for it.

The program shuffle also has resulted in the transfer of the Aerojet M-1 upper stage for the Nova vehicle from Marshall to Lewis, but the M-1 will be developed at a much slower pace than Centaur.

Congress and industry received the transfer favorably because both feel it reflects a decision that will give new life and enthusiasm to Centaur and high-energy propulsion. The decision was made despite a recommendation by Marshall that the Centaur vehicle be scrapped entirely and its primary mission—the Surveyor unmanned lunar soft lander—be assigned to a new vehicle consisting of a Saturn S-1 booster with an Agena B second stage.

NASA decision to push Centaur was made Sept. 28 (AW Oct. 1, p. 15) and is based on a belief that the vehicle will provide the earliest flight experience for missions dependent on hydrogen-fueled upper stages. Most important of these missions is the manned Apollo lunar landing, since the Saturn C-5 Apollo launch vehicle has an S-2 second stage and S-4B third stage.

View expressed by Marshall spokesmen at the Sept. 28 decision meeting was that hydrogen engines and stages can best be developed in the S-4, S-2 and S-4B stages. The S-4 is the second stage of the Saturn C-1 launch vehicle. Management of these stages remains with Marshall, as does Saturn booster development.

Headquarters feeling at the meeting was that hydrogen technology cannot wait for flights of the advanced Saturn upper stages. First S-4 flight is scheduled in about a year—by which time NASA hopes to have tested three more Centaurs. The second Centaur flight test, scheduled for February, is not expected to be affected by the transfer in management. First Centaur test failed last May 8 (AW May 14, p. 36).

Future of Centaur has been in question since mid-year, when the House Space Sciences subcommittee held extensive hearings on the troubled program (AW May 21, p. 28; May 28, p. 32; July 9, p. 19). In its report, the subcommittee recommended that NASA re-evaluate Centaur and submit a report on its re-evaluation. Detailed report is scheduled to be submitted to the subcommittee Oct. 12.

Major shift in the Centaur program became imminent late last August when NASA's Space Sciences Management Council met at NASA's Ames Research Center to discuss the program. Although Marshall had been less than enthusiastic about Centaur in the past, Marshall Director Wernher von Braun suggested at this meeting that the program be killed, the payloads re-assigned and that S-4, S-4B and S-2 be used to develop hydrogen technology. Chief spokesman for continuing Centaur was Edgar M. Cortright, NASA deputy director for space sciences.

Immediately after the Ames meeting, headquarters, Marshall and the prime vehicle contractor—General Dynamics/Astronautics—were directed to prepare new weight capability figures for Centaur in its application as a Surveyor launch vehicle. Both NASA headquarters and General Dynamics concluded that Centaur can accomplish the Surveyor mission; Marshall said it could not. In its present configuration, Surveyor weighs, 2,103 lb. (see p. 76).

Marshall's stand on Centaur has led to the charge that the center is following a "not invented here" philosophy—meaning that if a propulsion project didn't originate at Marshall, it is not worth developing. Although von Braun's position on the substitution of Saturn-boosted vehicles gives credence to this charge, other fundamental factors entered into the transfer decision.

Marshall is heavily-loaded with Saturn C-1 and C-5 work and does not have the management manpower to conduct another DX priority program. Conversely, since NASA decided to use the lunar orbit rendezvous technique for the Apollo mission, the Lewis workload has lightened considerably.

Lewis had been selected to manage development of the Apollo lunar landing propulsion module, which was to have been an essential part of the earth orbit rendezvous technique (AW July 2, p. 106). When it received this assignment, Lewis reorganized to perform a dual role—hardware management and research and development backup.

Assignment of Centaur and M-1 management to Lewis will exploit this organization, with Bruce Lundin, associate director for development, heading the program.

Before NASA was established, Lewis was the primary facility for propulsion research in the National Advisory Committee for Aeronautics organization. This center began research into exotic and high energy space propulsion applications in 1953. Largely as the result of technology developed at Lewis, Air Force funded hydrogen aircraft and rocket engine research at United Aircraft Corp., beginning in 1955. Defense Department's Advanced Research Projects Agency ordered Air Force to enter a hardware program for the RL-10 hydrogen-fueled engine with United's Pratt & Whitney Aircraft Division in October, 1958. ARPA assigned project management to the Air Force, and because the Defense Department insists that hardware programs have mission assignments, Centaur was named as the launch vehicle for the Advent synchronous-orbit communications satellite.

Centaur responsibility and funding shifted from ARPA to NASA July 1, 1959, but NASA retained USAF as project manager and contract administrator until January, 1962. Marshall's technical management began in June, 1960. Lewis propulsion experts remained on the periphery of the program throughout its development difficulties, which continued through last year (AW Oct. 2, 1961, p. 26; Oct. 23, 1961, p. 22). A team from Lewis was called in several times to trouble-shoot the program, particularly when static tests resulted in three explosions during the winter of 1960-61.

In its hearings, Congress was critical of what it considered inadequate program management of Centaur, with technical management done by a total staff of 15 until this past January.

Since the Centaur-Advent mission has been canceled (AW June 18, p. 32), NASA could simplify objectives of the next few Centaur test flights in order to obtain fundamental information on hydrogen technology. Advent had a considerably more complex mission profile than Surveyor, since the communications satellite flight called for three separate burnings of the Centaur stages' two engines and extremely long coast periods between them to attain the 22,400-mi. stationary orbit altitude. Surveyor does not require this type of performance.

Rep. Joseph E. Karth (D.-Minn.), chairman of the space sciences subcommittee, told AVIATION WEEK he is "delighted" with NASA's decision to transfer Centaur and accelerate the project with a DX priority. "I'm happy with it," he said, "because first of all Centaur has got to work—not necessarily as a vehicle, but as a technology."

Government Is Pressing for Early IAM-Aerojet Strike Settlement

Government was pressing for settlement of the International Assn. of Machinists strikes at Aerojet-General plants in Azusa and Sacramento, Calif., late last week by bringing union and company negotiators together in Washington. Federal Mediation and Conciliation Service is handling the talks with Secretary of Labor W. Willard Wirtz pushing for early action.

Possibility that President Kennedy might invoke an 80-day cooling-off period under the Taft-Hartley Act loomed at Aerojet in the event the dispute was not resolved swiftly. Earlier in the week Wirtz had insisted that the strike called last Tuesday be postponed in the interests of national defense. About 10,000 Aerojet employes are involved; 8,000 of them at Sacramento.

Union membership rejected the company's last offer prior to the walkout. The offer appeared in line with the pattern of other economic settlements at several major aerospace companies. It included a wage boost totaling 25 cents per hour in increments over the three-year period of the proposed contract. The IAM local wanted a 25-cent increase immediately, a one-year contractual period and an additional increase in the vacation period. Also at issue was a union demand that Aerojet let subcontracting pacts only to those companies where a union (not necessarily IAM) is represented.

The question of a union shop, in the forefront of union-management negotiations throughout the aerospace industry, is not an issue at Aerojet where a union shop has been in effect since 1948. The company has not proposed discontinuing the arrangement. A union shop agreement requires that all eligible employes join the union within a specified period after their employment.

Negotiations between Lockheed Aircraft Co. and IAM continued with little sign that the company was backing down on its refusal to accept a presidential fact-finding panel's recommendation of a union shop should two thirds of eligible employes voting in a special election approve it.

The IAM deferred a threatened strike at Lockheed although it is free to give five-day written notice of strike at any time (AW Oct. 1, p. 27).

Meanwhile, union shop voting will be conducted by the National Labor Relations Board at three other major Southern California aerospace companies starting late next week. Under separate agreement between the various parties, consent by two-thirds of those casting ballots is necessary to realize a union shop. The decisions will be binding for three years, the period of contracts at each of three companies—North American Aviation, General Dynamics and Ryan Aeronautical.

Negotiations between Boeing Co. and the IAM resumed last week in Washington, D. C., under the aegis of another presidential board whose recommendations for settlement of the dispute are due Oct. 15. Two major issues are union shop and wage demands.

Meanwhile, a new three-year work contract offered last week by General Dynamics/Ft. Worth has been accepted by three unions representing about 1,350 of its employes, but a fourth union representing about 5,000 employes has rejected the package.

New contract calls for a 2.3% increase in all basic wage rates the first year with provisions for 2.5% increases the second and third years. This amounts to immediate raises ranging from five to eight cents an hour. Also increased were group insurance benefits, pay rates for overtime and holiday work, and sick leave and layoff benefits.

Unions which accepted the offer were the Federated Independent Texas Union, International Brotherhood of Electrical Workers and Office Employes International Union. Membership of the International Assn. of Machinists voted to reject the offer.

Although IAM did not spell out its objection to the contract, it is thought that IAM's demand for a clause requiring a union shop vote by the employes was one point of contention. General Dynamics said it cannot agree to such a vote since it would be in conflict with Texas' right-to-work law.

Company spokesman said IAM members are continuing to work under the terms of their old contract, which expired July 30. Federal mediators were expected to enter the dispute late last week.

Wage increases for members of the three unions accepting the contract are retroactive to July 9, the date when the previous two-year contracts expired. Those employes have been working under continuation clauses in the expired contracts.

New contracts are expected to add about $167,000 to the company's annual $7.5-million payroll, based on the present 11,000-employe level.

Other labor developments with East Coast aerospace firms included:

• **Stalemate** in the dispute between Westinghouse Electric Corp.'s Defense Center in Baltimore and Local 1805 of the International Brotherhood of Electrical Workers over the status of 40 maintenance workers (AW Oct. 1, p. 27). National Labor Relations Board scheduled a hearing on the dispute for last Tuesday, but it was postponed until last Thursday at the union's request.

• **Agreement** between Bell Aerosystems Co. and Local 205 of the American Federation of Technical Engineers on a 2½-year contract covering 320 Bell technicians who staged a one-day strike Sept. 24. Contract provides for an immediate 3% wage increase, retroactive to Apr. 30, and 3% raises in April, 1963 and 1964.

• **Announcement** by General Electric Co. that in April it will begin laying off 1,000 employes, working on Polaris Guidance, from its Ordnance Department in Pittsfield, Mass.

News Digest

Federal Aviation Agency has awarded two contracts totaling $170,000 for design and production of Type 3 altitude-reporting transponder beacons for light aircraft (SLATE) to Transco Products, Inc., and Hazletine Technical Development Center.

Telstar communication satellite transmitted digitally coded data from England to the U.S. last week at the rate of 875,000 bits per second, the equivalent of 1,460,000 words per minute. This week, computer manufacturers will participate in Telstar tests to demonstrate transoceanic communications between business machines.

Western Electric Co. has received a $145,976,431 follow-on contract from Army, extending research and development on the Nike Zeus anti-ICBM system 12 months.

General Dynamics/Astronautics will receive a contract soon for approximately 35 Standard Space Launch Vehicle versions of the Atlas D missile from Air Force's Space Systems Division. Contract will total about $70 million.

Riddle Airlines' top management was reorganized last week with the election of James B. Franklin as president and chief executive and James H. Carmichael as chairman of the board of directors.

Edward H. Heinemann, 30-year veteran of the aerospace industry, has been elected a vice president of General Dynamics Corp. During 28 years with the Douglas Aircraft Co., he had been honored for his contribution to the development of many military aircraft. He most recently had been executive vice president of Guidance Technology.

Witnesses' Fate Debated in Safety Probe

Halaby would prosecute stewardesses who admitted flying airliners; Rep. Brooks opposes punishment.

By Robert H. Cook

Washington—Congressional probe of air safety violations, highlighted last week by new photos and testimony alleging offenses by airliner crews, is centering on the difference between a sin of commission and a sin of omission.

Rep. Jack Brooks (D.-Tex.), chairman of a House Government Operations subcommittee, is opposed to punishing pilots or stewardesses whose violations may come to light during the hearings, or the flight engineers who submitted photographs of the alleged violations on Eastern and Trans World Airlines (AW Sept. 24, p. 47). Brooks contends his only interest is to eliminate such violations and prevent "14 million Americans from being guinea pigs" in air safety.

Najeeb E. Halaby, administrator of the Federal Aviation Agency, questions the validity of the photographs, has threatened to prosecute two witnesses who admitted their unauthorized piloting of aircraft several years ago, and plans to submit the voluminous series of pictures to the Federal Bureau of Investigation for "authentication."

Any pilots identified in the photos will be contacted by the FAA, he said, but the agency has no interest in grounding any pilot for "taking a nap five years ago."

The administrator said FAA has lacked sufficient authority to detect and punish those who disobey civil air regulations and needs additional powers to ensure that violation information is made available to the government. Under its present authority, FAA is powerless to prosecute those who fail to come forward with evidence or who willfully destroy such evidence.

Rep. John E. Moss (D.-Calif.) a subcommittee member, has given strong support to Halaby's views through his questions and statements during the hearings. He has been highly critical of the flight engineers' motives in submitting the photographs, and has questioned their validity.

Moss said last week that William J. Miller, a TWA flight engineer who took the latest pictures displayed to the committee, "did nothing voluntarily to help air safety" since he failed to produce the evidence of alleged violations until subpoenaed by Congress. Miller had testified that he withheld the pictures because he had been threatened.

Moss also objected when Brooks entered into the record several letters from the public commending the investigation and citing other alleged violations. Brooks said it was "reprehensible" that most of the letter writers found it necessary to request their identity be kept a secret because of fear of reprisal.

The investigation has grown beyond its original purpose, since Brooks has also taken the opportunity to delve into FAA's role in the Air Line Pilots Assn. and Flight Engineer International Assn. battle over control of the third seat on turbojet airliners. He has particularly questioned Halaby on why FAA favors the current demand for pilot qualifications, as opposed to mechanical, as a prerequisite for flight engineers on turbojets. Brooks reminded Halaby that the presidential aircraft, the Air Force, Navy and even the FAA's own long-range aircraft employ flight engineers with a mechanical background.

Halaby, accused by one witness of "putting forth the pilot's cause," replied that FAA has no evidence there is any difference in the safety records between airlines employing pilot-qualified flight engineers, as opposed to flight engineers with only a mechanical background. The flight engineer has been "designed out of the airplane" and is a "victim of technology," Halaby said, in much the same manner that navigators are being replaced by a "pilot and machine."

Halaby also said that as a "temporary political executive" he was caught in the middle of a "rough battle between labor and management over who shall occupy the third seat in the cockpit."

"The pilots give us unshirted hell for not making all those seats pilot monopolized seats," he complained, "engineers give us hell for letting pilots in the seats and management beats on my door every day for making it too hard to train flight engineers."

Brooks replied that if FAA feels a strong technical and mechanical background, such as required by the Air Force and others, is not necessary for commercial airline flight engineers, the agency "should so state" rather than conduct an experiment on the question, employing the flying public as "guinea pigs."

Testimony from several former airline stewardesses who either witnessed other stewardesses "flying" airliners at the invitation of the captain, or who admitted having done so themselves, later triggered a sharp exchange between Brooks and Halaby.

Mrs. Margaret Sweet, a former Pan American World Airways hostess, described how in 1955 she had flown a scheduled airliner for 5 min., during which she made the aircraft lose and then gain altitude. Another ex-hostess, Miss Margaret M. Donofry, told how she once flew an Eastern Air Lines Constellation from Atlanta, Ga., to Charlotte, N. C. She said she was at the controls nearly 40 min., during which the aircraft was taken down from its 9,000-ft. cruise altitude to 1,500 ft. before she left the controls. It was such a "thrill of a lifetime," she added, that it might not be possible to impress on new stewardesses that this is illegal and dangerous.

Halaby's reaction to these admissions was that he was duty bound, as FAA administrator, to prosecute both witnesses for the violations. Brooks said that he did not condone such action, but, if Halaby insisted, he might fine each witness $2.90. This is the same amount that FAA levied against Eastern recently for each count of operating an aircraft not approved by FAA inspectors, Brooks emphasized.

Other witnesses told of more cockpit violations, including one case in which a captain and copilot customarily played cards on a Western Airlines night flight between San Francisco and Portland. The witness—a steward—said that when he remarked that the interior cockpit lights were turned up so high that it was difficult to see outside, the captain assured him there was nothing to worry about since "we're so far off course they'd never find us anyway."

The high point of last week's testimony was the display of more than 100 cockpit pictures taken by Miller. Most depicted pilots either sleeping or reading while at the controls. Several showed hostesses at the aircraft controls while seated in a pilot's lap. All

Soviet Il-62 Uses Aft Engine Mounting

First photo of Russia's giant Il-62 jet transport shows general similarity to Western jets using aft engine mounting, particularly the Vickers VC.10. Il-62, however, is larger, with 182-seat capacity, than any other passenger jet now flying. Passengers ride in upper half of 168-ft. fuselage, lower section being for cargo, aircraft systems and a galley connected to upper area by stairway and food elevators. Dorsal extension from base of vertical fin may house antenna in addition to aiding lateral stability. Main landing gear trucks, with four wheels each, apparently fold into fuselage as on Boeing 707, indicated by absence of wing gear housings like those of Tu-104. Designer Serge Ilyushin also extended the trailing edge wing fillet back along the fuselage past the engine mountings, evidently seeking more uniform airflow in this area. Bulge on lower side of fuselage beneath cockpit was not explained. Four engines are 23,000-lb.-thrust bypass turbojets designed by N. D. Kuznetsov. Plane is designed for 560 mph. cruise on long nonstop flights (AW Oct. 1, p. 29).

means of identification, such as flight numbers and the facial features of the crew members, had been carefully cut out. Miller said he had burned the negatives and that the prints submitted to the subcommittee were the only ones in existence.

Referring to one picture of a blonde hostess trainee perched on the lap of a copilot, Miller said the girls were "under constant pressure" from the captains and have to comply with their wishes even though they may be reluctant.

Miller estimated that this type of violation had occurred on 75% of the TWA flights on which he had served.

In one particularly unique picture, a donkey was shown running loose in the passenger compartment of a TWA aircraft. Miller said the captain had permitted 12 conventioneers to bring the animal on board at Las Vegas. Members of the party later became drunk and tore parts of the aircraft seats from their moorings. The donkey roamed loose, and during a descent started to slide through the door to the cockpit. Miller said he was forced to hold the door shut with his foot to prevent the animal from hurtling forward and hitting the controls.

Miller said he took 298 such pictures between May, 1957, and June, 1961. To aid the committee, he read approximate altitude and speeds as depicted by the aircraft instruments in the pictures. In addition, Miller gave the subcommittee a stack of index cards which he said were a record of other violations he has witnessed since he ended his photographic project.

Miller explained that he, like Eastern flight engineer D. K. Carson, had used an infrared camera in a black box mounted near the engineer's panel. With the aid of a 6-ft. extension cord, Miller said, he was able to take pictures without leaving his post.

The pictures were first shown to Warren Lee Pierson, then board chairman of TWA, in 1959, Miller said. Pierson asked the flight engineers to be "discreet" and later suggested they show them to the airline's operations executives. Rejecting this idea, Miller said, he later brought the matter to the attention of TWA's senior engineering vice president, but got no results. Finally, a responsible FAA official was shown 30 of the pictures, but still nothing happened, Miller said.

Halaby replied that the official, Philip N. Goldstein, now in FAA's Flight Standards Service, was then a Civil Aeronautics Board accident investigator. Goldstein contends he never saw the photos, and was only told of their existence by Miller, Halaby said. Goldstein was instructed by CAB to accept Miller's "conditional offer of evidence," Halaby testified. Miller repeated to the subcommittee that he had actually shown the pictures to Goldstein.

First general knowledge of the pictures, disclosed by AVIATION WEEK (Jan. 16, 1961, p. 25), resulted in two threatening telephone calls to his house and warning of legal action by ALPA if Miller did not drop his photo project, he said. Later, his garage was broken into and his hotel room ransacked, Miller added.

FAA inspectors are at a disadvantage in attempting to spot inflight violations under the present system, he said. Airlines generally instruct ticket counter agents that when an FAA inspector presents his credentials at the counter, the agent must report it to the hostess and captain. The effect is to forewarn the entire crew that the FAA is on board, he explained. Miller suggested that the problem might be solved by locking the cockpit door and providing keys only to the crew and the FAA.

Halaby denounced Miller's idea, which he termed "sky-spies," and took issue with Miller's contention that the pictured violations are considered acceptable operations by the airlines. To support his stand, Halaby submitted a lengthy list of enforcement actions taken by FAA since its creation. An estimated 0.75% of all airline flights are inspected by the FAA and the figure should be higher, he said, but Congress refused FAA's Fiscal 1963 budget request for additional inspectors.

Halaby also invited Miller to discuss the alleged violations with FAA further and promised to call TWA President Charles C. Tillinghast to plead for Miller's continued availability here.

Brooks earlier had assured Miller that Tillinghast has given his word that no action will be taken by the airline against the flight engineer, who has been grounded for several weeks because of an ulcer condition.

Canadians Balk U.S. Carriers' Try For New Bilateral Discussions

Washington—Failure of Canada's Air Transport Board to authorize inauguration of service to Toronto by two U. S. airlines—after eight months of deliberation—is apparently part of an intensive campaign by Canadian carriers for greater penetration into this country.

Eastern Air Lines may be forced to shelve its plans for a Toronto-Buffalo-Pittsburgh-Florida service this winter, and American Airlines has been unable to transfer its Toronto-Buffalo route to Mohawk Airlines because of the delay which Air Transport Board (ATB) members indicate may continue for several more months.

Authorization for the route is contained in a 1959 bilateral air agreement between the two countries, and the Civil Aeronautics Board last December selected Eastern to operate the route. In the same order, CAB approved the transfer of American Airlines service between the points to Mohawk.

Informed observers believe Canada is using the Eastern application as a political wedge to force a re-opening of bilateral talks. They point out that this type of application in the past usually has been handled with dispatch by the Canadians in a matter of weeks, rather than several months.

In contrast, they point out, Eastern applied in February, expecting a quick approval, but was informed that the Canadian ATB was considering holding hearings on the matter—a procedure rarely employed in the past.

Eastern is still waiting for an answer. The ATB recently advised the airline that is "processing" the applications and would not make a decision before the end of November. An ATB spokesman added that public comment has been invited, and that if much opposition to the new service is voiced, a final decision will take much longer.

Trans-Canada Airlines, which operates a Toronto-Tampa nonstop service, has already filed an objection to the applications on grounds that the added U. S. competition is not needed and that the 1959 bilateral agreement has not afforded an equal penetration of U. S. markets for Canadian carriers.

The CAB's order last year noted that the mandatory stops at Buffalo and Pittsburgh were being placed on the Eastern route to avoid the possibility of undue competition with TCA. Past figures showed TCA carried the vast majority of Toronto-Tampa passengers.

State Department spokesmen said that the U. S. and Canadian representatives discussed the bilateral agreement last year but came to no conclusions. They have suggested re-opening the bilateral negotiations several times, but the U. S. is not prepared to take such action until after the "full implications" of the White House international air transport policy study (AW Oct. 1, p. 28) have been studied, he said.

CAB spokesmen also noted the Canadians' insistence on new bilateral talks, and pointed out that while Canada contends it has not enjoyed economic reciprocity from the route exchange, it has made such U. S. border points as Cleveland highly profitable by providing service to Europe via Montreal. When the Cleveland point was granted TCA, he said, it was not intended that it would be utilized to compete with U.S. carriers in Europe.

The Canadian airlines argue that they have too little access to long-haul traffic into the U. S., and are forced to serve such unprofitable "border points" as Seattle, Detroit, Cleveland, Chicago, New York City and Boston. In contrast, U. S. carriers serve all major Canadian cities, they contend.

U. S. airlines reply that while access to all major Canadian cities has been granted, most of these population centers are themselves "border" cities in Canada. Beyond these points, there is virtually nothing to "trade" for the heavy traffic points such as Miami, New Orleans or Los Angeles. One of the few remaining markets for which U.S. airlines say they would be willing to bargain is Montreal-Chicago.

Northeast Credit

New York—Civil Aeronautics Board has approved a $3.5-million revolving credit agreement between Northeast Airlines and Chase Manhattan Bank set to expire Apr. 30, 1963.

Under the agreement, Northeast can borrow the difference between its cash on hand and whatever it needs to cover seven days' operating expenses. Repayment is due at two-week intervals, but only if Northeast's cash on hand exceeds 10 days' cash operating expenses. If not, Northeast can add the loan to its debt, provided it doesn't exceed $3.5 million, and borrow more if necessary.

Northeast will borrow $1 million to pay off an earlier $1 million revolving credit loan from Chase Manhattan (AW Jan. 15, p. 42), and an additional $1 million to pay installments on equipment debts now in arrears. Hughes Tool Co. secured the loan with $4 million in TWA subordinated income debentures and about 130 acres of unimproved land.

TWA Doppler Flight

New York—First transatlantic flight using Doppler radar instead of a professional navigator to maintain course was performed last week by Trans World Airlines. Boeing 707-320, with 115 passengers and 11 crew members aboard, departed New York at 10:45 a.m. EDT and arrived London at 9:39 p.m., six minutes ahead of schedule.

TWA has furloughed 37 of its 55 navigators with the adoption of Doppler on over-ocean routes, the equipment being operated by the pilots. Eighteen remaining navigators will work on international piston schedules.

FAA May Eliminate Middle Airway Level

Las Vegas—Middle layer of the U. S. three-level airway-route structure, which extends from 14,500 to 24,000 ft., probably will be abolished in response to pilot and air traffic controller complaints, FAA Administrator N. E. Halaby said.

Under a plan being studied by the agency, the floor of the high-altitude, jet route structure would be lowered to 18,000 ft., and the low altitude airway ceiling raised to the same height. As predicted by AVIATION WEEK (AW Nov. 13, 1961, p. 43), the move is to ease the problem of rapidly transitioning from one airway structure to another—a maneuver that often involves cluttering an aircraft's cockpit with maps and re-tuning navigation radios.

In a speech prepared for the Air Traffic Control Assn.'s annual meeting here last week, Halaby said that above 45,000 ft., "a random type of operation could be conducted" depending on the number of navigation aids available. Area above 45,000 ft. would then lend itself more readily to the military's typically random operation, he said.

Halaby also suggested that the future of the FAA-recommended bill to establish an independent Federal Aviation Service, a force composed of air traffic controllers who could be pressed into limited military service during national emergencies, still was in doubt. An inter-agency steering group is studying the subject, he said, and will make a final recommendation not later than this January. Halaby also disclosed:

- **FAA's consolidation** of U. S. ATC centers would leave 21 such facilities in operation "for the predictable future." Despite a recent FAA report that indicated the number might be reduced to 15 by 1975, Halaby said "there is no present plan or current intention for further closings or consolidations."
- **Phraseology that controllers** are instructed to use in communicating with pilots probably will be simplified.

TWA Considers Heavier Regional Service

By James R. Ashlock

New York—Selling air travel as a consumer product and applying more market research to flight schedule planning are key points of Trans World Airlines' new management philosophy.

The change is expected to result in TWA abandoning some transcontinental nonstop frequencies in favor of heavier regional service, plus more nonstop flights in 1963 between New York and major European business centers such as Geneva, Milan and Rome.

TWA officials said consideration is even being given to changing TWA's advertising policies, where "we must start making the people in our ads look like people who actually fly on airlines, not someone who just stepped out of a fashion display."

Largely responsible for the shift is Thomas B. McFadden, vice president of marketing, who joined TWA in July after a promotional career with the National Broadcasting Co.

"I know many in the industry wondered what TWA was up to, hiring a radio and television man for airline sales work," McFadden said. "But you'd be surprised at the similarity between selling programs to sponsors and airlines seats to passengers."

Sales View

McFadden's view is that an airline seat is like a bit of broadcasting time.

"You either sell it today or you lose the revenue from it," he said. "There's no stock inventory; you can't reduce the price before the new model comes out."

McFadden feels the airlines, fighting among themselves over a set number of air travelers, are in the same position major broadcasting networks were in some years ago when availability of top program sponsors was limited.

"We finally attracted more sponsors by improving our product, thus expanding the radio and television audience," he said. "We have to do the same thing with the airline business, making it acceptable to more people."

Now consolidated under McFadden are the formerly separate departments of scheduling and market development, thereby making sales and planning a unified effort.

"The single aim is to begin tailoring our scheduling and customer service according to the changing nature of the airline market," McFadden said.

McFadden says there has been a definite lack of aggressiveness in airline sales. Under his direction is a new staff of five vice presidents who McFadden feels will inject more enthusiasm into the sales effort.

Victor H. Harrell is now vice president and general sales manager. Former general manager of Ethiopian Airlines under TWA's management assistance contract with that carrier, Harrell is responsible for the success of TWA's sales programs throughout its system.

Russell K. Rourke, formerly assistant vice president of equipment planning and development, has been promoted to vice president of scheduling and market development. J. N. Martin was brought from a New York district position to become vice president of passenger sales. S. C. Dunlap, vice president of cargo sales, and H. G. Riegner, vice president of advertising and sales promotion, complete the staff.

Market Research

McFadden will rely heavily on market research in determining sales programs. His initial move was to intensify selling efforts in the four major markets —Chicago, New York, Los Angeles and San Francisco—putting these points on a direct reporting line to Harrell.

"But we must get into the mass of what was once called the 'blue collar' trade," McFadden said. "That's where the money is today. We know that class has dollars to spend on air travel if we can convince it to do so."

He said TWA will not ignore the business traveler, who represents 9% of all air travelers and provides 75% of TWA's repeat business. TWA is also taking care of the expense-account traveler through its Briefcase Commuter service on Convair 880s, and its Conference Special whereby it will reserve conference rooms and secretarial service in any city at the traveler's request and expense.

"Our main tool in attracting business outside the expense-account market is through vacation promotion," McFadden said. "We know the non-executive class has money to spend for such travel, because it doesn't have to maintain the country club memberships and extensive entertainment expense considered necessary in management circles.

Travel Expenses

"The challenge is to get people to analyze their over-all travel expenses," he said, "and they will see that they can go as economically by air as by surface in many areas."

McFadden says selling, not haphazard fare cutting or gimmicky tour programs, is in his estimation, the way to expand the market.

"We're considering changing our advertisements to make the passengers shown look more like regular air travelers," he said. "We know that many people don't fly simply because they've decided from present ads that they must dress like a Madison Avenue executive or a Hollywood actress."

Airline markets can be determined and tapped in the same way that soap manufacturers and other commodity distributors do it, McFadden believes.

"We're going to begin a concentrated survey program, taking in specific industries and population centers," he said. "For example, look at the electronics industry. It is scattered all over the country.

"We'll determine the travel patterns of people in this industry, where and when they want to go, and then pitch our sales and schedule approach to meet the need."

Floyd D. Hall, TWA's senior vice president and system general manager, says the airline is abandoning outmoded philosophies about the airline market. He said there are two schools—one that you can generate business, the other that the market is static.

"We're scrapping the idea that you can't generate business," Hall said. "This is the view that has led the industry into fighting over a set group of customers."

Potential Business

Hall said there has been too much attention devoted to the larger cities, and to transcontinental nonstop markets. He wants to find out how much potential extra business there is in other cities, like Cleveland, Cincinnati, St. Louis and Denver.

"Nobody exploits these areas, or seeks new business in them," he said. "But to achieve continuing market growth, we must begin better service for all the cities in which we operate."

Hall said that if market analysis proves TWA can capture more revenue regionally than in the highly competitive markets, then it will set up schedule patterns designed to serve these areas better. He concedes that TWA might have to reduce its transcontinental nonstop frequencies to release aircraft for such a move.

McFadden said TWA's survey force also will go into cities and analyze the salary, ethnic and travel characteristics of the population, resorting even to block-by-block doorbell ringing where necessary.

The prime incentive for any sales force, money, is also being dangled by McFadden in firing up TWA's field representatives.

"There are few in any sales group who are really aggressive men who will go out on weekends or spend an eve-

Flight Propulsion NEWS

A report about progress in research and products from the Flight Propulsion Division of the General Electric Company

Mock-up of U.S. Army's VZ-11 lift-fan VTOL flight research aircraft shows vertical takeoff or landing configuration. Nose fan inlet louver doors, nose fan thrust modulation doors and lift-fan inlet closure doors are all in open position. At right,

VZ-11 cockpit features familiar pilot controls. For vertical flight, a lift control stick similar to those in helicopters (left side) has been added. Airborne transition from vertical to horizontal flight requires no shift in hand or foot positions.

GENERAL ELECTRIC–RYAN UNVEIL LIFT-FAN POWERED VTOL VZ-11

SAN DIEGO, Calif.—Final design of the U.S. Army's VZ-11, world's first lift-fan V/STOL aircraft, was unveiled recently by the Army at the Ryan Aeronautical Co. plant here.

Also shown was a full-scale VZ-11 mockup, forerunner of the advanced fan-in-wing aircraft which will be flight-tested in mid-1963. General Electric is prime contractor, and Ryan a subcontractor in charge of designing and building the aircraft.

Flight-testing the VZ-11 is expected to support G.E.'s contention that lift-fan propulsion can most ably meet designers' requirements for many future VTOL aircraft. The system produces two to three times more lift for a given amount of engine thrust than other high-performance V/STOL designs, since the lift-fans multiply available engine thrust by 300 percent. Hence, the basic engines can be sized for cruise conditions but not oversized to meet vertical flight requirements.

This major advantage will make possible important savings in fuel consumption and logistics support, and provide greater range and payload capabilities. As a result, the VZ-11 concept is unlike typical V/STOL test beds in that it is designed to have performance which closely approximates anticipated requirements for military missions.

The Army feels the V/STOL aircraft can make a major contribution to mobility needed for limited and general war. The VZ-11 concept blends battlefield mobility with high performance. It will be capable of taking off vertically, transitioning to conventional flight, and will fly at speeds of more than 600 miles per hour. Aircraft using this concept may be used for future combat surveillance or target acquisition missions, and will greatly extend the vision of Army field commanders.

Basic components of the aircraft's propulsion system are two J85 turbojet engines mounted high on the fuselage, two five-foot diameter tip-turbine-driven fans submerged in the wings, and a smaller fan in the nose of the fuselage.

For vertical flight, diverter valves direct the jet exhaust to the tip-turbines to drive the lift-fans. For forward flight, the diverter valves close the fans off and allow operation as a conventional jet aircraft. The nose fan is used to provide lift, pitch trim, and control.

Crossover ducting between engines and fans insures that 60 percent of the total lift will be available with only one engine operating. Under standard conditions and normal landing weights, adequate lift will be available for vertical landings with a single engine. Conventional landings can be made with a single engine under any loading condition.

The VZ-11 is designed to have outstanding control capabilities in hover and slow flight. The fan crossover duct system will provide balanced forces for attitude control as well as 60 percent of lift, should one engine become inoperative.

The VZ-11 program culminates three years of static and wind tunnel testing of the lift-fan propulsion concept. First tests were conducted at G.E.'s outdoor testing facility in 1959 at Evendale, Ohio.

Rocket Case Contract Won

CINCINNATI, Ohio—General Electric's Large Jet Engine Department was recently awarded an $11.7 million contract from Thiokol Chemical Corporation for continued production of first-stage rocket motor cases for USAF's Minuteman ICBM.

A follow-on to earlier awards of $11.4 million for 1962 production, the new contract will cover production through 1963. The rocket cases serve as the main structural member for the missile's first stage.

Machining Breakthrough Predicted Superior to Conventional Metalworking

CINCINNATI, Ohio—Electrolytic machining techniques developed by General Electric for manufacture of critical jet engine parts and rocket motor casings may soon replace current machining methods used to make many engine components, company officials predicted here recently.

Developed initially for drilling holes in the high-temperature alloys used for jet engine buckets and blades, electrolytic machining can also be applied to die-making and machining of ordinary metals—at substantial reductions in cost.

The main advantages of the new technique over conventional machining methods are the increased machining speed and longer tool life. With conventional methods of tapping or drilling, the rate falls off as the hardness of the workpiece increases. But with electrolytic machining, rates are essentially constant, whatever the material, as long as power input is constant.

General Electric is currently seeking licensees in the U.S., England, France, West Germany, Japan, and Italy to manufacture machining equipment using the technology perfected during a five-year development program.

G-E CJ610 Turbojets Boost STOL Capability of Fairchild C-123H

EGLIN, AFB, Florida—Flight tests of a Fairchild C-123H equipped with two wing-mounted G-E CJ610 turbojets were completed here recently in an accelerated effort to provide the transport with STOL capabilities.

Fairchild hopes the CJ610's will help prove the C-123's capability as an interim STOL transport in the 20,000-pound payload class.

Under current procurement schedules, advanced assault transport aircraft of similar size will not be available until the 1964-66 period when Vought-Hiller-Ryan's XC-142 and deHavilland's Caribou II become operational. Meanwhile, the only operational STOL transport is the Caribou AC-1, which is limited to 8000-pound payloads.

In Fairchild's recent flight tests each of the two CJ610 installations, including engine, accessories, pod, and pylon, added 690 pounds to the basic weight of the C-123H.

Developing 2850 pounds thrust, the CJ610's were hung below the wing, outboard of the piston engines. The extra structural strength needed was gained by adding ribs, doublers, and sections of heavier skin to each wing.

To guard against ingestion of rocks and dirt kicked up during propeller reversing, butterfly valves seal off the two jet intakes automatically. After reversing is completed, the butterfly valves can be opened with a switch in the cockpit.

During flight testing at Fairchild's Hagerstown, Maryland plant, the C-123H has shown significant improvement in take-off and landing distances normally associated with the conventional versions of the aircraft.

THREE XB-70 TEST PILOTS from North American Aviation and the Air Force recently completed an orientation course at G.E.'s Large Jet Engine Department on the YJ93 engine, powerplant for the USAF XB-70. Al White (center foreground), NAA's chief test pilot, will be at the controls during the first XB-70 flight, scheduled for December. White's fellow XB-70 pilots who attended were USAF Lt. Col. Joseph Cotton (seated rear), and USAF Major Fitz Fulton (standing center). The three pilots were accompanied by USAF XB-70 Joint Test Force Director Col. Guy Townsend (right) and NAA's O. E. Deal (right center). B. W. Bruckmann (left), manager of G.E.'s J93 Engine Project, headed the technical team that conducted the briefings.

Ring of G-E Jets to Power CG&E Generator

CINCINNATI, Ohio—An unusual new use for aircraft jet engines was revealed here recently when the Cincinnati Gas and Electric Company announced it will use 10 clustered CJ-805's to drive a new reserve power turbine-generator.

Arranged cylindrically, the 10 lightweight turbojets will operate as gas generators exhausting into a single-stage 100,000-kilowatt load turbine. The turbine will drive a conventional, hydrogen-cooled generator at 1200 rpm.

The Cincinnati utility will use the new unit to meet such increasing power demands as daily and seasonal peak loads and system reserve requirements.

The CJ-805's for this reserve powerplant will be slightly modified versions of the CJ-805 turbojets which power Convair 880 and 990 jetliners, now in service with domestic and overseas airlines. The engines are the commercial twin of G.E.'s record-setting J79 military turbojet, powerplant for the Navy's F4H and A3J and USAF's F-110, F-104, and B-58.

The turbine-generator unit in Cincinnati will be housed in an adequately sound-proofed steel and concrete structure. A separate control and maintenance building will be adjacent to the power unit's foundation. One section will contain plant instrumentation, controls and the auxiliary power transformer; another section, the plant heating and sanitary facilities; and the third section, a maintenance shop.

JET-BOOSTED, this C-123H was recently flight-tested with two General Electric CJ610 turbojets. Fairchild reports significant reductions in take-off and landing distances.

FOR MORE INFORMATION

If you would like additional information on these G-E flight propulsion programs, write on your company letterhead to: General Electric Company, Section 206-52, Schenectady 5, New York.

Progress Is Our Most Important Product

GENERAL ELECTRIC

TURBINE-POWERED AIRCRAFT ORDERED AND DELIVERED UP TO 31 DECEMBER 1961*

	Ordered			Delivered		Remaining to be delivered	
	Before 1961	During 1961	Total up to 31.12.61	Before 1961	During 1961	Total up to 31.12.61	During 1962	1963 and after
TURBO-JETS								
Boeing 707	162	49	211	148	13	161	50	—
720	91	30	121	22	68	90	31	—
Convair 990 (600)	37	—7	30	—	—	—	30	—
880	48	11	59	13	39	52	7	—
Douglas DC-8	157	15	172	102	52	154	18	—
Comet IV	55	5	60	45	12	57	3	—
Caravelle	109	43	152	58	37	95	36	21
Vickers VC-10	45	4	49	—	—	—	—	49
DH-121 Trident	24	—	24	—	—	—	—	24
Boeing 727	80	37	117	—	—	—	—	117
BAC 111	—	16	16	—	—	—	—	16
Total	808	203	1 011	388	221	609	175	227
TURBO-PROPS								
Britannia	59	—	59	59	—	59	—	—
Vanguard V-900	43	—	43	20	23	43	—	—
Electra L-188	170	4	174	162	12	174	—	—
Viscount V-800	136	11	147	130	17	147	—	—
700	259	—	259	259	—	259	—	—
Friendship F-27	130	32	162	93	37	130	32	—
Avro 748	8	9	17	—	—	—	17	—
H.P. Herald	10	—	10	—	—	—	10	—
Convair/Canadair 540	16	—	16	16	—	16	—	—
Total	831	56	887	739	89	828	59	—
CARGO TURBO-PROPS								
Canadair CL-44D	17	2	19	—	9	9	10	—
Argosy AW650	7	3	10	1	9	10	—	—
Total	24	5	29	1	18	19	10	—

*** Notes:** **(1) The numbers given are estimated on the basis of the best available information.**

(2) For lack of information, aircraft built in non-ICAO States are not included in this table: It is known, however, that a small number of Tupolev 104's and Ilyushin 18's have been delivered to airlines of Contracting State

ning downtown to sew up a sale," he said.

"To stimulate this, we're hanging a money carrot before our salesmen's noses. For any district that tops its sales quota in a given month, its sales people receive an extra month's pay."

McFadden said TWA will not be so concerned hereafter with taking customers away from the competition, but will strive more toward over-all market expansion. He said there is definite need for some type of industry cooperation in promoting air-mindedness among the public.

"This would be particularly beneficial in the areas of safety and education in the benefits of air travel," he said. "TWA would get behind such a movement immediately."

Despite the broader view toward market expansion, McFadden said TWA will not ease up in its competition with other carriers. The sales incentive program is already showing effects in TWA's share of the New York-Los Angeles traffic, he said.

"But when you consider that there is the equivalent of about eight jet aircraft flying empty coast-to-coast every day, based on load factors, then reducing our emphasis on that service doesn't seem too impractical," Hall said.

Hall realizes that competing airlines may also boost their regional frequencies to challenge TWA's emphasis in that area, thus repeating the overcapacity cycle.

"The patterns we visualize would link a number of cities," he said. "And while the competition might meet us on certain segments, we don't think they could match us on the over-all schedule pattern."

He said TWA will try to convince people to go to new places for their vacations. "How many realize that you can fly to Lisbon instead of Miami, stay the same length of time, and at less cost?" Hall said.

Pan Am to Run Tests Of Inertial Navigation

Washington—Pan American World Airways will conduct a six-month evaluation of an inertial navigation system in a DC-8 in a series of 90 flights, 54 of which will be transatlantic crossings, under a $22,520 contract awarded by the Federal Aviation Agency (AW June 11, p. 93).

The inertial navigation equipment will be supplied by Litton Systems, Inc., a subsidiary of Litton Industries, under a $260,000 FAA contract which includes modification of a military type inertial system for airline use. Litton is scheduled to deliver the equipment to Pan Am in about six months.

The Litton system is expected to weigh about 80 lb. including gyro stabilized platform, computer and pilot display. The company produces inertial navigators used in a variety of military aircraft, including the WF2, W2F, A2F, P3V, F-104G, CF-104, and recently was selected to supply the inertial navigator for the new F-110.

The FAA program is intended to evaluate the feasibility of airline use of inertial systems for navigation over water and areas which are not equipped with ground-based navigation aids. While inertial systems have important advantages for military aircraft, because they emit no radio energy which might facilitate enemy detection and cannot be jammed, they are considerably more complex and expensive than Doppler navigators. One objective of the FAA tests will be to compare the accuracy and reliability of an all-inertial system with a Doppler navigator. Observers familiar with both Doppler and inertial systems predict that the Doppler will prove superior in terms of accuracy per pound and per dollar.

However, since a Doppler navigator requires the same type of dead-reckoning computer as an inertial system, and both need a precise azimuth reference, it is conceivable that a combination Doppler-inertial system might offer some advantages over the dual Doppler systems currently installed to provide standby capability.

AIRLINE OBSERVER

► Lower fares on the North Atlantic appear to be in the making at the International Air Transport Assn. traffic conferences at Chandler, Ariz. (AW Oct. 1, p. 28). However, the drive for lower fares, being led by Lufthansa German Airlines (AW Sept. 24, p. 43), could become bogged down in the question of conditions under which new rates will be applied. Carriers opposed to lower fares are expected to propose conditions such as time limits or seasonal rates to protect present level of revenue yield.

► Watch for British cabinet to approve full participation in the British-French supersonic transport project by mid-November, perhaps earlier. French have already allocated funds, but British have limited participation to a comparatively small contract with British Aircraft Corp. for continuing design study. Initial British funding probably will involve allocation of about $150 million.

► FAA last week gave general aviation pilots and 14 U. S. airlines permission to use the new Dulles International Airport near Washington, D. C., for familiarization and training purposes. The terminal's control tower and associated navigation aids were commissioned Oct. 1, but the airport is not scheduled for dedication until Nov. 17. Airlines may gain experience connecting their transports to the Dulles mobile lounges, without charge, until the inauguration of scheduled service.

► Order by Alitalia for five Douglas DC-8 transports powered by Rolls-Royce Conway by-pass engines is imminent. Possibility that the order will include some DC-8F convertible passenger-cargo planes is strong.

► American Airlines stewardesses are striving to eliminate from their contract the provision for mandatory retirement at age 32. Air Line Stewards and Stewardesses Assn., a division of the Transport Workers Union, contends that the age limitation is discriminatory since it is not employed by any other U. S. carrier. ALSSA members so retired are forced to take lower-paying jobs and are often being replaced by hostesses recruited from foreign countries, the union claims.

► British Overseas Airways Corp., which is cancelling its pool agreement with Ghana Airways (AW Aug. 20, p. 43), will supplement its Bristol Britannia turboprop flights with a twice-weekly service between Accra and London with Boeing 707 by-pass engine-powered transports. Britannias will be operated on the route on a thrice-weekly basis. Ghana Airways' Il-18 turboprop transports apparently will be used only on flights from Accra to Khartoum every two weeks.

► Federal Aviation Agency last week began using Air Defense Command's large new FPS-35 radar at Montauk Point, Long Island, to monitor airway traffic between Boston and New York City. The Montauk installation, part of the Sage intercept system, will fill former gaps in FAA's radar coverage of the northeastern coastal area. The agency plans to begin using another FPS-35 radar at Benton, Pa., later this year to supplement coverage of the area between New York and Cleveland.

► Brazilian airline VASP has ordered four Sud Caravelle Mark 6 transports and has taken an option on two additional aircraft. VASP is the fourth Brazilian airline—after Varig, Panair do Brasil and Cruzeiro do Sul—to buy the twin-jet transport. Sud's Caravelle backlog now stands at 159 firm orders from 21 companies in 19 countries.

► International Assn. of Machinists and FAA are keeping a close eye on possible maintenance violations arising from labor disputes. Nearly a year ago IAM began providing FAA with a continuous report of alleged violations committed by the carriers. Volume of these reports has increased sharply whenever labor disputes have arisen, but the current rate is not considered serious, the union said.

► State Department will not schedule any more bilateral negotiations until a U.S. international air transport policy has been adopted by the White House (AW Oct. 1, p. 28).

SHORTLINES

► **Federal Aviation Agency** has awarded a $134,445 contract to Maxson Electronics Corp. for the development of an experimental TACAN transmitter.

► **Federal Communications Commission** has extended the use of frequency 122.6 mc. to Apr. 1 to permit continued participation of airlines in FAA's direct pilot-to-weather forecaster tests.

► **Iberia Airlines** of Spain has ordered five additional Douglas DC-8 turbofan transports at an estimated cost of $31 million.

► **Lufthansa German Airlines** has been flying donated medical supplies and food at its own expense to Teheran from Germany as an aid to earthquake victims. Iberia has conducted a similar operation from the U.S. to flood-stricken areas in Spain.

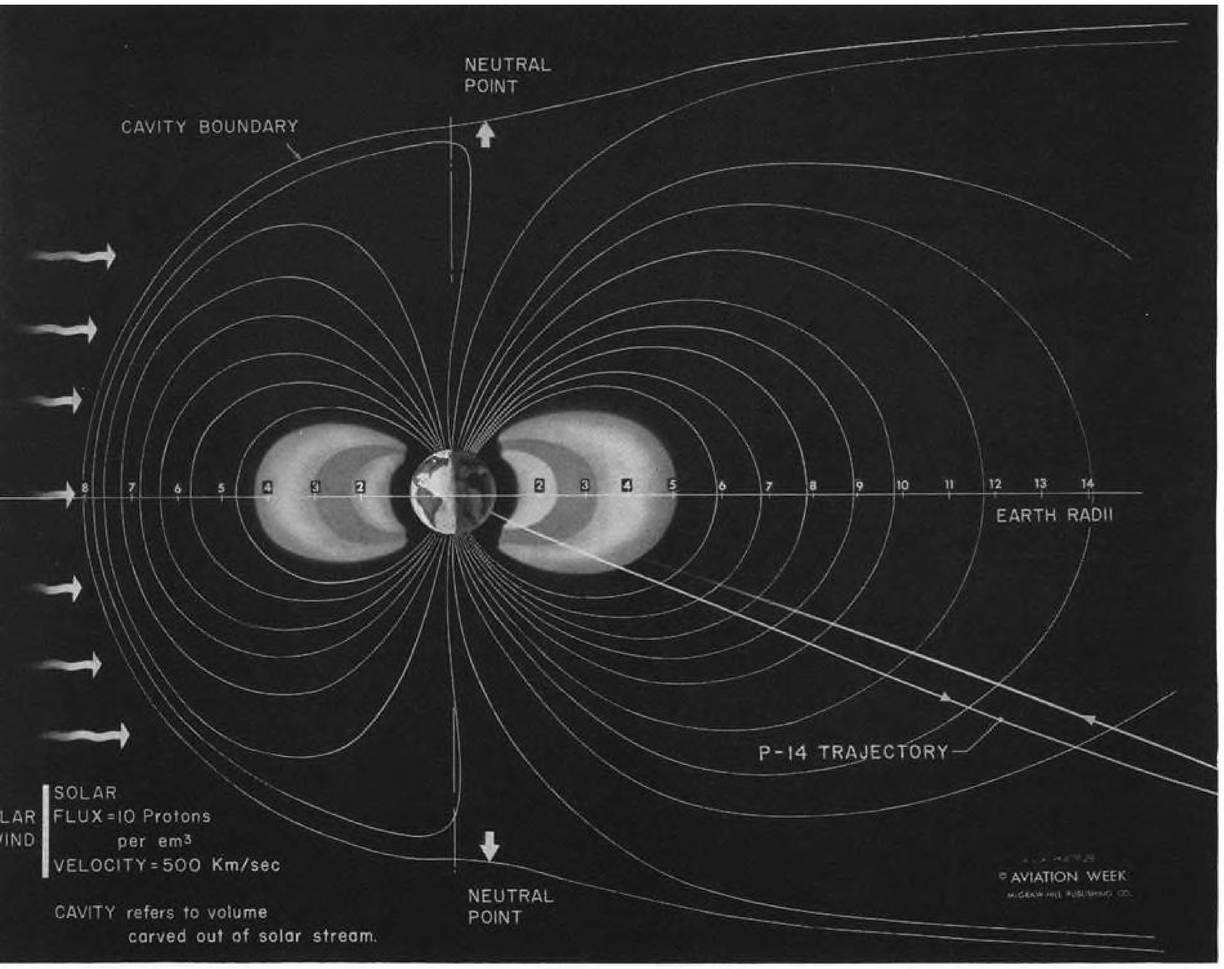
► **Maintenance personnel** will be surveyed next month by FAA as a means of evaluating aircraft certification and surveillance programs. FAA said programs have remained unchanged for 30 years and probably should be revamped to meet maintenance requirements in handling more complex aircraft.

► **National Airlines** now plans to retire its fleet of piston aircraft Jan. 1, after which it will operate all flights with Douglas DC-8 turbofan and Lockheed Electra turboprop transports.

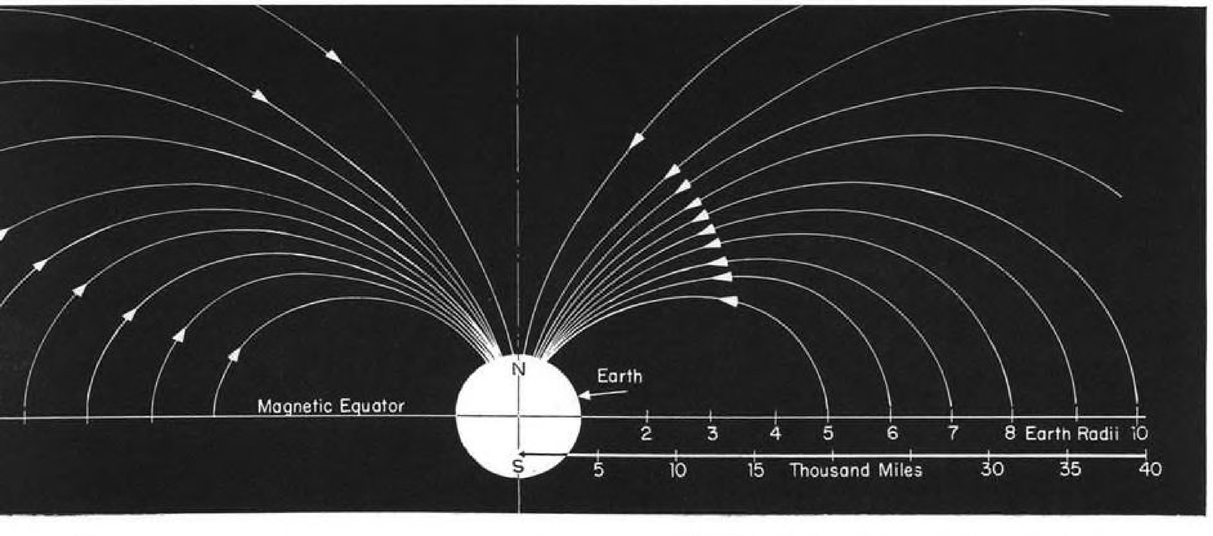
► **Northeast Airlines'** request that testimony given in executive session of the New York-Florida renewal case be withheld from the public has been denied by the Civil Aeronautics Board. Northeast held that publicity about any pending merger would be harmful. The Board stated that the testimony reveals no definite plans for a merger between Northeast and another carrier.

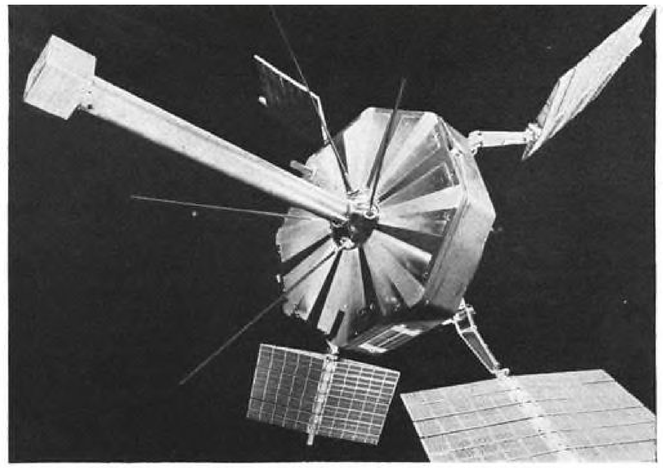
► **Sabena Belgian Airlines** has reported an 18% increase in traffic during the first six months of 1962, compared with the same period last year. Load factor for the period was 61% compared with 57.2% in 1961. Number of transatlantic passengers carried in the first half of 1962 increased 30%.

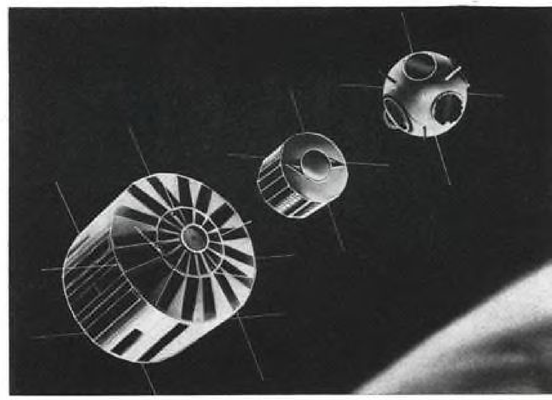
► **U. S. trunklines** have agreed to extend the no-show penalty and oversale compensation plan through Jan. 31 (AW Oct. 1, p. 30). One modification provides that unticketed passengers who hold reservations will be canceled if they fail to purchase tickets less than 30 min. prior to flight departure.



NEW PICTURE of the geomagnetic field, above, which has been developed as the result of data from Explorer 10 and Explorer 12 satellites, shows the effect of solar wind pressing against the sunlit side, and the cavity carved out of the solar stream by the earth. On the dark side, the earth's magnetic field gradually merges into the limitless interplanetary magnetosphere. Explorer 12 measured the extent of the field on the sunlit side, and Explorer 10 passed through the cavity boundary at the lower edge of the drawing at a distance of 86,000 mi. from the earth. Below is a cross-sectional drawing of the geomagnetic field as it was believed to appear in 1958 before the opportunity became available for direct measurements with satellites and probes.







EXPLORER 12, launched Aug. 15, 1961, found the outer limit of the sunlit side of the trapped radiation averages an altitude of 40,000 mi. Injun satellite, in center at right, first detected and monitored new radiation zone created by nuclear blast.

Space Sciences Expansion—Part 1:

Research Challenge Encompasses Galaxy

By Edward H. Kolcum

Washington—Growing national need for fundamental knowledge is adding new demands, urgency and scope to the work of the space scientist, whose physical laboratory is being extended to the farthest reaches of the galaxy.

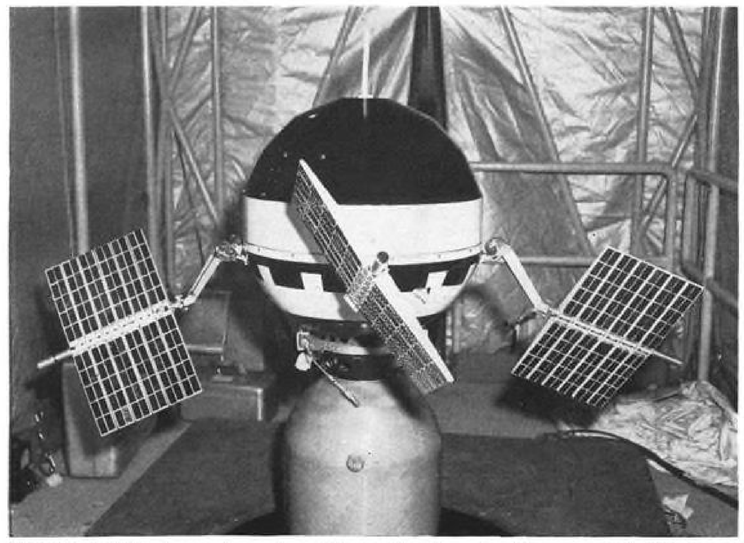
The space scientist today is characterized by a new impatience to exploit the rapidly-filling storehouse of data collected by instruments already launched beyond the protecting, but distorting, atmospheric mantle of the earth. Information from space will not only help man in his search for understanding of the universe, but will furnish the critical data points required to design, engineer and equip manned and unmanned space vehicles.

Although the technique of sending instruments into space to make direct measurements is a relatively new one, it already has provided an indication of the promise and the hazards which space holds. It has forced a closer relationship between the scientist and the engineer, so that now the U. S. can perform such feats as designing, building and launching a special satellite in just 60 days to sample the radiation in the lower edge of the Van Allen belt, increased by a U.S. nuclear detonation last July 9 (AW Sept. 17, p. 26).

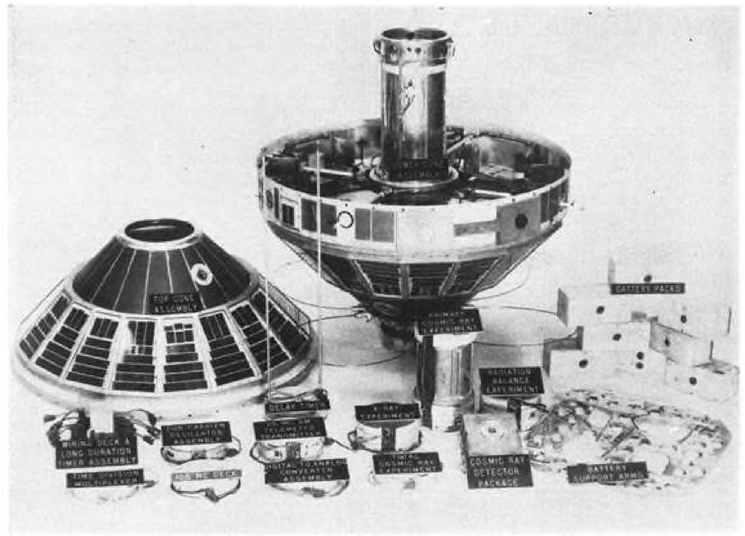
Early space science payloads discovered the belt of geomagnetically-trapped radiation around the earth; they have mapped the belt, measured its constituents and found at least five distinct intensity zones within it. They have sampled the atmosphere, provided 200,000 photographs of the cloud cover over the earth, and have established the basis for advancements in the art of weather prediction and analysis that will save

Major Space Science Experiments

Payload	Launch	Significance
1. ENERGETIC PARTICLES		
Explorer 1	Jan. 31, 1958	Discovered Van Allen radiation belt
Explorer 3	Mar. 26, 1958	Verified Van Allen belt existence
Explorer 4	July 26, 1958	Found that inner belt zone consists mainly of penetrating (high-energy) protons
Explorer 6	Aug. 7, 1959	Detected electrical ring current circling outer belt zone
Explorer 7	Oct. 13, 1959	Monitored major solar storm simultaneously with Pioneer 5 probe (see below); detected low-energy electrons in outer zone
Explorer 12	Aug. 15, 1961	Upset Explorer 7 data by finding that the outer zone consists mainly of low-energy protons
Injun	June 29, 1961	Discovered and monitored high intensity radiation belt formed by July 9, 1962, U.S. nuclear test detonation
Pioneer 1	Oct. 11, 1958	Found that the outer Van Allen belt limit varies with solar wind
Pioneer 3	Dec. 6, 1958	Discovered what was thought to be a second distinct radiation zone
Pioneer 4	Mar. 3, 1959	Confirmed Pioneer 3 and Explorer 7 data
Pioneer 5	Mar. 11, 1960	Registered Forbush decrease (decrease in cosmic ray intensity) after solar flare; measured ring currents found by Explorer 6; measured magnetic field and penetrating protons in deep space
2. MAGNETIC FIELDS		
Pioneer 1	Oct. 11, 1958	Found disturbed transition between earth's magnetic field and interplanetary space at 53,000-mi. altitude
Explorer 10	Mar. 25, 1961	Discovered draping effect of the earth's magnetic field on the dark side; crossed magnetosphere at 86,000-mi. altitude
Explorer 12	Aug. 15, 1961	Found that magnetic field on the sunlit side "breathes," averaging an altitude of 40,000 mi.
Rocket Flights	.....	Measured magnetic field intensities; found daily variation over the equator
3. COSMIC RADIATION		
Nerv, Big Shot piggy-back experiments, plus 11 rocket flights	.....	Determined that nuclei ratios differ in rays from the sun and rays from stars outside the galaxy
4. SOLAR RADIATION		
OSO 1	Mar. 7, 1962	Confirmed rocket data that solar radiation is emitted from bright spots on the sun, which constitute only 3% of the solar surface
Rocket Flights	.....	Studied solar spectra in ultra-violet from 977 to 2,900 angstroms; discovered solar X-rays in the E-region of the ionosphere



PIONEER 5 (above) now in a solar orbit, monitored a solar flare, measured ring current around outer Van Allen belt zone, and detected particles and magnetism in deep space. Solar flare measurements were made simultaneously with those of Explorer 7, shown with experiments disassembled below.



untold billions in damage caused by storms.

They have provided new, precise information about the ionosphere to increase the quality and reliability of radio communications. They have discovered a layer of helium around the earth and magnetism and energetic particles in deep space. They are supplying data which may aid in predicting solar storms and allow computation of safe periods for manned space exploration.

They have upset the theory that matter is created and decays at continuous and equal rates, and have strengthened the theory of the consistent universe, which says that each visible star may be the center of its own system containing nine planets.

In doing these things, space science has set the stage for a new chapter of correlated, cause-and-effect measurements of the galaxy by observatory satellites which will contain as many as 50 different experiments in the physical, chemical and biological disciplines. The goal is a detailed map of a hostile, fluctuating environment.

The immediate, practical requirements of the manned lunar landing program and weather and communications satellites, as well as the esoteric goals loosely categorized in "pure science," are being translated into hardware, experiments and programs by National Aeronautics and Space Administration's Goddard Space Flight Center located at Greenbelt, Md., near Washington.

Goddard's management techniques and its current and planned programs were reviewed extensively by AVIATION WEEK (July 2, pp. 178; 183; 195). This center has the major U. S. responsibility for scientific earth satellites, some of which are developed in-house and the others by industry, under Goddard's supervision.

At Goddard, the space science program consists of inter-related experiments designed to gain understanding of the solar-terrestrial relationship—the way the sun's emissions influence space in the solar system, and more particularly, the way these emissions influence the earth's magnetic field and atmosphere.

Dr. Harry J. Goett, Goddard director, views the program as an 11-year movie, keyed to the solar cycle, in which the number of solar storms peaks and ebbs on a fairly regular schedule. A composite picture of the earth-sun relationship, Dr. Goett said, will come from data obtained from space vehicles flown throughout the cycle.

Historically, the U. S. is considered to have entered the space age with the launching of the Explorer 1 satellite on Jan. 31, 1958. Scientifically, the country began its space program on Apr. 16, 1946, when the first of 64 captured German V-2 rockets was launched from White Sands, N. M.

From 1946 until NASA was established on Oct. 1, 1958, the U. S. had fired an estimated 450 rockets in an upper atmosphere research program. Not all were successful, and support for the rocket program was often sporadic and always meager in comparison with the U. S. space program today.

Sounding rocket payloads, in the early years, thoroughly probed the upper atmosphere over White Sands and Ft. Churchill, Canada. But the greatest contribution from them was that they gave scientists a means to learn how to do things in space—what to measure, and how to measure. They stimulated thinking in the physical sciences which was to evolve into ideas for experiments for satellite and probe payloads.

Major studies in space have been in these areas:

- **Solar physics**—The nature of the sun and its emissions.
- **Energetic particles** and the relationship of these particles to electro-magnetic force fields.
- **Ionosphere and its structure.** This is the envelope of low-energy particles surrounding the earth that reflects radio waves and influences the quality of radio wave propagation.
- **Aeronomy,** the field that describes the pressure, density, temperature and constituents of the atmosphere.
- **Astrophysics**—observation of the stars,

interstellar gases and galaxies by analysis of the light they emit.

Discovery of geomagnetically-trapped radiation surrounding the earth, and subsequent interpretation of this discovery by Dr. James A. Van Allen of the State University of Iowa, ranks as the major scientific discovery of space. Discovery by itself is significant, but its real importance in this case is that it stimulated the entire field of physical science research by demonstrating the value of the earth satellite as a measuring platform.

Experimental Evidence

There had been speculation before this discovery that the earth's magnetic field was strong enough to trap energetic particles. Because of a lack of experimental evidence, it was not known how many particles were trapped, extent of the entrapment, and makeup of the particles.

Repeated satellite measurements, which are continuing, show that the earth's field is similar to a dipole magnet, and the magnetism gradually merges into a limitless interplanetary magnetic field called the magnetosphere. The magnetosphere dominates paths of near-earth energetic particles, and is distorted by variations in the sun's magnetic field, tending to be compressed on the sunlit side and extended on the other. As a result, the region in which it exerts major control over energetic particle paths varies from 34,000 to 52,000 mi. from earth—which defines the outer limit of the Van Allen belt on the sunlit side.

Direct Measurements

Chronology of direct measurements in the Van Allen belt shows these highlights, according to Goddard's Leo R. Davis and George H. Ludwig:

• **Explorer 1** discovered a region of high corpuscular energy with a single Geiger-Mueller counter. Finding was verified by Explorer 3, launched Mar. 26, 1953, with similar instrumentation by the Army, which also had launched Explorer 1. The particle counters in these experiments were able to detect high-energy radiation, but were unable to determine the nature of the particles—that is whether they were electrons or protons.

Sputnik 2, launched Nov. 3, 1957, penetrated the inner zone of the trapped radiation at apogee, which was out of the line of sight of USSR tracking stations. The satellite also had no tape recorder. With a recorder or a more extensive tracking network, Soviet Russia could have substantiated its claim, made after Van Allen's, that Sputnik 2 discovered the Van Allen belts.

• **Explorer 4**, launched July 26, 1958, was designed to survey the magnetosphere to altitudes of 1,400 mi., and particularly to determine the number and makeup of particles. This was an Advanced Research Projects Agency-Army project and was flown in conjunction with ARPA's Argus high-altitude nuclear explosions.

Basic findings were that the inner zone of trapped radiation consists largely of penetrating protons with energies greater than 30 million electron volts (mev). Explorer 4 went through the lower region of the outer zone and found no penetrating protons there. Argus experiments indicated that electrons released by nuclear explosions at altitude are also trapped in the magnetosphere.

• **Pioneers 1, 3 and 4** provided the first information on the extent of the outer zone. Pioneer 1, launched Oct. 11, 1958, by the Air Force under ARPA sponsorship in an attempt to place a satellite in a lunar orbit, reached an altitude of only 70,700 mi., but discovered that the outer limit of the magnetosphere "breathes" or changes location. This phenomenon was subsequently attributed to the pressure exerted by the low energy protons and electrons continuously emitted by the sun, called the solar wind. Another important finding of this probe was that the more intense radiation is closer to the earth.

Pioneer 3 Data

Pioneer 3, launched Dec. 6, 1958, by the Army and also intended as a lunar probe, reached an altitude of 63,580 mi., and its sensors supplied data during both outward and return flights. It is credited with discovering what then was thought to be a second distinct belt. Subsequent investigations indicated a number of zones, but no distinct lines between the zones.

Comparison of data from Pioneers 3 and 4, the latter launched by the Army for ARPA on Mar. 3, 1959, verified the theory that the outer limit of the magnetosphere varies directly with solar activity, and gave birth to the postulation that the sun is the principal source of particles in the outer zone.

A belief that survived until the findings of Explorer 12 was that the outer zone was made up largely of electrons.

• **Explorer 6**, launched by NASA on Aug. 7, 1959, into a highly elliptical orbit ranging from 156 to 26,357 mi., detected a large ring current circling the outer zone of trapped radiation between the altitudes of 20,000 and 28,000 mi. This satellite mapped the Van Allen belt between 49.2 deg. north and south latitudes, using a proportional particle counter array, an ionization chamber, single component magnetometer and scintillator.

• **Explorer 7**, launched Oct. 13, 1959, monitored the lower edges of the belt

between the altitudes of 344 and 673 mi. Lower limit of the trapped radiation is about 600 mi. above the earth's surface. Combined study of the phenomena of solar events occurred during the spring of 1960, when data from Explorer 7 could be correlated with data from the Venus probe, Pioneer 5.

• **Pioneer 5,** launched Mar. 11, 1960, on a trajectory toward the orbit of Venus and into a solar orbit. A large flare occurred Mar. 30, and Pioneer 5 registered a decrease in cosmic ray intensity, called a Forbush decrease, 22 hr. after the flare was emitted.

The Forbush decrease had been thought, on the basis of ground-based measurements, to occur only in the presence of the earth's magnetic field. But Pioneer 5 registered the phenomenon when the probe was well outside the influence of the earth's magnetic field.

Solar Plasma

Computations based on the Mar. 30 flare led to the finding that the solar plasma ejected then traveled at a velocity of 1,200 mi./sec. A second major flare occurred Apr. 1, and the transit time for particles from this storm was measured at 400 mi./sec. This has led to the existing theory that solar protons spiral around the magnetic field lines of the solar plasma cloud, and that the protons in the second cloud followed the channel made by the particles of the first cloud.

Pioneer 5, with a long list of accomplishments, also measured the magnetic field between the earth and sun, verified the existence of ring currents discovered by Explorer 6, and detected penetrating radiations in deep space.

The magnetic field between the earth and the sun was found to vary between 2.7 and 40 gammas, the latter measure made during a solar storm. Magnetic field on the surface of the earth varies with latitude between 35,000 and 72,000 gammas.

• **Explorer 12,** launched Aug. 15, 1961, upset earlier theory by showing outer zone consists largely of low energy protons, and not electrons.

Outer Zone

Composition of the outer zone became a subject of scientific controversy shortly after it was discovered by Pioneer 3. Following the assessment of Explorer 7 data, the theory became popular that the zone was dominated by low-energy electrons, probably in the 50 kev range, with a density of 10^{10} to 10^{11} electrons/sq. cm.

About the time these findings were announced in mid-1960, a Soviet ionospheric scientist and theoretician, K. I. Gringauz of the Radio Engineering Institute of the USSR Academy of Sciences, postulated that the number of particles in the outer zone was three or four decades (powers of 10) below the U. S. figure. He based his theory on extension of data from Luniks 2 and 3, but because the theory was not validated by direct measurements, it was not accepted here or in Russia.

Data from Explorer 12 are still being analyzed, but the satellite has detected that low energy protons, averaging several hundred kev in energy, dominated the geomagnetically-trapped radiation from an altitude of 4,000 mi. above the surface of the earth to the edge of the field, which averages 40,000 mi. altitude. Density of the particles has been found to have an upper limit of 10^{8} particles/sq. cm.

The NASA energetic particles program has been the most active in the agency, and has been supplemented with data from Discoverer and from Transit hitch-hiker satellites in the Greb and Injun series, launched by the Defense Department.

Two Theories

The multitude of satellites and considerable amount of data that the satellites have returned have led to two theories regarding the origin of the Van Allen belts.

The first, or neutron decay theory, is widely accepted as the explanation of the inner zone. This theory postulates that heavy galactic and solar primary particles interact with the atmosphere at an altitude of about 20 mi. Neutrons are stripped from the particles and spin

off in all directions, decaying into protons and electrons, which are trapped in the magnetosphere.

The second theory holds that solar and galactic particles are directly injected into the magnetosphere and are trapped near earth to form high intensity radiation zones.

Theories on the cause of auroras also are unresolved, and the origin of the energetic particles that cause them remains a mystery.

The two most widely accepted ideas are that the particles are injected directly from the sun, or that they are dumped from the Van Allen belts, which act as a storehouse.

Magnetosphere

Explorer 10 satellite, launched Mar. 25, 1961, has produced the most significant measurements of the earth's magnetic field and its interaction with the solar wind. Vanguard 3, the first satellite to contain a magnetometer, produced data in a detailed mapping of the near-earth field after its Sept. 18, 1959, launch.

Dr. Norman F. Ness of Goddard explained that discovery of the draping of the geomagnetic field by the solar wind on the side of the earth away from the sun has been the most important force field discovery of satellites. In addition to this finding, Explorer 10 results indicate it is this cavity carved out of the solar stream which shapes the magnetosphere on the earth's dark side.

The satellite crossed the cavity boundary on the dark side at an altitude of 86,000 mi., allowing a first plot of the magnetosphere from direct measurement (see picture, p. 54).

Since Explorer 10 determined the dark-side cavity, Explorer 12 made the measurement of the boundary on the sunlit side as it varies from 34,000 to 52,000 mi., averaging an altitude of 40,000 mi.

None of the three satellites which have made major contributions to information on the magnetic force field —Vanguard 3 and Explorers 10 and 12 —has shown the existence of the steady ring current around the outer zone of the Van Allen belt, the phenomenon detected by Explorer 6 and seen by Pioneer 5.

Pioneer 1, launched Oct. 11, 1958, returned data which substantiated and extended previous data from sounding rockets. Rocket probes had indicated that magnetic field intensity decreased as a function of distance from the earth in an inverse cube relationship. Pioneer 1 found this to be true to an altitude of 27,000 mi., but found no regular relationship beyond this point.

This probe also determined that there is a relatively disturbed transition between the earth's magnetosphere and

When you follow these welding instructions— you can perform wonders with USS "T-1" Steels

USS "T-1" Steel, and "T-1" type A, are two of the most versatile steels ever developed. They combine very high yield strength (100,000 psi minimum), outstanding toughness, and ready weldability. Designers have taken advantage of this remarkable combination of properties to build stronger, lighter structures of many types, and to improve the performance of an impressive array of heavy-duty equipment.

Achieving great strength and toughness in a steel is not an earthshaking event. But combining these properties with weldability *is,* as in the case of USS "T-1" and "T-1" type A Steels. It is this weldability that permits the designer to take full advantage of the strength of "T-1" Steels.

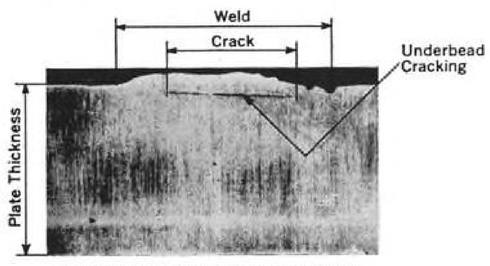
Being heat-treated constructional alloy steels, USS "T-1" Steels require different welding techniques than other high strength steels. They are not difficult to weld, just different. Strong, reliable joints are obtained when the following three precautions are followed. We invite you to read them as a guide to realizing the full benefits of USS "T-1" Steels. They are detailed in a booklet which includes a Welding Heat-Input Calculator, and in our new welder-training film, "How to Weld USS 'T-1' Steels" (see coupon).

RULE 1—Use the proper electrodes

When manual-arc welding "T-1" Steels, use only electrodes with low-hydrogen coatings. Or, use a welding method which is "low hydrogen" such as inert-gas shielded-arc or submerged-arc welding.

Hydrogen is the number one enemy of sound welds in "T-1" Steels, as in all alloy steels, because it causes underbead cracking, resulting in unreliable joints.

To be sure you have selected the correct electrodes, remember that low-hydrogen coatings are designated by the last two numbers of the electrode classification as 15, 16 or 18. None other. For example, E8015, E9016, and E11018 are satisfactory for welding USS "T-1" Steels.



Underbead Cracking in an Actual Weld

When you want to be positive that the finished weld will be as strong as the parent "T-1" Steel, use E11015, -16, or -18 rods.

Never use electrodes or wire-flux combinations containing vanadium to weld "T-1" Steels if the weldment is to be stress relieved. Weld metal containing vanadium is likely to be made brittle by stress relief. (Stress relief is only necessary with "T-1" Steels when required by codes and one or two other special cases.)

When welding "T-1" Steels to a lower-strength steel, use low-hydrogen rods of the strength level recommended for the *lower*-strength steel.

Proper handling of electrodes is also important. When exposed to air, low-hydrogen coatings will pick up moisture which is a rich source of hydrogen. Keep your electrodes dry. Make it a practice never to open more than 30 minutes' supply of rods at a time. A sure way to keep rods dry is to keep them in a 250-300°F oven. If your rods have absorbed moisture, hot bake them in an oven according to the manufacturer's recommendation. One hour at 800°F is average.

To sum up Rule 1, for manual welding use low-hydrogen electrodes and keep them dry. For submerged-arc or inert-gas shielding arc welding, use thoroughly dry fluxes and water-free shielding gases.

RULE 2—Use correct welding heat

On most kinds of structural steels, high heat input results in superior welds. With "T-1" Steels, just the opposite is true. The best welds in "T-1" Steels depend on *never getting over a certain maximum amount of heat.* Less heat is used so the weld will cool quickly which, in "T-1" Steels, results in good, tough welds. Thus, *you must closely control the amount of heat put into the weld.*

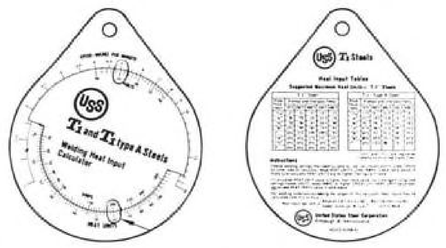
For this reason, never preheat "T-1" Steels except in special cases. Preheating means more heat to get rid of and a longer cooling off period, which can be harmful to welds on "T-1" Steels. The cases in which preheating is necessary are those in which the steel must be warmed to get rid of excessive moisture (a hydrogen source), where the piece is so restrained it doesn't have room to shrink after welding, or when thick pieces over 1" are being welded. Much of the time, however, preheating isn't necessary, and *never preheat* "T-1" Steels on hunch alone.

The heat you put into a weld depends principally on amperages and the speed at which the arc travels along the joint. The higher the amperage, the more heat input. The slower the speed, the higher the heat input. Controlling heat input requires keeping amperage below certain ceilings and keeping the speed of arc travel above certain speeds.

There are two other important items to keep track of: steel thickness and temperature. Thicker sections can safely soak up more heat than thinner ones, so you can use more amps and slower speed. As for temperature, the section may have been heated up by preheating or by previous passes of the electrode. So if the section is already hot, you must cut down on amps or increase speed to avoid excessive heat input.

Heat Input Calculator.

There's an easy way to determine the safe heat input for USS "T-1" Steels: the circular Heat Input Calculator which is provided with the book offered in the coupon. With it you can quickly find out what amount of heat will result from any given setup, and determine how much more you can safely put in. It is a



circular "slide rule" which tells, on the front side, how much heat will be put into the joint if you know the amperage, voltage, and arc speed. On the back side of the calculator are tables showing the safe heat inputs for "T-1" Steels in several different thicknesses at different temperatures. This handy device is designed to help you get good welds every time. Heat inputs may also be calculated from this formula:

$$\text{Heat Input per inch} = \frac{\text{Amperes x Arc Volts x 60}}{\text{Speed, inches per min.}} = \frac{\text{Watt Seconds (Joules)}}{\text{Per inch of weld}}$$

RULE 3—Use recommended welding procedure

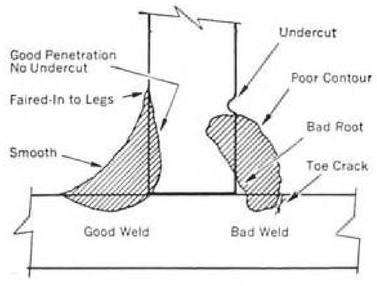
The straightforward stringer bead method is preferred for welding "T-1" Steels. *Do not use the "full weave" method.* Weaving heats the metal more because the arc travel speed is slower and may cause excessive heat input. The proper method is to fill the groove with a succession of stringer beads.

Before a bead can be laid over an earlier bead, the flux, scale, or oxidation must be removed.

Back gouging. The preferred method is arc-air gouging followed by clean-up grinding. *Do not use an oxyacetylene torch.* There is danger of overheating which may cause an unsatisfactory joint.

Speed. Whether you control speed by machine or hand, control it closely. The Heat Input Calculator described above is your guide to the proper speed to avoid excessive heat input.

Fillet welding. Good fillet welding technique is more important with "T-1" Steels because the joints are usually required to withstand greater forces. Fillet welds in "T-1" Steels should be smooth, correctly contoured and well faired-in to the legs of the pieces to be joined. The layers of each weld should be made so that there is good root penetration but no undercutting. The weld shown on the left is ideal, the one on the right is to be avoided.



When thick pieces are joined, and when the weldment is to be stress relieved, fillet welds can be troublesome because of toe cracking. There are several ways to eliminate toe cracking near fillet welds on "T-1" Steels. In the case of Tee or Ell joints where lower strength welds are often the rule, use low-hydrogen rods of the E90, E80, and E70 classes. Being lower in strength and more ductile, they are less likely to "pull cracks" at the toe of the fillet weld.

Air hammer peening of the weld can also be very helpful in preventing cracks, especially if the weld is to be stress relieved. Joints made even with the higher strength rods (E100, E110 and up) should be free from toe cracks if peened. Sometimes it is necessary to peen each pass; at other times, peening only the toe passes will prevent cracking. After peening, the fillets should be smoothly ground to fair the fillet into the legs of the joint.

Other methods that can prevent cracking include use of a soft wire pedestal, machine grooving the base of the upright piece, and laying down "butter" welds in toe areas. The first two methods allow the upright leg to "shrink down." The "butter" weld strengthens the "T-1" Steel in the area where a toe crack may start. It is ground off prior to actual fillet welding and must be located so that the toe passes of the fillet will be laid right over the strengthened zone.

Free Welding Help. The above information is spelled out in greater detail in our free book "How to Weld USS 'T-1' and 'T-1' type A Steels." Included in the book is a Heat Input Calculator that helps the welder choose the proper welding machine settings. We'll gladly furnish enough free copies for your shop personnel. Also, you'll find our 18-minute, 16mm color motion picture of the same name a big help in demonstrating to your welders the proper techniques for welding USS "T-1" Steels. Send the coupon. USS and "T-1" are registered trademarks.

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USS United States Steel

United States Steel, Room 6621
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Pittsburgh 30, Pa.

Gentlemen:

☐ Please send me____copies of "How to Weld USS 'T-1' Steels."

☐ Also lend me your 16mm, color sound movie of the same name. I understand there is no obligation.

Name_____

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Company_____

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This mark tells you a product is made of modern, dependable Steel.

the magnetism in interplanetary space, starting at an altitude of about 53,000 mi.

Cosmic Rays

Goddard has relied primarily on recoverable emulsion stacks carried on rocket payloads to obtain data on the charge composition of solar cosmic rays, according to Dr. Carl E. Fichtel of Goddard. Rays leave streaks in emulsion plates which in effect are signatures of their charges and energy spectra. Most heavy primary cosmic rays are stopped or broken apart when they strike the atmosphere, and rockets provide a means of measuring above this influence.

From rocket-borne emulsion payloads, scientists have determined that at least four recognizable differences exist between cosmic rays from the sun and those from outside this solar system.

The differences are found in the nuclei ratios—carbon to oxygen, light to medium, helium to medium, and medium to heavy charge groups.

Space research has thus confirmed the belief that stars other than the sun contribute importantly to the population of cosmic rays which strike the earth's atmosphere, and has strengthened the hypothesis that some cosmic rays come from stars of unusual composition, such as super novae.

Rays from sources other than the sun have unusually high energies compared with the energies of solar particles, and space research has found that the principle constituent of both galactic and solar cosmic rays is hydrogen.

Solar Physics

Even though stars outside the galaxy add to the cosmic ray population, the sun is the star which exerts the greatest influence on the earth and on man's ambitions to explore deep space. Research from space vehicles will overcome the distortion and obscuration of the earth's atmosphere which prevents direct measurements of the ultraviolet, X-ray and long radio wave spectra from earth.

Although the sun's surface cannot be observed directly by satellites and solar probes, these vehicles will lessen the effects of the opaque gases steaming from the lower photosphere. New information can be obtained on temperatures of various regions—photosphere, chromosphere, sunspots—and on brightness and the sun's chemical make-up.

Dr. John C. Lindsay, chief of solar physics at Goddard, looks on the sun as a body which is continually sending out information about itself. "All we have to do to find out what is going on," he said, "is to break the telemetry code."

First attempt to break the code with instruments which continually point at the sun came last Mar. 7 when OSO 1 was launched to carry instruments above the absorbing influence of the atmosphere. These instruments are measuring in the ultraviolet, X-ray and gamma ray spectral regions.

Analysis of data from this satellite may determine which solar flares eject particles, and possibly aid in predicting solar flares.

The Apollo manned lunar landing mission schedule depends to a large extent on whether the U. S. can develop a synoptic technique for flare prediction. Apollo timetable calls for lunar landing in 1967, about two years after the solar minimum. Delays in this schedule will increase the hazard, because the number of solar events increases to a peak in 1969-70.

First massive attack on the secrets of the sun came during the International Geophysical Year in 1958 when a number of rocket payloads observed the sun in ultraviolet and X-ray wavelengths. The program has continued since then, with the normal procedure being to launch rockets during solar storms. For example, NASA launched seven rockets Nov. 12-16, 1960, during the largest solar event yet observed.

Ultraviolet spectrographs obtained from rocket payloads, and substantiated so far by OSO 1, indicate that most of the solar radiation comes from a very small portion of the total area of the sun. The "bright" areas constitute only about 3% of the total solar surface, and are centered over sunspots.

With its ability to point continuously at the sun, OSO 1 is studying the sunspots in detail in an attempt to reduce fairly broad spectral bands to precise lines. Once spectral lines are identified, ground-based spectrographs can determine the composition and atomic makeup of the solar elements.

Instruments on board OSO 1 are measuring in the 1 to 10, 50 to 400 and 1,100 to 1,250 angstrom lines. Next satellite in the series, S-17, will include a high-resolution ultraviolet spectrometer which will measure from 500 to 1,500 angstroms.

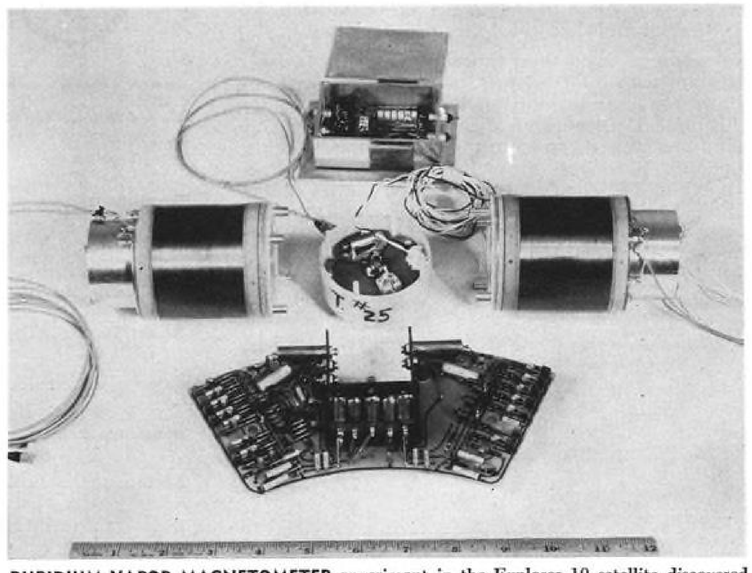
These fundamental findings of space science experiments in the area of energetic particles, magnetic fields and solar physics (summarized in chart, p. 55) have resulted in the identification of some of the primary objectives for the next generation of spacecraft. According to Ludwig, these objectives by discipline are:

- **Galactic cosmic rays:** measurements of the charge spectrum, relative abundances of isotopes, energy spectra of constituents, population and energy spectra of high-energy electrons, anti-matter, photons and other particles, cosmic ray variations and their directional characteristics.
- **Solar flare particles:** relationship between elements in the solar stream and in the sun itself; particle fluxes as a function of time; energy spectra of constituents, and correlations between the production of energetic solar particles and phenomena such as visible flares, coronal streamers, solar radio noise, transit time for particles, geomagnetic disturbances, radiation belt structure variations and auroras.
- **Solar plasma:** fluxes and energies of components, variations of plasma as functions of time and position, and a correlation of the plasma, as with other solar and geophysical behavior.
- **Van Allen belt:** energy spectra of the inner zone as a function of position, and characteristics of the zone as a function of time; detailed study of the energy spectra of the outer zone, angular distributions in this zone, and complete time histories of solar flares and the relationship of these flares to geomagnetically-trapped radiation.

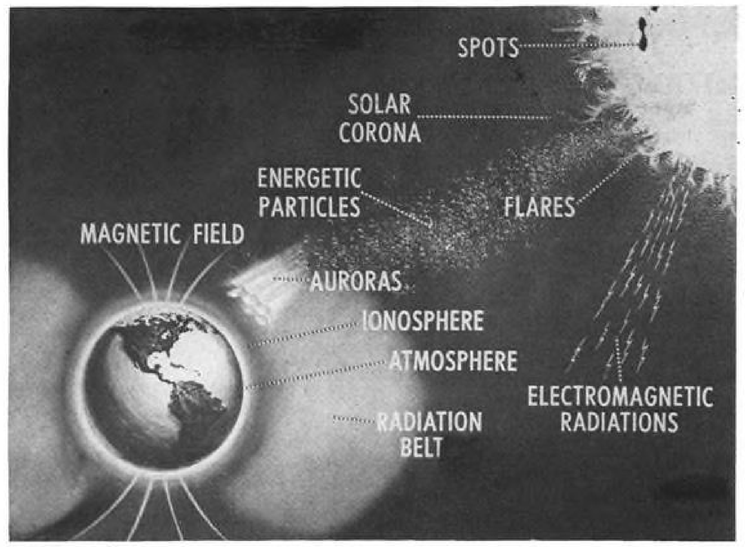
Most important objective of research in the earth's magnetic field, according to Dr. Ness, is a complete survey of the geomagnetic cavity on the dark side. This study will determine the complex behavior, interactions and effects of solar plasma and the earth's magnetic field.

Dr. Goett estimates that the observatory experiments designed to meet this variety of objectives will carry the major portion of scientific experiments in the near-earth region during the next 10 years. These will be supplemented by smaller satellites designed for special-purpose measurements.

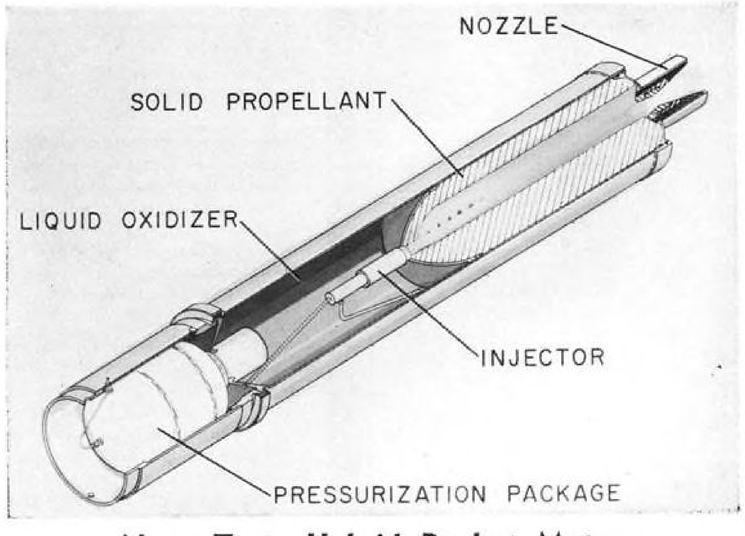
(Part 2 of this series will discuss experiments in the ionosphere and aeronomy.)



RUBIDIUM VAPOR MAGNETOMETER experiment in the Explorer 10 satellite discovered draping effect of the earth's magnetic field on the dark side. Rubidium lamp and gas cells are in the center, oscillator is at top, and amplifier, bottom.



SPACE SCIENCE STUDIES are focused primarily on the solar-terrestrial relationship, phenomena of which are shown in this National Aeronautics and Space Administration drawing.



Navy Tests Hybrid Rocket Motor

Drawing shows new hybrid rocket motor, combining liquid and solid propellant, which has been successfully free-flight tested by Navy at China Lake, Calif.

Floodlights Considered as Light Source for Night Lunar Landings

By C. M. Plattner

Bethpage, N. Y.—Night lunar landing research program under earthshine lighting conditions being explored by Grumman Aircraft Engineering Corp. here indicates a need for additional light sources, possibly floodlights, aboard the manned lunar landing vehicle.

Investigation is part of a company-funded study of lunar landings started last January and now in the pilot-simulator evaluation stage. Grumman has been an active bidder on different phases of Project Apollo, including the lunar excursion module, and is pursuing an independent lunar research program at its own expense to remain competitive.

Emphasis has been placed on night landings rather than day landings at Grumman because National Aeronautics and Space Administration currently favors the —250F cold of the lunar night to heating problems brought on by the 250F lunar day. Lunar night occurs when a portion of the moon's visible surface is no longer illuminated by the sun, i.e., the dark portion of anything less than a full moon. During this time, primary illumination of the lunar surface comes from light reflected from the earth (earthshine).

Search by Grumman of available data, including Russian studies, of composition of the lunar surface and incident light available from earthshine has indicated that lighting conditions during night landing on the moon are marginal at best. Grumman studies show an average reflective coefficient of .07 and 1.4 foot candles of incident light yielding only .09 lamberts of brightness.

Object Definition

This small amount of brightness provides definition of objects equivalent to that experienced on a clear starlit night with no moon. This lack of definition combined with the already inherent hazards of landing in a hostile environment will present pilots with formidable problems in discerning landing areas and in depth perception.

Grumman study indicates that the lunar surface is covered with material which has a reflective characteristic similar to lampblack. The minimum reflectivity of such a surface provides fewer shadows to enhance depth perception.

Absence of a lunar atmosphere will further complicate night lunar landings, human factors researchers at Grumman say. The diffusion of light by the earth's atmosphere probably provides a different shadow structure than exists on the moon, they add. Although it is not known what type of shadows are created by incident light on the moon, effectiveness of pilot depth perception could be effectively reduced if they are different than those experienced on earth.

Landing light system, possibly a bank of floodlights aboard the lunar landing vehicle, has been suggested by Grumman to ease the night landing problem. Such a system would illuminate the landing path similar to those employed by conventional aircraft, and, according to Grumman engineers, would be preferable to flares.

With additional light and a forward landing technique to help alleviate dust problems, Grumman believes night landings can be made feasible. Evaluation of a forward landing technique is being carried on in a 6-deg.-of-freedom lunar landing simulator.

Simulator Construction

Simulator has the visibility and cockpit construction of a single-engine aircraft. Primary control instruments are on the front panel and indicate angle and rate of pitch, yaw and roll; lateral, longitudinal and total range from point of intended landing; altitude; rate of descent; thrust and translational velocity.

Single integrated display is also part of the evaluation program. This is believed necessary because pilots have experienced difficulty controlling yaw while at the same time controlling pitch and rate of descent.

Simulator's 6 deg. of motion include four motions which appear to the pilot on a translucent screen in front of the simulator. A four-axis light source projects a cross on the screen to represent the landing spot. The cross grows larger or smaller and is free to move in all directions, thereby indicating altitude, lateral and longitudinal translation and heading to the pilot. Roll appears as a translation of the cross on the screen. The simulator is hydraulically actuated and moves about the pitch and yaw axis to provide the additional 2 deg. of motion.

Preferred landing technique is to start from hover at 1,000 ft. and descend at an approximate 45-deg. angle straight ahead, with a minimum of left or right translation to about 10 ft. above the surface. An ideal approach would look something like a steep ILS landing approach. With all vehicle motion stopped, the final descent of 10 ft. or

less would be executed by chopping rocket power and dropping to the surface. Moon gravity is one-sixth as strong as that of the earth.

Pilots have performed the approach in 65 sec. within the fuel requirements felt necessary. NASA requirement is that the lunar landing vehicle be able to hover for 2 min.

Grumman engineers feel that dust clouds will be behind the vehicle in a forward movement type of landing approach to a large extent, giving better visibility as well as providing pilots with the opportunity to look over the terrain at lower altitudes. It is also felt that since the proposed landing method corresponds basically to an airplane-type landing approach, pilots will adjust to it more readily.

Reaction jet control programed into the simulator utilizes a finger-tip controller which presently has a response rate of 10 deg./sec. on all three axes. Pilot studies, so far, have indicated a need for greater response, and plans have been made to increase the rate to 15-20 deg./sec. about all three axes of the system.

Grumman feels the three-axis finger-tip control is easier to use and more efficient than the two-axis side-arm controller and yaw pedals presently called for in the Apollo vehicle or the three-axis wrist control for two reasons:

- **Greater frequency response** because control can be moved faster through a given deflection, providing more sensitivity. Grumman also claims the finger-tip system requires less cross-coupling than with the wrist control.
- **G-bias can be eliminated** during periods of acceleration or deceleration by mounting the control perpendicular to g-forces. The control is approximately 3½ in. long with a ¾-in. diameter knob on the end and may be grasped easily by the pilot while in either a vertical or horizontal configuration.

Lunar landing studies at Grumman are based on the supposition that the last 1,000 ft. of descent will have to be made under manual pilot control. Entering a hostile environment for the first time and landing under lighting conditions unfamiliar to the pilot will necessitate flexibility, particularly as the lunar vehicle approaches the landing site.

At present, the lunar simulator studies being conducted at Grumman have two purposes—to optimize a control system and also to explore lunar landing techniques.

The company has been asked by NASA to evaluate informally, without funding, the three-axis finger-tip controller and the two-axis side-arm control with rudder pedal which is presently called for in Gemini and Apollo. The company plans to start on this evaluation within a month.

NASA Contracts

National Aeronautics and Space Administration recently awarded the following contracts and research grants:

HEADQUARTERS, WASHINGTON, D.C.:

University of Michigan, Ann Arbor, Mich.—$100,000 to conduct theoretical and experimental studies of generation and transmission of low frequency sound in upper atmosphere.

National Beryllia Corp., Haskell, N. J.—$65,000 for research on low density thermal insulating material for use at temperatures above 3,000F.

Atomic Energy Commission, Washington, D. C.—$115,000 to conduct research directed toward development of biopaks and experiments for use in space environment.

University of Chicago, Chicago, Ill.—$222,000 for training of graduate students in space-related science and technology.

University of Maryland, College Park, Md.—$192,000 for training graduate students in space-related science and technology.

University of California, Los Angeles, Calif.—$132,000 for training of graduate students in space-related science and technology.

State University of Iowa, Iowa City, Iowa—$170,000 for training of graduate students in space-related science and technology.

A. & M. College of Texas, College Station, Tex.—$220,000 for training of graduate students in space-related science and technology.

Rice University, Houston, Tex.—$192,000 for training of graduate students in space-related science and technology.

Rensselaer Polytechnic Institute, Troy, N. Y.—$177,000 for training of graduate

students in space-related science and technology.

Massachusetts Institute of Technology, Cambridge, Mass.—$447,000 for research on organizational and management concepts suitable for large scale technology-based enterprises with particular application to NASA.

University of California, Berkeley, Calif.—$500,000 for inter-disciplinary space-oriented research in physical, biological and engineering sciences.

University of California, Los Angeles, Calif.—$92,000 to develop measurement techniques for directional spectral intensity of low energy protons, including construction of a prototype.

Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y.—$117,000 for experimental and theoretical research on flow of high temperature hydrogen through jet nozzles.

Documentation, Inc., Bethesda, Md.—$200,000 for establishment, maintenance and operation of NASA documentation center.

Bellcom, Inc., Washington, D.C.—$250,000 for systems analysis, study planning and technical support for Project Apollo.

Advanced Kinetics, Costa Mesa, Calif.—$76,000 for laboratory simulation studies of outer space phenomena.

AMES RESEARCH CENTER, MOFFETT FIELD, CALIF.:

General Precision, Inc., Binghamton, N.Y.—$50,000 for manned transport simulator.

Metrotech, Inc., Mountain View, Calif.—$66,000 for indicating millivolt potentiometer.

A. J. Peters & Son, San Jose, Calif.—$57,000 for installation of jet simulation air system for unitary plan wind tunnel.

LEWIS RESEARCH CENTER, CLEVELAND, O.:

Feldman Brothers, Cleveland, Ohio—$197,000 for services and materials for modifications to test stand building and exhaust systems at altitude rocket test facility at Plum Brook station.

Electro-Mechanical Research, Inc., Sarasota, Fla.—$50,000 for digital decommutator for SERT project tank tests.

New Britain Machine Co., Cleveland, Ohio—$53,000 for horizontal boring mill.

LANGLEY RESEARCH CENTER, HAMPTON, VA.:

Radio Corp. of America, Camden, N. J.—$72,000 for study to determine radiation effects as function of proton particle energy.

Electro International, Inc., Annapolis, Md.—$144,000 for services to repair government-owned instruments.

Hoover Company, Timonium, Md.—$60,000 for telemeter system.

FLIGHT RESEARCH CENTER, EDWARDS, CALIF.:

J. R. Fetridge & Associates, Palmdale, Calif.—$56,000 for architect-engineering services for Flight Research Center building additions to the main facility.

GODDARD SPACE FLIGHT CENTER, GREENBELT, MD.:

Space Technology Laboratories, Inc., Canoga Park, Calif.—$71,000 for design study of accelerator for accelerating particles to meteoroic velocities.

Aero Geo Astro Corp., Alexandria, Va.—$50,000 for study of techniques for reducing noise introduced to R-F receiving system by antennas.

Van Storch & Burkavage, Philadelphia, Pa.—$77,000 for architect-engineering services for data acquisition facility in Pisgah National Forest.

Rohr Corp., Chula Vista, Calif.—$500,000 for 85-foot antennas for Rosman data acquisition facility.

Textron Electronics, New Haven, Conn.—$133,000 for vibration exciter, cooling system and other related equipment for payload test facility at Goddard.

Radio Corp. of America, Lancaster, Pa.—$87,000 for electron tubes.

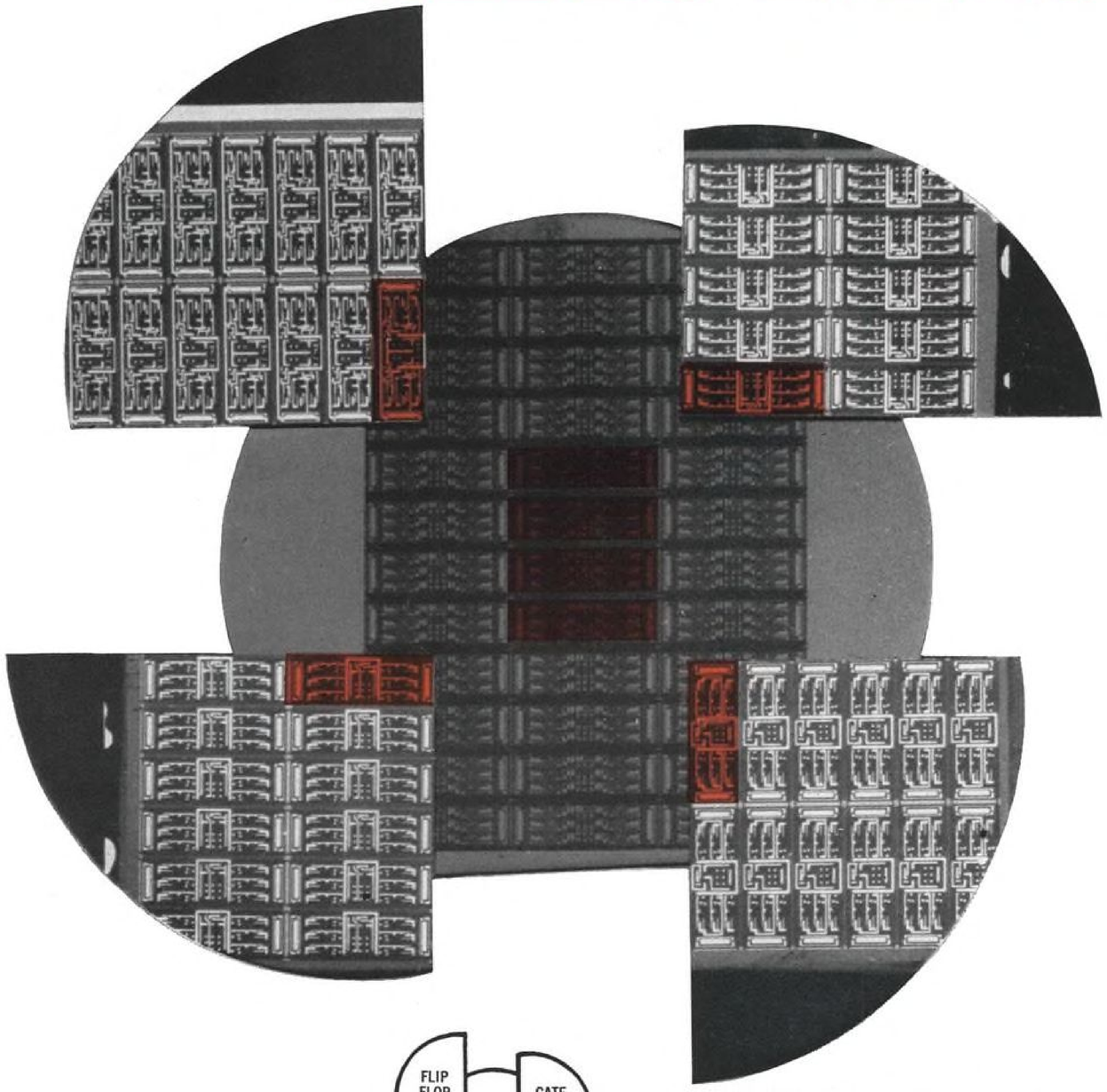
A-T Electronics, Inc., New Haven, Conn.—$57,000 for jacketed styroflex cable and non-returnable reels for Project Relay.

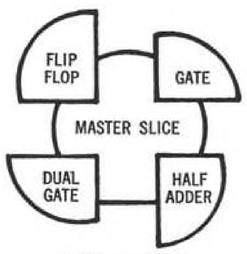
Operations Research, Silver Spring, Md.—$81,000 for reliability study for Nimbus meteorological satellite.

Vitro Corp. of America, Silver Spring, Md.—$127,000 for telemetry receivers.

International Business Machines Corp., Washington, D. C.—$1,756,000 for conversion of IBM 7090 to higher speed IBM 7094.

MASTER SLICE





(ACTUAL SIZE)

SOLID CIRCUIT semiconductor networks are manufactured from pure silicon "master slice" wafers (center illustration) which contain more than 30 separate circuit bars. Customized interconnection patterns (four corner wafer fragments) are then photo-etched in aluminum on "master slice" wafers, producing completely integrated semiconductor networks ready for packaging.

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HERE'S HOW: First, standard "master slice" integrated circuit bars — complete except for interconnections — are taken from established, high-volume production lines. Second, a special interconnection pattern mask for your circuit is prepared. Third, your special interconnection pattern is photo-etched in aluminum on the "master slice" circuit bar.

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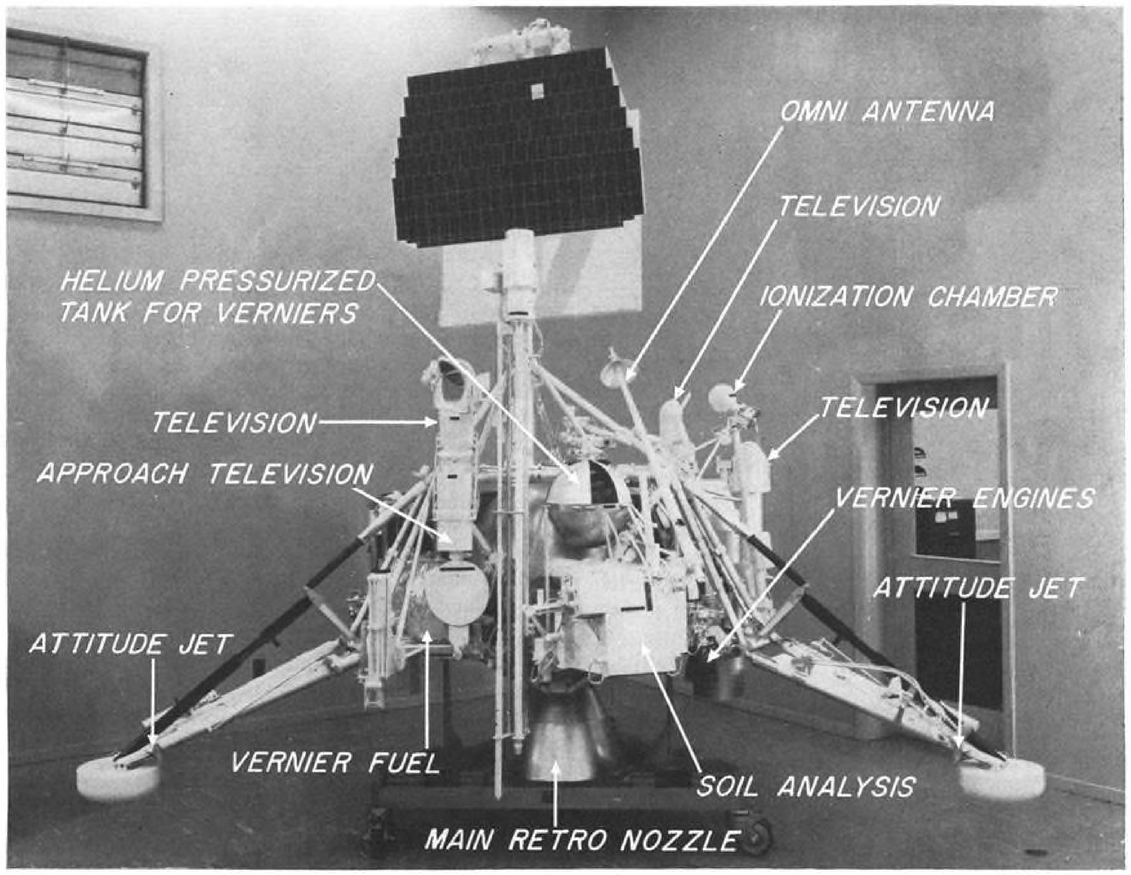
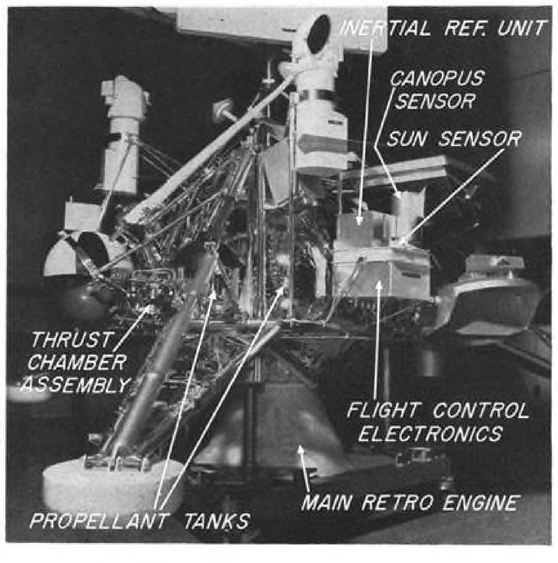
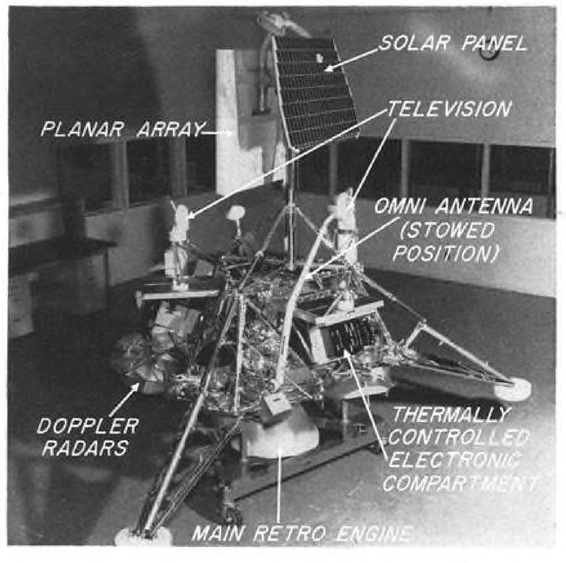


ENGINEERING MOCKUP of Surveyor soft-landing lunar spacecraft being fabricated by Hughes Aircraft Co. for Caltech Jet Propulsion Laboratory enables engineers to check gross interfaces and television camera view angles. In first flights, probably starting in summer of 1964, Surveyor will not carry full complement of instruments shown on flightweight spaceframe (above) in effort to cut injected spacecraft weight to meet unanticipated decrease in lift capability of early versions of its Atlas-Centaur booster. Surveyor appears in photos below stripped of instruments with the exception of surveillance television cameras that will scan moon's surface during post-landing phase of mission. Downward-looking television camera is an integral part of flight control.





Surveyor Vital to Manned Lunar Program

By Barry Miller

Culver City, Calif.—Complete operating prototype of a Surveyor spacecraft designed to soft-land on the moon's surface and return to the earth data collected by a series of onboard experiments will be completed here late next month or early in December. Surveyor, one of National Aeronautics and Space Administration's key lunar projects thus will move into its systems test phase.

Ability of spacecraft in the unmanned Surveyor series to demonstrate controlled, or soft, landing on the lunar surface is regarded as a crucial step in the sequence of scheduled events leading to success of a similar soft landing of men on the moon.

In addition, scientific instruments and television cameras aboard the seven Surveyor landing spacecraft hopefully will obtain information about lunar characteristics—lunar radiation environment, surface bearing and shear strength and the lunar physiognomy. This information will be invaluable for manned lunar spacecraft design and other aspects of lunar exploration and will be a boon to scientific knowledge.

Surveyor Development

The seven Surveyor spacecraft and other integral elements of the system are being developed and fabricated here by Hughes Aircraft Co., which was selected as the spacecraft systems contractor almost two years ago (AW Jan. 30, 1961, p. 50; Feb. 20, 1961, p. 70). The company has been working under a contract of approximately $70 million from California Institute of Technology's Jet Propulsion Laboratory, which has responsibility for the project within its mission as manager of NASA's unmanned lunar exploration program.

Surveyor project will consist of two spacecraft—Surveyor A, the soft-landing vehicle, and Surveyor B, a vehicle intended for orbital injection around the moon to secure extensive stereoscopic pictures of potential Apollo landing sites and to acquire other scientific data. The two types are called the lander and the orbiter, respectively.

Orbiter will be a heavily modified version of the lander spaceframe, plus a special 80-lb. dual camera instrumentation package, called Visual Instrumentation Subsystem (VIS), which mates to the spaceframe as a payload. A contractor for this camera subsystem was expected to be picked by early this month.

Hughes isn't funded for the orbiter spacecraft, although it does have study money for this and presumably will get the fabrication task. About $132 million is included in NASA's current budget for all costs associated with five orbiters. This includes spacecraft development, launch vehicles, salaries and institutional support.

Once the initial prototype of the lander, designated T-21, is completed later this year, and is subjected to extensive systems tests here, it will be moved to JPL's Goldstone tracking site in the Mojave Desert. There, a command and data console will command the spacecraft through a Deep Space Instrumentation Facility (DSIF) site, just as it ultimately will be expected to do when the spacecraft is hurtling through space or sitting on the lunar surface about 250,000 mi. away.

Later, T-21 will be transferred to Holloman AFB, N. M., where it will be suspended from a large tower, its vernier rocket engines fired and "buzz" tests conducted to spot undesired coupling with the vehicle's electronics.

Revised plans now call for total lander spacecraft weight of about 2,100 lb., with about 114 lb. allocated to scientific instruments. Roughly two-thirds of vehicle weight is consumed by the spacecraft propulsion system for making midcourse corrections in transit to the moon and for slowing the descent to the lunar surface.

The 2,100-lb. figure is a 400-lb. reduction from earlier weight limits, necessitated by the likelihood that at least the early Centaur booster versions, on which this spacecraft will ride, will not have the originally anticipated payload capability. Weight savings are gained at the expense of a sharply reduced instrumentation payload and consequent diminution in the spacecraft retrorocket's solid propellant.

First launch of a lander probably will not occur before the summer of 1964, almost a year's stretchout in schedule resulting from Centaur development delays (AW May 28, p. 33). Hughes is continuing to work on its initial schedule and is using the additional time for more extensive testing and possible spacecraft improvements.

Makeup Unchanged

General external makeup of the lander is the same as that described by JPL previously (AW Feb. 20, 1961, p. 70), although the spacecraft's appearance, subject to change with a complement of externally mounted instruments, will differ from the original model.

It has a tripod shape with characteristic landing legs spaced 120 deg. apart about the structure, an off-center, extendable boom supporting a solar panel and a broadband, high gain directional planar antenna array, and a large spherical, solid-propellant retrorocket, to slow

Lunar Environment for Surveyor

Design of the Surveyor lander is sharply influenced and constrained by the strange, largely unknown lunar environment. The spacecraft and its payload must be able to set down softly, at a speed probably not in excess of 20 fps., on a flat or sloping surface that may be hard or soft, pocked with rocks or other protuberances.

On the basis of what is known now or thought to be reasonable assumptions about the moon, Jet Propulsion Laboratory has advised Hughes on the lunar environment model it should assume for engineering design studies and subsequent development of the Surveyor A (Surveyor lander).

Hughes has designed the vehicle to survive these and more stringent environments in the eventuality that the lunar model proves inadequate. Some of the unknowns may be resolved in part by television pictures Ranger spacecraft may be obtaining over the next 15 months. Yet even these pictures may not feed into the project early enough to materially lessen the effort invested by Hughes and Jet Propulsion Laboratory in designing the spacecraft to meet the broad range of possible environments.

Assumed lunar environmental conditions for Surveyor include:

- Lunar atmosphere is a vacuum.
- Slopes greater than 15 deg. will not be encountered, although it is necessary to find probability of spacecraft survival if slopes of greater than 15 deg. are encountered. Surveyor may be able to land satisfactorily on 25 deg. slopes.
- Protuberances greater than 10 cm. (about 4 in.) will not be encountered.
- Hardness of lunar surface will range from that of soft wood to that of very hard rock. A Surveyor dynamic model has been dropped under simulated lunar conditions on surfaces covering this range, will soon be tested on simulated lunar dust (talcum powder).
- Friction properties of lunar surface are uncertain.
- Surface dust conditions are uncertain.
- Lunar surface temperature varies from a maximum of about 235F during lunar daylight to a night-time temperature of —245F. Reflecting power of the lunar surface is 0.07.

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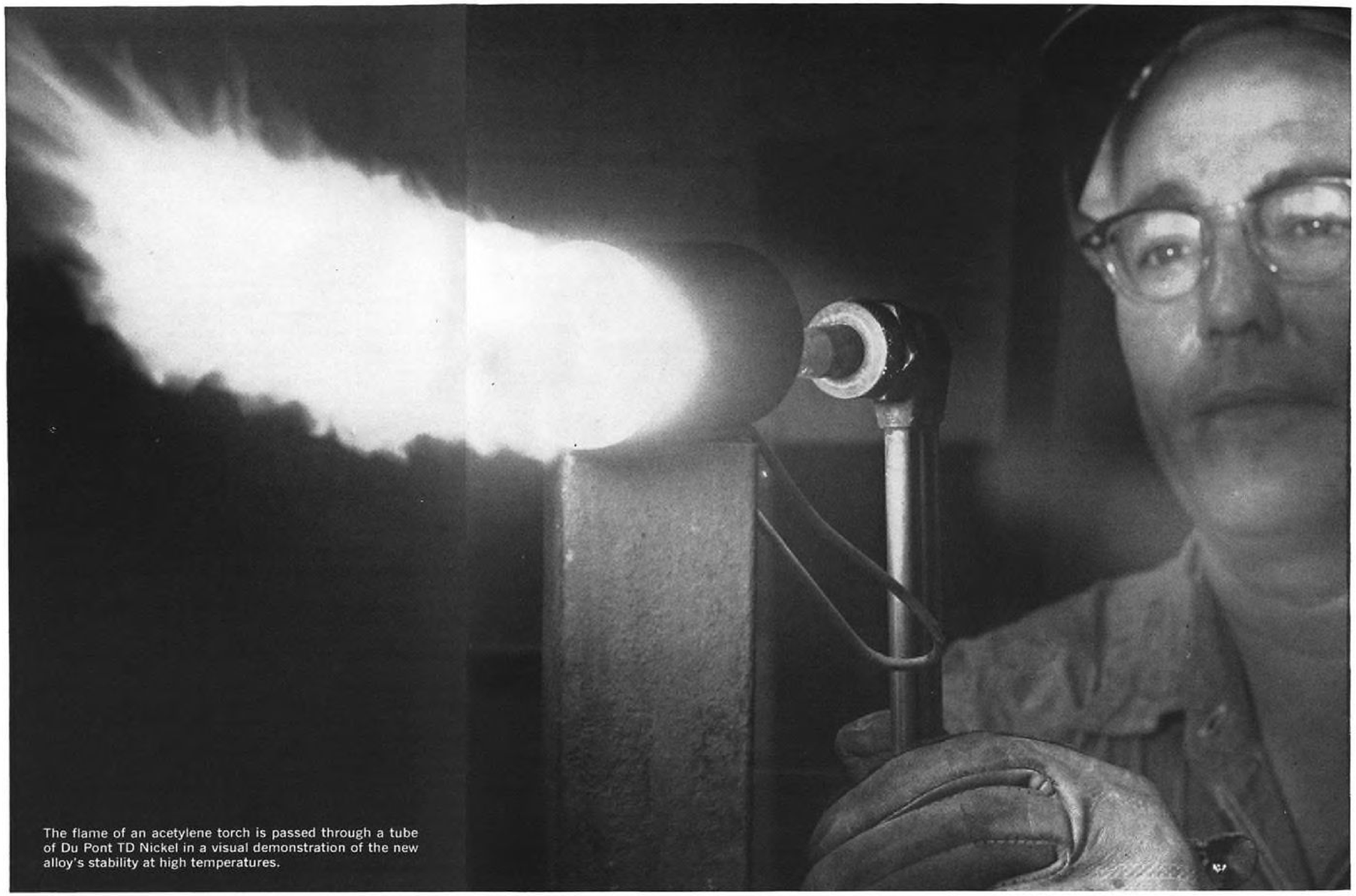

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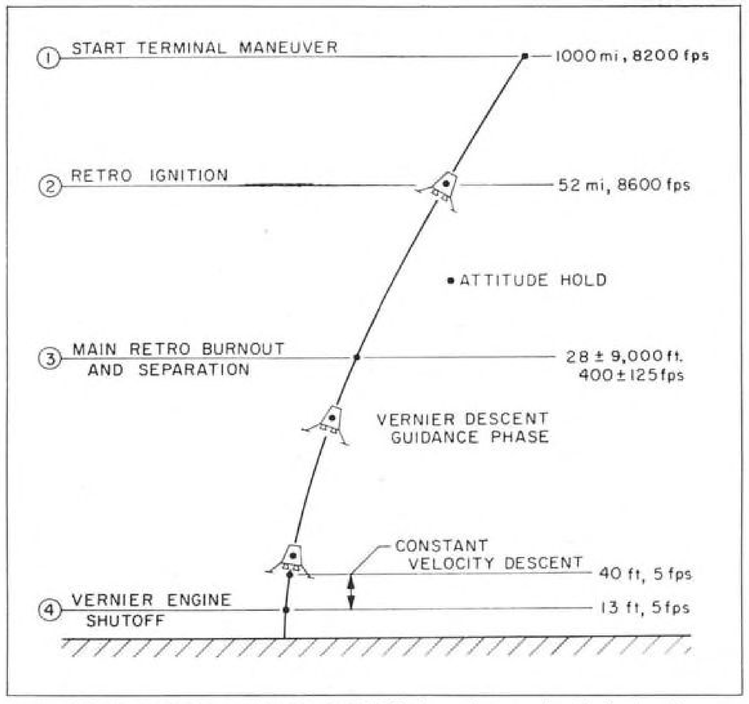


IN TERMINAL DESCENT PHASE OF FLIGHT, lasting only a couple of minutes, the spacecraft's propulsion and flight control systems attempt to cushion the vehicle's descent to the lunar surface and land it aligned within 5 deg. of the lunar vertical.

down lunar descent, connected to the spacecraft by three explosive bolts.

Erect, the spacecraft stands 8 ft. high from its crushable polystyrene landing pads to the top of the boom supporting the antenna and solar panel. It measures 13 ft. across its legs. The antenna can be raised another 40 in. if necessary for thermal reasons.

Main retrorocket provides 8,000 to 10,000 lb. of thrust with a propellant mixture similar to the one employed on the Minuteman ICBM first stage motors (AW Aug. 27, p. 54). This propellant includes ammonium perchlorate as the oxidizer, aluminum powder to boost specific impulse and control burning rate, polybutadiene acrylic acid for fuel and binder and epoxy resin as a curing agent.

Vernier Engines

Center of gravity of the spacecraft is at the center line of thrust of the retrorocket. By cutting instrumentation weight, Hughes was able to save about 250 lb. of propellant, thereby accounting for the new orbital weight of 2,100 lb.

Three vernier engines will change the vehicle's direction during midcourse maneuvers and control final descent velocity. Two of these are fixed and one is gimbaled to assist the nitrogen gas jets, located near the landing pads on the spacecraft's legs, in maintaining spacecraft orientation at landing.

Verniers have a 3.5 to 1 thrust modulation capability. That is, they are individually throttleable over a thrust range from 30 to 104 lb. The system employs a hypergolic bipropellant. It has two tanks per engine, one for the oxidizer—nitrogen tetroxide—and the other for the fuel—mono methyl hydrazine. With a helium pressurization tank, the vernier elements are all manifolded together and portions of the system, particularly the tanks, are recognizable in accompanying photos of engineering mockups of the lander.

With 160 lb. of vernier fuel, there is a sufficient supply for the worst anticipated midcourse maneuver and the worst possible descent. Should an unexpectedly large midcourse correction have to be made, as was necessary to overcome excessive boost velocity in the Ranger 3 mission earlier this year, the vernier system could correct this, according to Dr. Leo Stoolman, Surveyor project director at Hughes.

Corrections of this magnitude would sacrifice the soft landing mission, but since Surveyor carries a downward-looking, or approach television which will operate throughout descent, it might accomplish as much as a successful Ranger 5 type vehicle mission before crashing on the lunar surface.

Complete redundancy in the vehicle's telecommunications, a technique now common in NASA spacecraft like the Syncom and Relay satellites, is designed into Surveyor.

Spacecraft will carry two high-power transmitters (10 to 12 w.), two low-power transmitters (100 milliwatts) and a pair of receivers, all designed for operation in S-band.

Any of the four transmitters can be connected to either of two receivers, and linked to either of the spacecraft's two omnidirectional antennas. During transit, one transmitter and one receiver operate together as a transponder to assist the DSIF network in tracking the spacecraft. The telecommunications gear employs solid-state components throughout, with the exception of traveling wave tubes in the transmitters.

Also aboard the spacecraft is a single central data processor which accepts data from small, individual processors linked with the instruments and can encode analog data and store some data on a tape recorder which may be included on the spacecraft. A central command decoder also is planned for the telecommunications package.

Minimum number of spacecraft commands are supplied from programmers aboard the vehicle; the bulk by radio command. This is a marked departure from Ranger, which operates primarily from onboard commands supplied by a programmer. The switch is made possible, Stoolman says, by the availability of a redundant, highly reliable radio command link.

Power Source

Power is supplied during transit and during the solar daytime by an 8½-sq. ft. solar panel which generates about 60 w. Rechargeable silver zinc batteries, operating on 14-earth day recharging cycles, can store about 4,400 watt-hours of energy for operation during lunar night. The spacecraft is designed for a minimum lifetime of 30 days, roughly the equivalent of a lunar day and lunar night. Desired maximum lifetime is 90 days.

Radioisotope thermoelectric generator (RTG), which is being developed by Martin Co. for the Surveyor project (AW Nov. 13, p. 85) will not be flown on the first Surveyor lander. The 30-lb., 25-w. (max.) RTG which would substitute for the solar panel could save some weight but poses handling and heat problems.

Hughes engineers have found an unusual solution to one of the principal problems of operating on the lunar surface—protecting electronic components from the extremes of lunar temperature, which is broader than the specified operating ranges for many military-approved electronic devices.

All critical electronic components required for lunar operation, excluding flight control electronics which are not operated after touchdown, are grouped into two compartments attached to either side of the spacecraft. The compartments are enclosed in one inch of super insulation, about 100 sheets of crinkled Mylar which minimizes thermal conductivity and thus cuts down on reradiation from the compartment.

During the lunar night, when electronic equipment and instrumentation operation is at a minimum, about 3 w. of power are generated internally to maintain temperature within the tightly-closed compartment between 40 and 50F, while outside the lunar temperature may dip to −250F.

During lunar daylight, when operation of instruments reaches its peak, and excessive heat is generated in the compartment, small thermal switches (10 in one compartment, six in the other) force circular covers, to which they are attached in the compartment, to open about 15 mils, sufficient to permit heat reradiation from the compartment. The thermal switches are small bimetallic elements which expand differently when heated, providing a force to close a contact and open the circular cover.

Temperature Variance

In this fashion, it is expected that internal compartment temperature will vary between 40 and 100F, while lunar temperatures may vary between plus and minus nearly 250F. A few of the instruments with sensitive components, which are integral to them and cannot be located remotely in the compartments, have their own heaters.

Flight sequence for a Surveyor lander launch, transit and landing will include:

• **Spacecraft will be launched** from Cape Canaveral by an Atlas-Centaur booster combination. After Atlas burnout and separation, Centaur engines will ignite and place this second stage and its spacecraft payload into a 100-mi.-altitude parking orbit where it will remain for 7 to 15 min. Over the South Atlantic, Centaur will fire again and inject itself and the spacecraft onto a lunar trajectory, about 2 min. after firing.

• **Separation of the second-stage** booster from the spacecraft takes place on command from the Johannesburg DSIF. Surveyor's legs and two omni antennas extend, the vehicle orients itself with respect to the sun and Canopus, one of the brightest stars in the heavens. A solar sensor senses the sun's location and supplies signals to a step motor which drives the solar panel so that it is facing the sun and perpendicular to the vehicle's roll axis.

Use of Canopus and the sun, rather than the earth and sun, as references extends the suitable launch period for a lunar spacecraft in any month. Ranger, which does not need light after its lunar impact, uses earth and sun sensors. Consequently, it cannot be launched during a full moon because the angle between the earth and sun is insufficient to orient a spacecraft effectively. Surveyor, on the other hand, requires light for its TV after lunar touchdown and also needs a minimum of five to seven days of sunlight for battery charge. By using Canopus and the sun as references, it can be launched near full moon and can be on the moon during third-quarter sunlight.

• **Surveyor's strap-down** inertial reference system accepts ground commands through a simple programmer and torques its gyros. The gyros supply signals to three attitude control nitrogen jets that control the spacecraft in yaw, pitch and roll. The spacecraft continues on the lunar trajectory in the coast phase.

• **About 20 hr. after launch,** when Surveyor is in view of Goldstone, it is put through a midcourse maneuver to correct for boost velocity errors. An hour before this maneuver it is reoriented so that the thrust vector of the vernier engines is properly pointed to make midcourse corrections.

• **Verniers are fired** a metered amount to alter spacecraft course. The spacecraft locks back on the sun and Canopus and continues its cruise toward the moon. Spacecraft propulsion is capable of making any number of corrections. The desired three sigma miss accuracy of the course with respect to the moon is 60 km., roughly 37 mi.

• **Nearly three days** after launch, Surveyor is expected to reach the vicinity of the moon. At 1,000 mi. altitude and in line-of-sight of Goldstone, attitude control jets reorient it to align the retrorocket thrust vector with the vehicle velocity vector. At this point, a downward-looking approach television, one of three TV camera systems to be carried on the spacecraft, begins taking pictures of the surface at the rate of one picture every three seconds. Video signals are transmitted back to Goldstone through the broad bandwidth antenna which is directed toward earth and used for the first time in the flight sequence.

While the TV pictures will arrive at earth and be reconstituted too slowly to enable ground controllers to act on what they see, they will provide pictures of the landing site and permit scientists to pin down the location of the landing within 1 mi. If the soft landing is not successful, at least pictures of the lunar surface will have been secured. During the terminal descent, as the vehicle accelerates under gravitational attraction of the moon, an 8-lb. marker radar altimeter, located in the exit cone of the main retrorocket, indicates when the spacecraft reaches the predetermined retro ignition altitude of 52 mi. At this point, the spacecraft should be dropping at 8,600 fps., 400 fps. faster than at initiation of the terminal phase. Then the main retro ignites, blowing out the marker radar, and the flight control system holds vehicle attitude.

• **At retro burnout,** with the spacecraft at 28,000 ft. (±9,000 ft.) altitude and slowed to a velocity of about 400 fps. (±125 fps.), an accelerometer senses that acceleration is below a low threshold value, retro release bolts are disengaged and the retro drops away from the spacecraft.

• **Verniers,** which had gone on before main retro separation, now control final descent. Doppler and altimetry radars go into operation during vernier descent, determining three velocity components and precise altitude and feeding this data back to other elements of the flight control system to null out lateral velocity and erect the spacecraft to the lunar vertical.

• **At a predicted point,** the engines are switched to full thrust, briefly holding the spacecraft at constant velocity during descent from 40 to 13 ft. and then shutting down. The spacecraft, descending at about 5 fps., drops the last 13 ft. to the surface. As it touches down, it is expected to be a maximum of 5 deg. from the lunar vertical.

Touchdown Speed

Five- to 20-fps. touchdown speed for this "soft" landing (about 3 fps. lateral velocity) compares with about 293 fps. velocity at which the survivable "hard" landed capsule on Ranger 5, which uses a less powerful retrorocket, is calculated to strike the moon. Total estimated time of Surveyor terminal descent is about 2 min. At touchdown, the vehicle will weigh slightly in excess of 600 lb. (earth weight). Three crushable polystyrene pads are expected to absorb the bulk of touchdown energy.

Surveyor is now designed to carry up to 150 lb. of instrumentation, and the two surveillance television cameras, which are certain to be included in initial payloads, consume about 33 lb. of this weight and are chargeable to the scientific payload. The vehicle can

Landing Problem

Fundamental problem confronting designers of the Surveyor soft-landing lunar spacecraft, and other controlled landing spacecraft that may follow it, is the uncertainty about interaction of electromagnetic (radar) signals and ionized gases generated in the spacecraft's retrorocket exhaust flames. No one, according to Hughes project people, knows for certain the degree of attenuation experienced by radar signals, used for securing altitude and velocity information for the flight control system, when interacting with ionized gases. Surveyor radars will operate at X-band.

be off-loaded to 114 lb. of instrumentation, which is the likely payload weight, at least on the first shots.

JPL and NASA, plus a sizable number of industrial and university contractors, have for some time been exploring a complete spectrum of instrumentation (AW July 3, 1961, p. 62), far greater in number than could ever be carried on a single Surveyor spacecraft, even before the reduction in payload.

Instruments to be flown on any given shot are recommended by JPL, then selected by NASA's Space Sciences Steering Committee.

Payload for the first shot has been selected, but JPL declines to divulge what it is, on the grounds that a disclosure at this early date might offend those experimenters whose instruments could not be squeezed onto this flight.

Apollo Interest

With the specialized interest of the Apollo program, it seems likely that in addition to the two surveillance television cameras, typical experiments might include a total radiation pyrometer for measuring lunar temperature, a redhead gage for measuring possible lunar atmosphere, a magnetometer for detecting fields, an ionization chamber for measuring charged particles, a penetrometer for determining hardness of the surface, and some type of simple soil mechanics experiment that can sense hardness and shear strength.

With emphasis on passive experiments in the first flight, those experiments requiring more complex spacecraft activity, such as extension of booms or drilling into the surface, probably will be held for subsequent flights.

Surveyor Orbiter

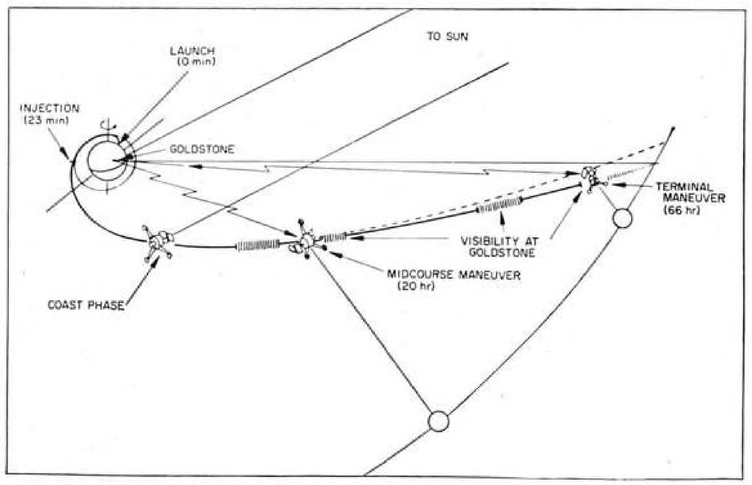
Surveyor orbiter (Surveyor B) will be a greatly modified version of the Surveyor lander bus designed to orbit the moon and obtain stereoscopic pictures of selected potential Apollo landing sites.

The orbiter will consist of the lander's basic spaceframe stripped of the landing gear and the large Thiokol solid-propellant retrorocket. It will use the same thermal control techniques employed in the lander and will have the same vernier retrorocket system, flight control components and telecommunications equipment. A horizon sensor and gyro compass system, not included on the lander, will be added to the orbiter's flight control system.

A lightweight retrorocket, perhaps one similar to the Aeronutronic device employed in Ranger 5, will provide sufficient thrust to enable the orbiter to go into a lunar orbit.

Payload will consist primarily of the Visual Instrumentation Subsystem, a dual vidicon camera system. Other scientific instruments will be carried on the orbiter which will have an injected weight of 1,800 or 2,000 lb. Boost vehicle will be the Atlas-Centaur.

One instrument very likely to be tabbed for the first payload is a micrometeoroid ejecta detector to measure the number of particles that may be released by the lunar surface on impact of a micrometeoroid. This phenomenon, which could pose a severe hazard for astronauts, is under study at NASA's Ames Research Center and is of sufficient concern to receive a high priority among possible Surveyor instruments.



FLIGHT PATH OF SURVEYOR lunar spacecraft in mission designed to demonstrate controlled landing on lunar surface. Spacecraft is expected to be launched from Cape Canaveral by Atlas-Centaur booster combination in series starting in the summer of 1964. After insertion into 100 mi. earth parking orbit, Centaur engines will restart and inject spacecraft onto lunar trajectory. Total flight duration through descent will be about 66 hr.

Two upward-pointing surveillance TV cameras are mounted on the Surveyor tripod frame, about 6 ft. above the landing pads. A gimbal-mounted mirror in front of each lens permits the camera to rotate through 360 deg. in azimuth although it is constrained when the spacecraft is loaded. The mirror also permits vision 45 deg. above the horizon and 10 deg. below it. For a later shot, a camera may be mounted on an extendable boom 20 ft. above the base of the spacecraft to give it a broader horizon.

On landing, the mirrors are in a closed position so that the lenses are entirely enclosed in a hood-like structure and shielded from any dust that may be stirred up on touchdown.

Operating together, the cameras can take stereo pictures, and color wheels are in the panning mirror assembly for color pictures.

Television is a 400-line system, has a 200-kc. bandwidth, and pictures are returned via the directional antenna at the rate of one frame per 3 sec. The TV and its lens are sufficient to give an optical resolution of about 5 mm. at a distance of 4 meters. There is no video storage capability aboard Surveyor.

In the event of an effective reduction in spacecraft power, the cameras have an emergency mode which reduces the bandwidth and frame rate to 120 kc. and 20 sec. per frame, respectively. Thus, even if the use of the directional antenna is denied for transmission of video to earth, an omni antenna could return the video.

Hughes has been conducting an extensive series of drop tests with a full-scale dynamic model of Surveyor to determine its ability to land on surfaces of different inclinations, varying hardness and physical nature. This is a flight weight spaceframe with landing gear and steel plates distributed about the frame to simulate spacecraft mass.

Suspended by a pair of pulleys to exercise $\frac{5}{6}$g upward acceleration, thereby simulating the one-sixth of earth gravitational attraction on the moon, the model is dropped over a range of vertical and lateral spacecraft velocities on a number of sloping surfaces. Surface materials include wood shavings to simulate thick dust layers or rock flour, plain hardwood floors and wooden surfaces with 4-in.-high wooden block protuberances.

A future series of tests will use talcum powder.

Surfaces are at various inclinations up to 25 deg. to determine what the spacecraft's stability boundary is.

Another series of tests to check out the final descent propulsion and control system will be conducted shortly at Holloman AFB on the T-2 model, a dynamic descent simulated spacecraft equipped with vernier engines, radars, flight control electronics, inertial reference system, etc.

Model will be suspended below a tethered balloon 1,000 to 1,500 ft. above Holloman AFB and released at dawn—the calm, windless period of desert day—in an effort to simulate lunar landing conditions. It will be stabilized by a drogue chute until it accumulates an 80-fps. velocity, then released to flare out to 5- or 10-fps. velocity with flight control and verniers operating in a closed-loop fashion.

At the 5- or 10-fps. velocity, reached at 600 ft. altitude, parachute recovery is initiated. In later tests, parachute recovery will be discarded and the vehicle will touch down at about 20 fps. using air bags in place of its crushable pads.

Besides its spacecraft design, development, fabrication and testing duties, Hughes also is responsible for ground support equipment at Cape Canaveral and will supply command and data handling consoles (CDC) at three DSIF sites—Goldstone, Johannesburg and Woomera—and at JPL's new Space Flight Operations Facility (SFOF) at Pasadena (AW July 2, p. 175).

CDCs, working through the Deep Space Instrumentation Facilities, will receive 500 channels of telemetry from the spacecraft, make real time assessments of spacecraft operation and issue commands. They will contain television monitors and facilities for tape recording and photographing video and other data. They will also permit insertion of pre-programed tapes.

Hughes' total system responsibility thus covers the spacecraft, its checkout and integration with launch vehicles, data retrieval and participation in the conduct of transit and post-landing missions. Data utilized in real time at the CDCs or SFOF is brought back to a data processing facility at Culver City.

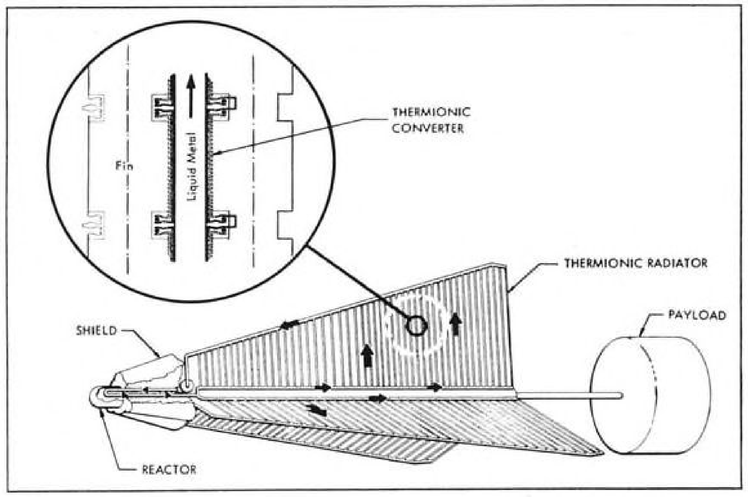
Lander vehicle weight breakdown:

- **Flight control,** including radars, Canopus sensor, gyros, cold gas jets—51.7 lb.
- **Telecommunications** and power control—97.3 lb.
- **Electrical power,** including rechargeable silver zinc batteries and solar cells —54.5 lb.
- **Mechanisms** for operating solar panel —29.5 lb.
- **Spacecraft vehicle,** including basic aluminum structure, landing gear, bracketing and compartments—196.4 lb.
- **Spacecraft propulsion** and propellant —1,560.2 lb.
- **Scientific payload**—114 lb.

Major subcontractors to Hughes include:

- **Thiokol**—Solid-propellant retro engine (Elkton) and vernier system (Reaction Motors Division).
- **Ryan Electronics**—Altimeter and Doppler velocity sensors.
- **Kearfott Division** of General Precision—Inertial reference system.
- **Electric Storage Batteries**—Batteries.
- **Heliotek**—Solar cells.
- **National Waterlift**—Shock absorbers.
- **Consolidated Electrodynamics Corp.** —Tape recorder.
- **Bell & Howell**—Variable focal length TV lens.
- **Menasco**—Gas bottles for jet controls.

Subcontracts and materials account for about 35% of total contract Surveyor dollars, according to Hughes.



Thermionic Converter Demonstrated

Aerojet-General Nucleonics has demonstrated a thermionic converter system illustrated above. Concept used converters directly in the powerplant radiators. Circulating lithium liquid metal provided temperatures ranging from 2,150F-2,270F.

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The secret of this performance is the extra thrust inherent in the F-104 design. While many other supersonic airplanes decelerate drastically in combat maneuvers, the F-104's thrust margin makes its full speed available. The F-104 continues to hold the USAF record for time-to-intercept.

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X-20 May Supply Orbital Space Stations

By David H. Hoffman

Las Vegas—Air Force-Boeing X-20 (Dyna-Soar) program now appears to be on firm technical ground and USAF is studying how it might be used to supply orbiting space stations.

This has happened despite Defense Department's refusal to spend funds voted by Congress, the uncertain character of X-20's military mission and two changes in boosters, made last year.

No military mission has yet been assigned to the program. Nor has instruction on the mechanics of space rendezvous been made a part of the six X-20 pilots' training curriculum (AW Sept. 24, p. 27). But Air Force-approved documents used in technical briefings to stress the program's potential show the delta-winged glider rendezvousing with wheel-shaped stations in space, then departing on an elliptical trajectory back to earth.

As Air Force Under-Secretary Joseph Charyk explains the subject, the X-20 has "no specific military job," but neither did the airplane or Robert Goddard's early rockets when they were developed. And one X-20 pilot told AVIATION WEEK: "We're not just going to tool around up there forever" after the glider has proven operational.

Key to what USAF thinks the X-20 should do in space is found in the capabilities of Titan 3's upper, or transtage—capabilities that were ordered by Air Force to conform with recommendations of the Golovin Committee on large launch vehicles. Aerojet-General Corp., which is building the transtage engine for Martin, says it will:

- **Change a payload's** inclination to the earth, altering payload's orbital plane.
- **Shift the perigee** and apogee of the payload's orbit by changing the payload speed.

Within transtage is a single, 16,000-lb.-thrust Aerojet engine with two nozzles and an ablative thrust chamber. It now carries no Air Force designation, but within the company it is called the AJ10-138. The engine is not throttleable but is capable of multiple starts and stops, and can be gimbaled.

Total burning time is approximately 7 min. Specific impulse is about 315. The AJ10-138's hypergolic, storable fuel is an equal-part mixture of UDMH (unsymmetrical dimethyl hydrazine) and hydrazine plus nitrogen tetroxide as the oxidizer.

Prime purpose of the AJ10-138 engine is to furnish the final thrust required to inject the Titan 3's payload—whether it be X-20 or a different package—into either orbit or escape trajectory, or to vary the first orbit achieved. When the first manned X-20 launches are attempted, probably in 1965, this will be accomplished in steps.

First burn on the transtage engine will take the glider to an altitude of about 300,000 ft. Following a coast phase, and on command from the ground, the engine is to re-start, powering the X-20 into a circular orbit with an altitude of about 100 mi.

Later in the program, precise transtage firing sequence will be varied to meet mission requirements.

X-20 Chronology

- November, 1957—Development directive for Dyna-Soar, later to be called X-20, issued and development plan approved.
- March, 1958—Proposals received from seven contractors.
- June, 1958—Two teams headed by Boeing and Martin selected to compete for prime Dyna-Soar development contract.
- April, 1959—Air Force begins evaluation of Boeing and Martin proposals.
- November, 1959—Boeing selected to manufacture, assemble and test glider and integrate it with booster to be manufactured by Martin.
- December, 1959—Air Force and Defense Department order Phase Alpha study of Dyna-Soar to verify technically the configuration, materials and construction approaches selected by Boeing. Study, completed in April, 1960, resulted in no significant changes.
- December, 1960—Minneapolis-Honeywell Regulator Co. named associated contractor for Dyna-Soar's primary guidance subsystem. RCA named associate contractor for communications package.
- January, 1961—Boeing awards first major Dyna-Soar subcontracts—to the then Chance Vought Corp. for the glider's ceramic nose cap and to Minneapolis-Honeywell for flight control electronics.
- January 13, 1961—Air Force announces decision to substitute Martin Titan 2 for Titan 1 as Dyna-Soar booster.
- September, 1961—Defense Department-Air Force review team examines full-scale mockup of glider.
- December 28, 1961—Air Force announces decision to eliminate suborbital flights and use Titan 3 as Dyna-Soar booster (AW Dec. 25, p. 17).

When readied for launch, Titan 3 is 120 ft. high without the X-20 glider. Tipped by the X-20, it measures 151 ft. The glider itself is 35 ft. long and 8 ft. high with a span of 20 ft. (AW Oct. 1, p. 25).

First unmanned orbital flights of the X-20 are scheduled to begin at the Atlantic Missile Range late in 1964. Earlier, perhaps late next year, an air-drop test series is to start at Edwards AFB, Calif. During initial drop tests, the glider will be flown at subsonic airspeeds so that pilots can evaluate stability and control, especially on landing.

An acceleration rocket motor will boost the X-20 to supersonic airspeeds during a second round of airdrops. According to current Air Force planning, each of the six X-20 pilots will be checked out in drop tests before a manned orbital flight is undertaken. First B-52 mother ship scheduled to take part in the test program is to be modified at Boeing's Wichita, Kan., facility in the spring of 1963.

The Edwards airdrops are in lieu of a suborbital test flight series, a series that was deleted from the X-20 program when Air Force approved development of the Titan 3 booster last December.

Linking the glider to the Titan 3 transtage is a conical transition section, or stage. Air Force officers close to the X-20 program told AVIATION WEEK here that configuration of this section still is fluid. But it probably will contain a Thiokol solid propellant engine capable of producing relatively high thrust for short periods.

Should an emergency crop up during launch, this engine would separate the glider from the booster. It can also double as an acceleration rocket capable of supplying additional power after the Titan 3's transtage is expended.

Essentially, an X-20 pilot has two options if an abort is called for after booster stage ignition: He can fire the abort rocket, using its power to attain a relative altitude of about 10,000 ft. He would then fly the glider through a maneuver very similar to an Immelmann turn. Hopefully, at this point, he would be in position to glide back to the so-called skid strip at Cape Canaveral, thus salvaging one X-20.

Should the abort engine malfunction, the glider be damaged during lift-off or some other pressing problem be encountered, the X-20 pilot might elect to use his ejection seat and descend by parachute. But the ejection seat, which is not an escape capsule, undoubtedly would be dangerous if triggered after the glider exceeds Mach 1.

Although the X-20 is to have a multi-orbit capability—how many is not yet known—there are no plans to send a multi-pilot crew aloft in the glider. The time the glider can remain in orbit is a function of how much life sustaining stores are injected with it in the transition section and transtage.

Titan 3 launch vehicle is designed to boost 20,000 lb. payloads to low earth orbits of about 100 mi., or 13,000 lb. payloads to 1,000 mi. By contrast, the X-20's maximum and minimum weights are programed to be about 15,000 and 10,000 lb. respectively. The 5,000 lb. margin between these figures furnishes an indication of what may accompany the glider into space later in the program.

Precisely how the various maneuvers demanded of the X-20 will be executed still is an open question. Answers will emerge as the glider's handling qualities are simulated on the ground, in Century-series fighters and probably in the North American X-15. Air Force now plans to transition at least a few of the six X-20 pilots in the X-15, thus familiarizing them with a reaction control system and the nature of re-entry in a winged vehicle.

According to current thinking—although some in the X-20 program disagree with this approach—the glider's retro maneuver will begin with a 180 deg. heading change in space. After this turn, retrorockets are fired in the plane of the glider's forward travel. Re-entry will be in a single, shallow glide that is to last roughly 30 min. During this relatively slow descent, skin temperatures of up to 4,000F will be dissipated by radiation. The X-20's wing and fuselage skin is paneled; cracks between the panels allow expansion when temperature rises above a certain point.

Prior to landing, when the glider has been slowed to less than hypersonic airspeed, heat resistant shields covering the forward sections of its windshield will be jettisoned. The X-20 pilot, however, must fly the first and longer portion of his "final approach" on instruments.

In typical, single orbit manned flights, which are to remain aloft 60 to 80 min., re-entry must be begun shortly after the glider reports over Australia for a landing at Edwards AFB. But George H. Stoner, Boeing's X-20 program manager when its configuration was fixed, says that the X-20 pilot will be able to "pick any air field between Point Barrow, Alaska, and San Diego, Calif., with equal ease."

Exact bounds of the X-20's re-entry corridor are not yet known. To explore the nature of this corridor and its outer limits is one goal of early X-20 flights.

As now configured, the X-20 glider will be somewhat more forgiving, less critical aircraft to fly at subsonic airspeeds than the X-15. For example, its rate of sink on final approach will be about 40% less—on the order of 7,000 fpm., as opposed to the X-15's sink rate of approximately 11,000 fpm.

Lift-over-drag ratio of the X-20 in aerodynamic flight will better that of the straight-winged X-15. But X-20 pilots say the 2.5 ratio cited earlier in the program probably is a little optimistic.

Design of the glider is straight-forward and clean. As a delta-winged vehicle, it has no leading or trailing edge flaps or other, more sophisticated high lift devices.

Air Force will not say just how many X-20 gliders have been ordered to date or how many ultimately will be built by Boeing. But according to Gen. Bernard Schriever, commander of Air Force Systems Command, this question has been answered specifically.

The X-20 program was given an official go-ahead on Apr. 25, 1960, when Air Force approved Boeing's Phase Alpha study report, verifying technical feasibility of the X-20's design. In Fiscal 1961, it was funded at $58 million; in Fiscal 1962 at $100 million, with an additional $85.8 million appropriated but unspent.

In Fiscal 1963, according to USAF Under-Secretary Charyk, Defense Department has not yet released the full $157 million voted by Congress. But Air Force has asked and expects to get the money.

Production of early AJ10-138 transtage powerplant hardware was to have begun last month by Aerojet in its Sacramento, Calif., facility. Because of this engine's similarity to the one Aerojet is building for the Apollo spacecraft's service module—a somewhat more advanced project within the company—development and testing cycle probably can be compressed.

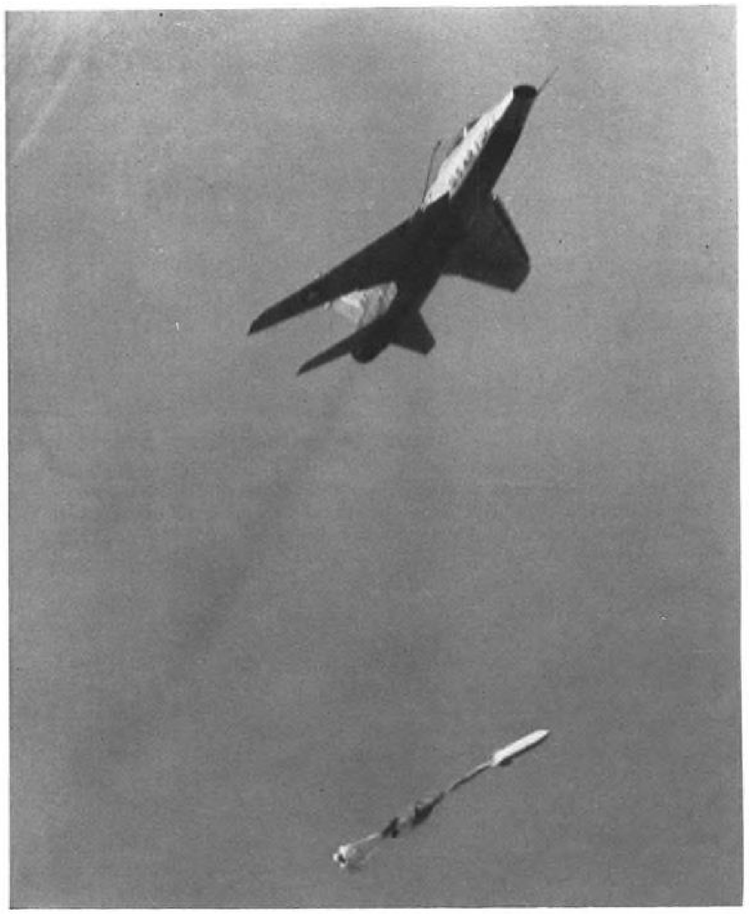
As an indication of the similarity between the two engines, the service module's powerplant carries the Aerojet designation AJ10-137. Developing 20,000 instead of 16,000 lb. thrust, AJ10-137 also used storable, hypergolic propellant and is capable of multiple starts.

Engineers who have examined both powerplants say they are indistinguishable, except in scale.

Significance of this is that fixes devised and lessons learned during development of the service module engine are being applied by Aerojet to the smaller AJ10-138. Performance criteria

Soviet Missile-Firing Sub Sighted by Navy

U. S. Navy photo of Russian missile-firing submarine shows sail, or conning tower, modified to hold three vertical tubes for relatively short-range ballistic missiles, probably adapted from land-type missiles. Navy said this type operates in both the Atlantic and Pacific. Open hatch is assumed to be an access door to the tube section. Diesel-powered sub apparently must surface to fire. About 25 G- and Z-class Soviet subs have been converted to fire missiles from the surface (AW Mar. 5, p. 17). Russia also has newer subs capable of launching missiles from underwater (AW July 30, p. 24; Apr. 2, p. 15).



Drogue Chute Slows Dummy Weapon

Simulated nuclear weapon falls away from USAF/North American F-100 Super Saber during the recent Air Force Fighter Weapons Meet at Nellis AFB, Nev. Small drogue chute attached to dummy's tail slows descent so fighter can escape simulated nuclear blast.

and tolerance laid down by National Aeronautics and Space Administration for the Apollo service module engine are tighter than those applied to the transtage engine by Air Force. Production of the AJ10-138, therefore, is viewed as an easier technical task.

Because of these factors, production and testing of the transtage engine is expected to overtake comparable work on the AJ10-137 in the near future.

Air Force will not say when testing of the transtage or its engine will get under way. Its first flight test, however, is scheduled before the first unmanned X-20 launch from AMR in late 1964. Booster will be a Titan 2 core topped by a control module and the transtage.

Deadline imposed for first engine firing by a special Defense Department committee last spring (AW May 28, p. 29) is November, 1963.

Transtage engine, in manned orbital X-20 flights, will not double as a retro-rocket; in early missions it probably will be jettisoned just after injection. But during later, longer endurance flights, transtage is to remain with the glider in orbit, supplying its pilot with life support items. Transtage and transition section, when used for this purpose, would be detached prior to re-entry.

As of early this year, Boeing planned to spend more than $50 million on major X-20 program subcontracts. Following is a description of the glider's principal systems, including those farmed out for development:

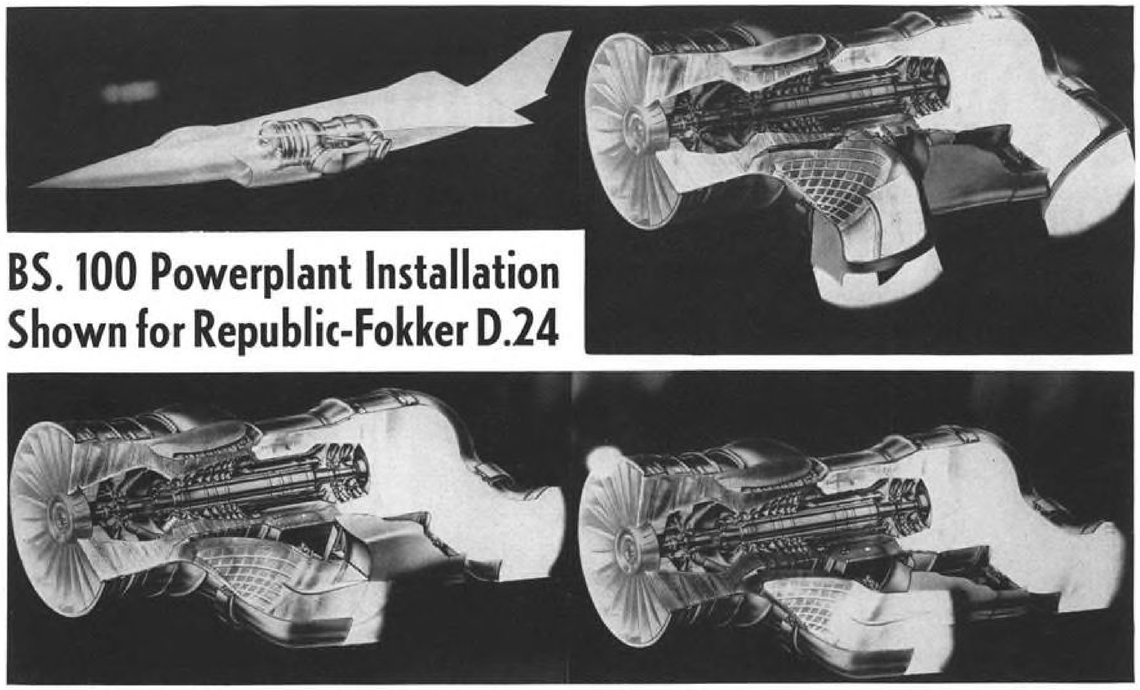
• **Landing gear.** Main landing gear are mounted near the root of the glider's delta wing. Because of high skin temperatures to be generated during re-entry—up to 4,000F—use of rubber in tire construction was ruled out. Instead, skids with clustered wire brushes on their undersurfaces are being built by Goodyear Tire and Rubber Co. under a $45,000 subcontract. Since the X-20 has no brakes, friction produced as the tightly-packed brushes wear down

during rollout will bring the glider to a stop. Retractable nose gear skid is dishpan shaped and has a diameter of approximately 20 in. Development is by Bendix Corp. under a $75,000 subcontract.

• **Aerodynamic flight controls.** X-20 has dual rudders that double as speed brakes when pivoted away from the flush position. It also has dual elevons, which, along with the rudders, are moved by hydraulic pistons. Actuators, in turn, are made to move by electronic signals generated by the pilot's control stick. Electronic channels from the stick to the hydraulic cylinders are redundant, as are critical components of the hydraulic system itself. Electronic flight control subsystem is by Minneapolis-Honeywell. Cockpit stick is mounted at the pilot's right side, not between his knees, to enable manipulation despite inflation of the pilot's pressure suit. Suit supplies 5 psi. in excess of ambient pressure. Reaction flight control system, being built by Bell Aerosystems, is very similar to Bell systems for the X-1 and X-15.

• **Structures and cooling.** Nose cap made of ultra-high temperature ceramic material is being made by Ling-Temco-Vought to protect the forward section of the glider from re-entry temperatures. To eliminate thermal stress in certain sections of the X-20's frame, triangular girder arrangements permit truss deformation—a technique commonly used in the construction of bridges, but not, according to Boeing, in aeronautics. High nickel-alloy steel, molybdenum or columbium, plus heat resistant ceramics, are the key components of the X-20's skin and frame. Heat, extracted from the X-20's cockpit and equipment compartments, will be absorbed by a cooling system manufactured by The Garrett Corp.'s AiResearch Manufacturing Division. System expels hydrogen from a storage tank into a heat exchanger where absorption takes place.

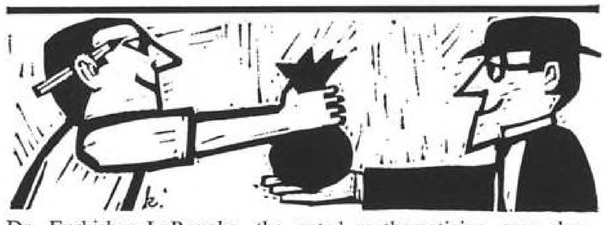
• **Accessory and electrical power.** Powering the X-20's generator in flight will be an accessory power unit designed by the Sundstrand Corp. Gaseous hydrogen-oxygen unit will consist of a reaction chamber, prime mover, gearbox, hydraulic pump, propellant shut-off valve, and metering valves and controls. Direct source of electric power will be a generator and control unit mounted on the glider's accessory power unit. Generator and associated components will be furnished by Westinghouse Electric Corp. A test instrumentation subsystem, designed to collect and transmit X-20 flight data, is being developed by Electro-Mechanical Research, Inc., as is the ground-based system required to process this information.



BS. 100 Powerplant Installation Shown for Republic-Fokker D.24

Model drawing (top, left), with approximate external fuselage and wing shape of the Republic-Fokker D. 24 Alliance Mach 2.5-plus VTOL fighter shows general installation concept for the Bristol Siddeley BS.100 variable-thrust powerplant, an advanced follow-on to the BS.53 which powers the present P. 1127 (AW Sept. 24, p. 88). For vertical takeoff (top, right), variable ramp is retracted laterally into fuselage to permit maximum outlet area for plenum chamber burning. Bottom, left, BS.100 nozzles are canted to horizontal position in transonic cruise. Plenum chamber burning would be used in supersonic cruise with variable ramp retracted into fuselage (right).

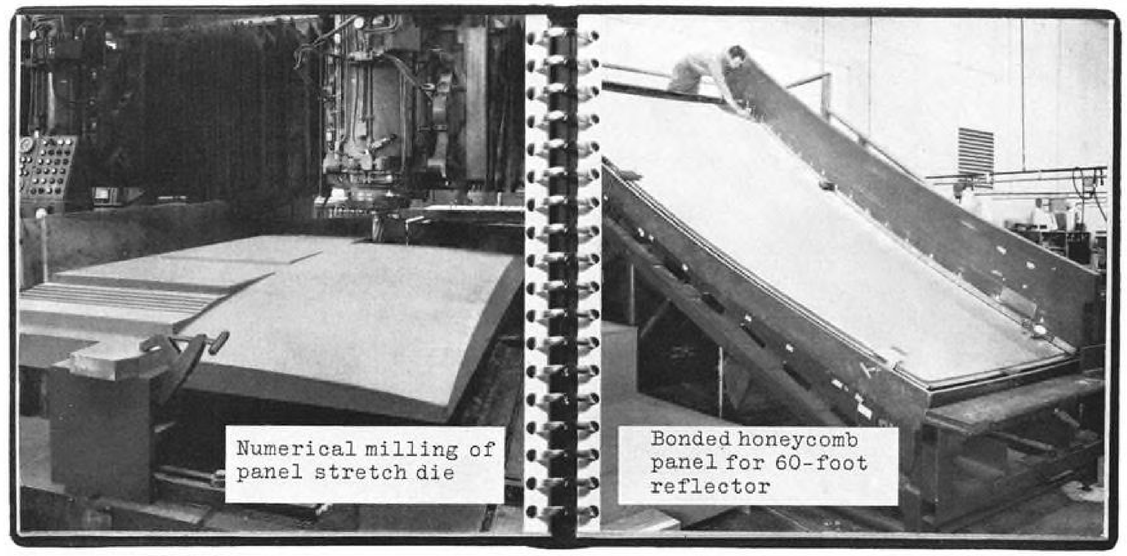
PROBLEMATICAL RECREATIONS 139

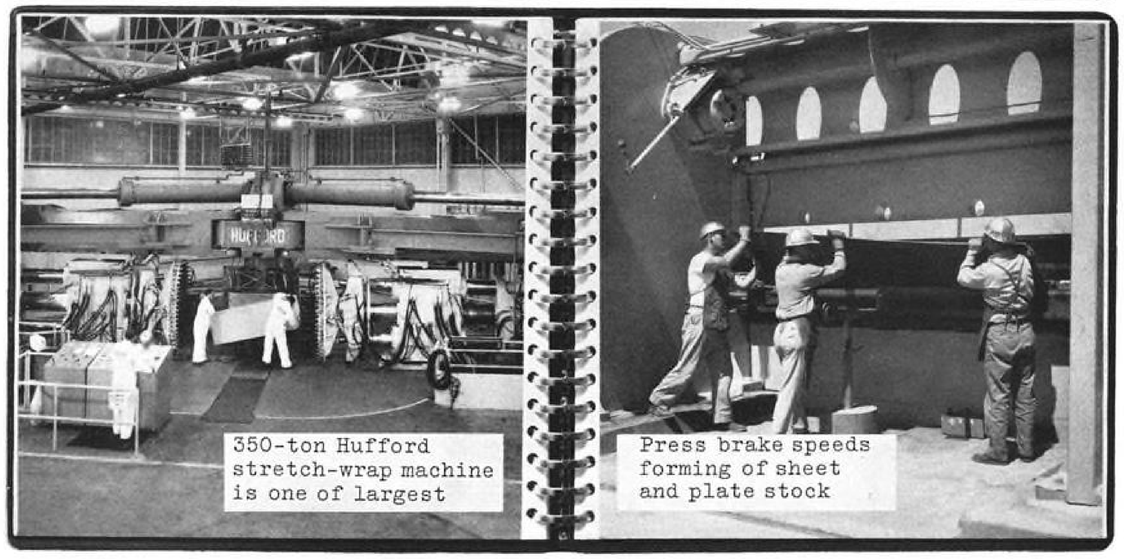


Dr. Furbisher LaRouche, the noted mathematician, was shopping at a hardware store and asked the price of certain articles. The salesman replied, "One would cost 10 cents, eight would cost 10 cents, seventeen would cost 20 cents, one hundred and four would cost 30 cents, seven hundred and fifty six would also cost 30 cents, and one thousand and seventy two would cost 40 cents." What was Dr. LaRouche buying? —*Contributed*

Rely on a Westrex RA-1683-B Reentry Blackout Recorder to get complete reentry data during the silent seconds of blackout and relay the information safely back. This dual-channel, endless loop magnetic tape recorder has been proved in 100-G linear acceleration and 100-G shock environments. Get one for your missile at: Westrex Company, 6701 Variel Avenue, Canoga Park, Calif.

ANSWER TO LAST WEEK'S PROBLEM: The dimensions of the sails are: (1) x = 6, y = 8, z = 10; area, 24 sq. yds. and (2) x = 12, y = 5; z = 13; area, 30 sq. yds.





VIBRATION NEWS

MB ELECTRONICS · *A DIVISION OF TEXTRON ELECTRONICS, INC.*
Representatives in principal cities throughout the world

New concept: MB Sine/Noise Discriminator boosts capability of vibration test equipment

More and more vibration test specifications require mixed sine and random signals, as well as independent control and programming of the sine and random spectra. Yet, present test practices for independent control have been impractical, expensive and time consuming.

The new MB Model N234 Sine/Noise Discriminator, when added to your test facility, will provide easier, more accurate mixed sine and random testing. It will also facilitate fundamental sine servo control.

In mixed sine/random testing this unique MB instrument performs four specific functions:

1. Permits control of sine spectrum independent of random noise.
2. Improves accuracy of sine servo control by eliminating resonant distortion from the feedback path.
3. Serves as 10 cps bandwidth spectrum analyzer.
4. Serves as a distortion analyzer.

Regardless of the random spectrum, the N234 provides a fundamental sine signal which can be used for programming constant acceleration; constant displacement; constant velocity; displacement-acceleration crossovers; or special shapes or steps.

Here's another important advantage: Set-up time of mixed sine random tests is reduced to 3 simple steps: (a) set random drive level, (b) set desired sine program and (c) energize sine sweep.

For complete information on how the N234 Sine/Noise Discriminator can improve your test capabilities write to MB Electronics, 781 Whalley Ave., New Haven 8, Connecticut.

PRODUCTION BRIEFING

Talley Industries, Inc., Mesa, Ariz., will develop a rocket catapult crew escape system for the T-33 jet trainer, permitting crew ejections at ground level. The work will be accomplished under a $2.5-million contract from Lockheed Aircraft Corp.

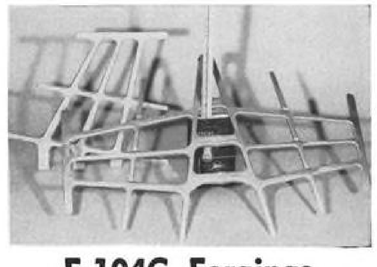
Collins Radio Co., Dallas, Tex., has received a $1-million contract from the Boeing Co.'s Transport Division to supply navigational equipment for 65 Boeing 727 jet liners ordered by Eastern and American Airlines.

Beckman Instruments, Inc., Richmond, Calif., will build three analog computer systems to be used for thermal, propulsion, flight control and other engineering design investigations on the X-20 (Dyna-Soar) program. Work is financed by a $1.5-million contract from the Boeing Co.

Chrysler Corp.'s Missile Division is studying problems involved in the launching of large solid rockets at sea. Included are motion studies of hulls, launching dynamics, launching techniques and arrangements of the shipboard complex. Navy's Bureau of Ships is sponsoring the study with a $73,129 contract.

Ling-Temco-Vought, Inc., is developing a spacecraft heat shield, made up of a composite material designed to minimize heat transfer, under a 13-month contract from National Aeronautics and Space Administration's Manned Spacecraft Center. Design will include an outer ablative layer and a means of sealing access hatches and windows to provide thermal protection.

Giannini Controls Corp., Duarte, Calif., has been awarded a $200,000 contract from Martin Co. to produce rate gyro packages which will detect excessive rate of attitude changes in the Gemini launch vehicle. The pack-



F-104G Forgings

Two forgings manufactured by Kaiser Aluminum and Chemical Corp., Erie, Pa., are used as beam pylons in tanks aboard F-104G fighters produced in Europe for NATO.

ages will be used in the malfunction detection system (MDS) of the modified Titan 2 booster (AW Sept. 3, p. 38).

Boland Machine and Mfg. Co., New Orleans, La., has been awarded a $3,439,792 Navy contract to activate and convert the victory ship SS Norwalk Victory, to a fleet ballistic missile resupply cargo ship.

Union Carbide Corp.'s National Carbon Co. division has received a contract from Air Force Rocket Research Laboratories to produce three graphite cylinders, measuring 103 in. outside diameter, 34 in. inside diameter and 70 in. long, as part of a program to study the high-temperature behavior of graphite in the large shapes which will be required in future solid-fuel boosters.

G. T. Schjeldahl Co., Northfield, Minn., will build two 135-ft.-dia. inflatable passive communications satellites under a $200,000 contract from National Aeronautics and Space Administration's Goddard Space Flight Center. Balloons will be fabricated from a lightweight, plastic-to-metal laminated material designed to allow solar radiation to pass through and not affect the balloon's orbit.

Howell Instruments, Inc., Ft. Worth, Tex., has received a $200,000 Air Force contract for production of an airborne instrument which monitors jet engine condition by checking the average temperature and temperature spread inside the engine and records damage due to excessive heating.

Maxson Electronics Corp., New York, has been awarded a $134,445 Federal Aviation Agency contract to develop new feedback techniques in an experimental TACAN ground station transmitter to determine if performance can be improved.

United Technology Corp. will conduct feasibility studies aimed at developing hypergolic ignition systems for solid propellants, under a $50,000 research contract from Navy's Bureau of Weapons.

Hycon Mfg. Co., Monrovia, Calif., has received a $2-million contract from McDonnell Aircraft Corp. for the production of camera systems for Air Force's RF-110, reconnaissance version of the F-110 Phantom jet.

Lockheed Propulsion Co., Redlands, Calif., will build a solid rocket motor for an advanced air-to-air missile under development by Hughes Aircraft Co. Work is financed by a $500,000 contract from Hughes.

NEW AEROSPACE PRODUCTS

Instrument Illuminator

Lightweight bezel assembly, adaptable to standard instrument cases, provides effective illumination without modification of the instrument, the manufacturer says.

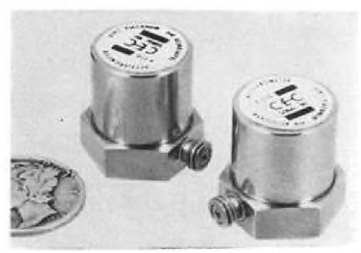
Four mounting screws hold the assembly to the panel, eliminating the need for separate mounting clamps. Wedge-shaped lens is made of clear acrylic plastic and lighted by six 5-v. MS-24367-683 lamps held by a black anodized aluminum backing plate.

Instrument viewing is assured over an angular range of 150 deg., the manufacturer reports.

Oppenheimer Plastics, Inc., Wyandotte Rd., Willow Grove, Pa.

Miniature Accelerometers

Two piezoelectric accelerometers—Type 4-270 and Type 4-271—are designed to measure high frequency acceleration found in shake table, shock tester, missile testing and similar applications.



Both accelerometers are 0.74 in. high by 0.57 in. in diameter and weigh 31 grams. Both units utilize a point-loaded-crystal isolation technique which achieves minimum case sensitivity and negligible response to acoustic noise.

Type 4-270 measures acceleration and shock up to 10,000g at frequencies from 7 cps. to 8,000 cps. Type 4-271 measures acceleration and shock up to 5,000g at frequencies from 2 cps. to 8,000 cps.

Consolidated Electrodynamics Corp., 360 Sierra Madre Villa, Pasadena, Calif.

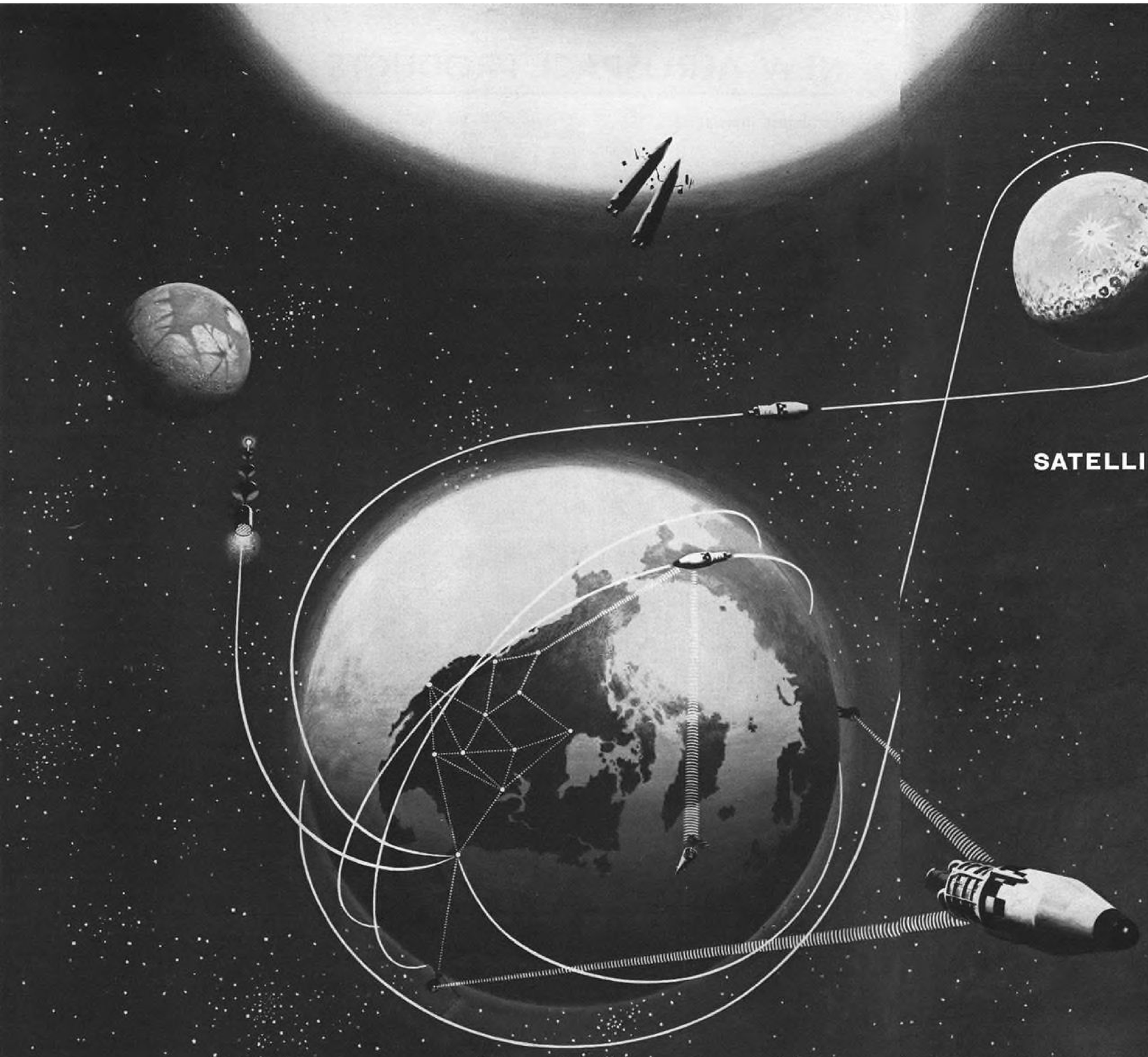
Foam Extinguisher

New foaming agent for combating liquid hydrocarbon fires forms an emulsion layer on top of the burning hydrocarbon, which in turn supports a layer of water to isolate the fuel supply from oxygen.

On contact with the fuel, according to the manufacturer, a water supporting layer of water-encased hydrocarbon droplets is formed which doesn't break down under extreme temperatures or get easily blown away exposing areas where flashbacks may occur. Small amounts of hydrocarbon released from the emulsion by heat are reported to be re-emulsified immediately.

The chemical, Emulsiflame, is mixed with water in ratios from ½ of 1% to 6%, depending on application.

Nocor Chemical, Inc., American Bank of Commerce Bldg., Odessa, Tex.



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Sophisticated orbiting biomedical capsules • Lunar probes • Interplanetary exploration programs • A space rendezvous system • Nuclear and other advanced propulsion systems • Communications satellite systems

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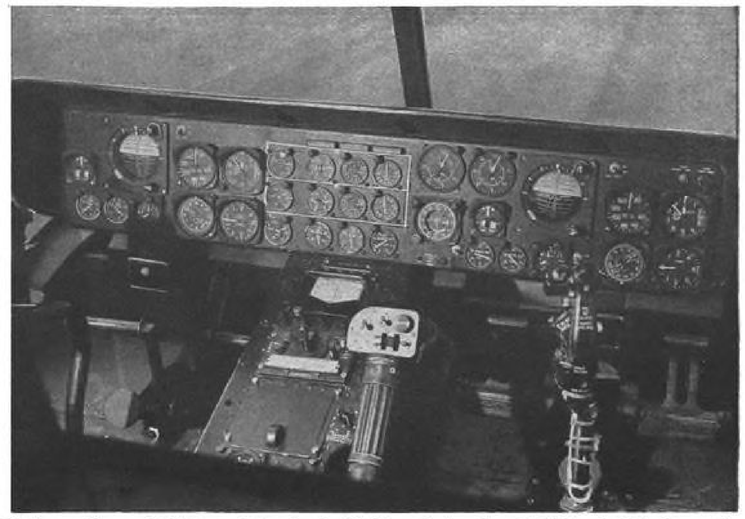
Systems Manager for the Navy POLARIS FBM and the AGENA vehicle in various Air Force Satellite programs. Other current projects include such NASA programs as the OGO, ECHO, and NIMBUS.

SUNNYVALE, PALO ALTO, VAN NUYS, SANTA CRUZ, SANTA MARIA, CALIFORNIA • CAPE CANAVERAL, FLORIDA • HAWAII

KAMAN K-1125, growth version of the Air Force H-43B, is powered by twin Boeing YT-60-10 turbine engines and has a redesigned cockpit, enlarged cabin and single-boom empennage. Note large amount of rudder travel available.



K-1125 DEMONSTRATES MANEUVERABILITY by making a tight turn at low-level. Right, redesigned cockpit has dual instrumentation for IFR flight and single twist-grip throttle on collective which controls both engines. Flat windshield also is designed for IFR work.

Twin-Turbine K-1125 Directed to Support of Missile Sites, Special Warfare Missions

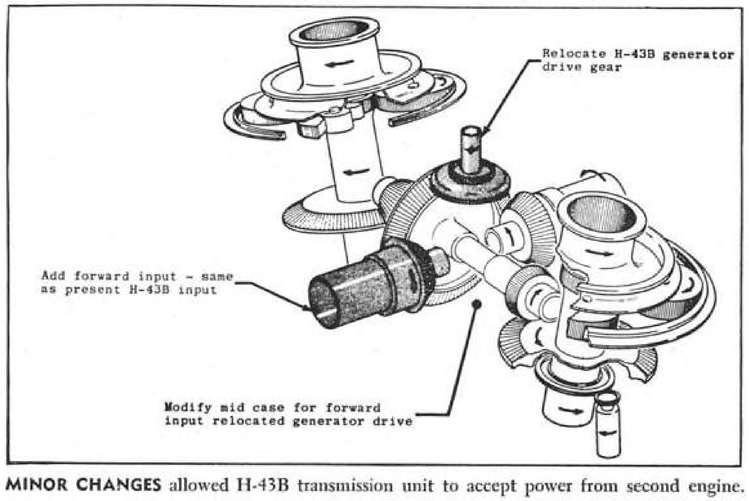
By David A. Brown

Bloomfield, Conn.—Kaman K-1125, a twin-turbine, twin-rotor helicopter unveiled here last week by Kaman Aircraft Corp., is being presented to prospective military purchasers as a machine capable of performing a variety of missions, including those associated with missile site support and special warfare requirements.

Designated Huskie 3 (AW July 23, p. 15), the K-1125 has been developed entirely with company funds. It is powered by twin Boeing YT-60-BO-2A engines (Boeing 520-2A) and will carry 12 persons in addition to the pilot and co-pilot.

While retaining the basic lines and design features of the Kaman H-43B from which it descended, the K-1125 has:

- **Single-boom empennage** with an airplane-like tail which increases stability around all three axes.
- **Single-unit transmission,** basically the same unit as on the H-43B, which provides power from both engines to the rotors and is interchangeable between the two machines.
- **Gross weight** increased to 10,500 lb. with the airframe stressed to +3g and −½g structural load factor limits. H-43B gross weight is 6,100 lb. Disk loading on the K-1125 is 5.5 lb./sq. ft. compared with 3.19 lb./sq. ft. on the H-43B.
- **Fore-and-aft** mounting of the engines.
- **Redesigned cockpit** with flat windshield and dual instrumentation for complete instrument flight capability.
- **Rear-loading** with a dropping ramp to speed entrance and exit.
- **Glass-fiber blades** which will be individually interchangeable rather than paired.
- **Internal fuel capacity** increased 120 gal. to a total of 320 gal.
- **Improved engine controls** and throttle linkage.



MINOR CHANGES allowed H-43B transmission unit to accept power from second engine.

Kaman attempted to design a helicopter which would be capable of performing missions in a number of different environments and under different operational requirements of the various services. The result, Kaman officials stress, is a helicopter that has been designed for no particular mission and with no particular military customer in mind. The K-1125, they say, should be able to perform a number of different missions equally well.

Despite these claims, it is obvious that Kaman hoped to get a jump on the industry in the forthcoming missile site support helicopter competition. Although USAF has not yet issued a request for proposals, Kaman evidently believes that a twin-engine machine will be required and has based its design on this anticipated requirement.

K-1125's ability to carry 12 fully-armed troops, to convert rapidly from a personnel to cargo carrier, and its IFR capability also are slanted toward the missile site support mission.

Two other primary missions are foreseen for the K-1125 by Kaman. One is the downrange recovery of satellite reentry vehicles and ballistic missile warheads. Philosophy is that twin engines greatly enhance the helicopter's ability to perform extended overwater missions, and that extended range, provided by the increased internal tankage of the K-1125, will allow the helicopter to cover many of the impact areas along the Atlantic Missile Range from land bases.

Standard 320-gal. fuel capacity allows the K-1125 to fly 340 naut. mi. with more than 3,000 lb. payload, either carried internally or slung from the cargo hook. With an auxiliary fuel cell in the fuselage, the helicopter can fly between 450 and 500 naut. mi., pick up a 1,500-lb. payload and return to its starting point.

As an adjunct to this capability, Kaman also sees the K-1125 as a superior rescue vehicle for the Military Air Transport Service's Air Rescue Service. Additionally, the company notes that more than 600 USAF pilots and about 1,600 ground crewmen already are qualified on the H-43B.

For the Army's special warfare requirements, Kaman has devised armament attachments which permit the helicopter to carry four forward-firing machine guns (standard infantry M-37s or M-60s or the NATO 7.62-mm. Minigun) fed from externally-mounted ammunition boxes, as well as swivel-mounted guns which can fire rearward or to either side.

Troop-carrying capacity is designed with Army tactical units in mind. The K-1125 can carry a standard Army 12-man squad in the fuselage, plus another man in the co-pilot's seat. Squad would be able to exit through the rear door in a compact group.

Again, Kaman believes that twin engines will add to the helicopter's ability to complete its mission, especially in areas where a forced landing would probably mean loss of the vehicle.

K-1125 was designed to meet Army requirements for maintenance, component accessibility, time-between overhaul (TBO) and component life.

K-1125 is basically a military helicopter, and any commercial develop-

ENLARGED CABIN OF THE K-1125 can carry 12 fully armed troops or 3,000 lb. of cargo. Rear door swings down to form loading ramp. Six-seat VIP configuration also has been designed. Control tunnel in ceiling will be removed from production version.

ment will depend on prior military orders. Kaman believes that commercial potential for the vehicle may reach 200 orders, however. In fact, there already has been interest expressed in a commercial version by a European helicopter operator.

Final advantage Kaman believes the K-1125 possesses is in cost, both the initial price and the subsequent operating cost.

Although the airframe of the K-1125 is larger than that of the H-43B, it will not cost any more to produce in volume, according to E. J. Odlum, Kaman senior vice president. Design refinements, principally the change from a twin-boom to single-boom empennage, have made the K-1125 easier and as cheap to manufacture as the H-43B.

Based on a production run of 200 aircraft, the K-1125 airframe "won't cost a nickel more to build than the airframe of the single-engined helicopter," Odlum said.

In addition to the airframe similarities, 85% of the components of the dynamic system of the K-1125 are interchangeable with those of the H-43B. Other components of the K-1125 can be taken directly from the H-43B production line.

This will enable Kaman to deliver the K-1125 in flyaway condition for approximately 10% more than it could deliver a single-engine helicopter, again based on a 200-unit production run.

Key factor in the program to keep the cost of the K-1125 down was development of a single-transmission unit which could deliver power from both engines to the twin intermeshing rotors without combining or tail rotor gearboxes.

Transmission unit of the K-1125 is remarkably similar to that on the H-43B, from which it is derived, and, in fact, the Huskie 3's transmission can be used on the H-43B, although the reverse is not true.

Conversion was made by relocating the generator drive gear on the H-43B

K-1125 Weight

Standard configuration	
Basic operating weight	5,295 lb.
12 passengers	2,400 lb.
2 pilots	400 lb.
320 gal. JP4	2,080 lb.
Gross weight	10,175 lb.
All-weather configuration	
Basic operating weight	5,579 lb.
12 passengers	2,400 lb.
2 pilots	400 lb.
320 gal. JP4	2,080 lb.
Gross weight	10,459 lb.

Optional equipment (hoist, cargo hook, bear paw skids, emergency flotation gear and TAR) weight totals 362 lb.

unit 90 deg. upward, to the top of the ring gear which accepts power inputs from the engines. A second input gear was placed in the forward position which had been occupied by the generator drive gear.

Engine input gears are located 180 deg. apart around the ring gear, allowing fore and aft engine placement with respect to the rotor towers.

Only other change necessary was to modify the transmission housing to accept the new input gear and the new location of the generator drive gear. Both input gears are equipped with overrunning clutches in case of engine failure.

Entire dynamic assembly, from the controls up to and including the rotor hub, is qualified as a single system. The entire package can be lifted out after removing 12 bolts. Rotor blades and blade grips are not a part of this system.

Although the prototype K-1125 now flying does not have them, glass-fiber rotor blades are to be on the production version of the aircraft. All internal sections of the blades, as well as the outer skin, will be glass fiber. Only other materials to be used in the blades will be stainless steel and neoprene in the anti-abrasion cover on the leading edge.

Kaman expects the glass-fiber blades to improve blade life significantly and to lower maintenance costs. Also, they will be cheaper for the purchaser, since they will be interchangeable.

Present Kaman blades carry right or left designations depending on which side of the helicopter they are to be installed. When a blade is replaced, the user must obtain a matched pair of left or right blades. Glass-fiber blades also will carry left or right designations, but no longer must be in matched pairs. A single blade can replace another single blade.

Glass-fiber blades are believed to improve safety characteristics, since fatigue failures in the blades are not self-propagating and a failure causes crazing on the blade surface which is easily detected. Kaman has tested glass-fiber blades to about 30 million cycles thus far.

At the other end of the dynamic system, Kaman has added to the standard H-43B control system a unique throttle and engine control linkage designed to relieve the pilot of much of the extra burden usually associated with twin-engine operation.

Twin quadrant throttles, located on the cabin roof beween the pilots' seats are used to start each engine individually. Engines then may be controlled by a single twist-grip throttle on the collective stick and by the up-down movements of the collective. Thumb switches (beepers) located on the col-

lective stick head control rotor speed and allow the engines to be synchronized.

Quadrant throttle positions are stopcock, idle and fly. When the quadrant throttles are in the fly position, engine control is transferred to the twist grip, whose positions are idle to full power. When the twist grip is in the full power detent, up-down movements of the collective automatically adjust engine power output.

After the engines are synchronized, one engine may be shut down, and, when re-started, will return to synchronized operation.

For single-engine operation, one of the overhead quadrant throttles may be retarded to the idle position in practice or to the stopcock position in the event of an actual engine stoppage. The remaining engine will automatically increase its power output to the limit of its ability to compensate for the loss of power.

This relieves the pilot of the necessity to analyze the difficulty and act to correct it in the event of engine failure. He has only to stopcock the dead engine or attempt to restart it.

Because of this, Kaman says, K-1125 operating techniques will be similar to those of single-engine, turbine-powered helicopters.

Boeing YT-60-10, which is due to complete its 50-hr. Preliminary Flight Rating Test (PFRT) in March, will be installed in the Huskie 3 in January, 1963.

Although basically a stationary engine (it is descended from a gas turbine originally designed as a ship engine), it has a power/weight ratio that compares favorably with aircraft turbojet engines. The YT-60 weighs 240 lb. and develops 500 hp. Military rating (30 min.) is 550 hp., and takeoff power rating is 600 hp.

Engine has back-to-back centrifugal compressors, floating sleeve bearings and rotates around its mass axis rather than its geometric axis. The YT-60 does not require auxiliary power to start, and acceleration is good by aircraft turbine standards. Specific fuel consumption is 0.65 lb. fuel per shaft horsepower hour (AW June 4, p. 114).

Good engine recovery from autorotation configurations has been noted, along with only a small degree of rotor rpm. decay.

Prototype K-1125 currently is being flown with airscoops projecting from both front and rear air intakes, mostly as a noise prevention measure. Aircraft has been flown without the airscoops.

Extensive redesign of the cabin and frontal area of the H-43B was undertaken to give K-1125 complete IFR capability. Central instrument console was removed and replaced with a dual instrument panel directly in front of each pilot seat. This arrangement removed the danger of parallax induced by a line of sight off to one side of the pilot.

Bubble front of the H-43B was replaced by a flat windshield which is easier to sweep with windshield wipers and also is more easily de-iced. Cabin structure had to be changed slightly to provide new windshield mounts.

Despite the relocation of the instrument panel, visibility from the flight compartment is good, according to A. W. Newton, Kaman chief test pilot, who said that the design adopted is believed to be the best possible compromise between visibility requirements and instrument presentation requirements.

Avionic equipment has been brought nearer the instrument display, and more space has been made available for fuel tanks by the addition of a chin pod. Pod contains the avionics gear.

Fuselage of the K-1125 has been stretched 17 in. horizontally and 7 in. vertically without materially affecting the structural design of the basic H-43B airframe. Cargo area of the K-1125 is 120 in. long, 60.5 in. wide and 53.5 in. high. Prototype has a tunnel protruding down from the ceiling which carries control rods to the tail, but this will be removed in the production version.

Tray and tub (upper and lower horizontal fuselage members) are basically unchanged from the H-43B, and the K-1125 retains the A-frame side construction of its predecessor.

Horizontally-split, flat rear door has replaced the clam-shell doors of the H-43B. Lower two-thirds of the door drops down to form a cargo or passenger loading ramp. Top one-third swings up flush against the cabin ceiling. Large windows in the door provide an excellent rearward view. Visibility to the side also is improved by the addition of oval windows, which were placed between side structural members and did not cause airframe design changes.

Most noticeable external feature of the K-1125 is the long, single-boom tail with airplane-like control surfaces. Single boom was decided upon because it provides a cleaner tail, reduces production and maintenance costs and adds stability, especially around the yaw axis. Instability in yaw, particularly at low airspeeds, has long been one of the prime drawbacks of the synchropter (intermeshing, contrarotating rotor) design.

Tail boom originally was circular, but vibration problems developed, and a turtleback addition was fitted over the topside of the boom to give it a slightly humpbacked appearance.

Boom on the prototype, as a result of the fix, has a double top wall, which will be eliminated in the production version.

Horizontal stabilizer is an all-movable, slab-type, which originally was farther aft and rigidly fixed. Long moment arm provided by the single boom allowed it to be moved forward without loss of effectiveness, and conversion to a movable surface increased control.

Elevator travels from 12 deg. leading edge up to 11 deg. leading edge down. It also has a hover position of 30 deg. leading edge up which allows it to streamline fairly well into the rotor downwash.

Increased elevator effectiveness has given the K-1125 a permissible center of gravity travel of 10 in., compared with 6 in. for the H-43B.

Vertical fin, like the horizontal stabilizer, originally was all rigid, but a movable rudder surface was added when flight tests showed the fixed fin provided too much stability and hampered turns. The rudder had the effect of decreasing stability but added maneuverability. Rudder has a 30-deg. travel either side of neutral.

Because of the increased effectiveness of the tail surfaces afforded by the longer moment arm, the K-1125 does not have the directional autostabilization system built into the H-43B.

Landing gear on the K-1125 has been modified from that of the H-43B to provide improved ground resonance characteristics. Rear tires are the type used on the Kaman HU2K, which are laterally stiffer. Modification is designed to prevent the side-to-side rocking motion which occasionally occurs in ground operation of the H-43B.

The K-1125 has flown at a gross weight of 9,150 lb. in the current test program.

Kaman has financed the entire airframe development program with company funds. Boeing has funded engine development, and the two companies have agreed to see the program through together.

K-1125 development program began only last March with the decision to build the prototype. The helicopter first flew in June, with an H-43B rotor system, engine and empennage fitted to the K-1125 fuselage. In July, the single-boom tail was added, and the turtleback modification was made in August when the T-53 turbine was removed and the twin YT-60s installed.

The K-1125 flew as a twin-engine aircraft Aug. 8.

With about 50 hr. flight time on the machine so far, the K-1125 is now being readied for customer demonstrations prior to continuing flight test and component refinement. Development program is aimed at a production date of January, 1964.

While the company considers the K-1125 basically a military helicopter, the machine has been designed in accordance with Federal Aviation Agency requirements for type certification.

Navy Plans Avionics Classification Change

By Philip J. Klass

Washington—Bureau of Naval Weapons' avionics division intends to identify all future avionic development programs to indicate clearly whether its primary objective is to improve reliability, performance or a combination of both.

This will be done by dividing future avionic development programs into three classes, it was disclosed here last week by Col. Arthur C. Lowell, chief of the avionics division, during a two-day Navy-sponsored microelectronics conference attended by more than 500 industry and government representatives.

The classification assigned will depend upon the degree of maturity of existing equipment and the extent to which its performance meets Navy's needs. The three categories are:

• **Type 1,** where existing equipment performance represents 80-85% of the achievable ultimate—such as airborne communications equipment—will emphasize reliability and serviceability in future developments, with maximum use of standardized proven microcircuitry.

• **Type 2,** where performance of existing equipment is 50-80% of the ultimate realizable, will place roughly equal emphasis on improving both performance and reliability, with use of standard microcircuits wherever possible.

• **Type 3,** where performance of existing hardware is under 50% of what is needed and achievable. Contractor will be instructed to place primary emphasis on improving performance.

Lowell said the avionics division soon will award a contract to design eight standardized power supplies whose use will be mandatory for all Type 1 equipment.

The avionics division has developed specifications for 83 types of standardized microcircuits for use in its Type 1 and 2 equipment. This includes 17 types of basic digital functions, in three different operating speed ranges: 200 kc., 1 mc. and 10 mc. maximum speeds. The division is working with the Electronic Industries Assn. microelectronics committee to obtain industry reactions to the proposed standards, Lowell said. The division will not, however, force the use of standard microcircuits until they have undergone extensive proof testing, Lowell emphasized.

Navy avionics equipment now in service uses some 5,000-10,000 different circuits. Lowell expressed the hope that in the future some 200 types of standard microcircuits could handle 95% of the Navy avionic equipment circuit functions. By February, 1963, Navy expects that there will be multiple sources for most of its standard microcircuits, Lowell said.

Although the avionics division is placing its major emphasis on semiconductor type microcircuitry (AW July 9, p. 46), Johns Hopkins University's Applied Physics Laboratory, which has developed the Navy's family of anti-aircraft missiles, plans to evaluate thin-film microcircuitry for use in the Typhon.

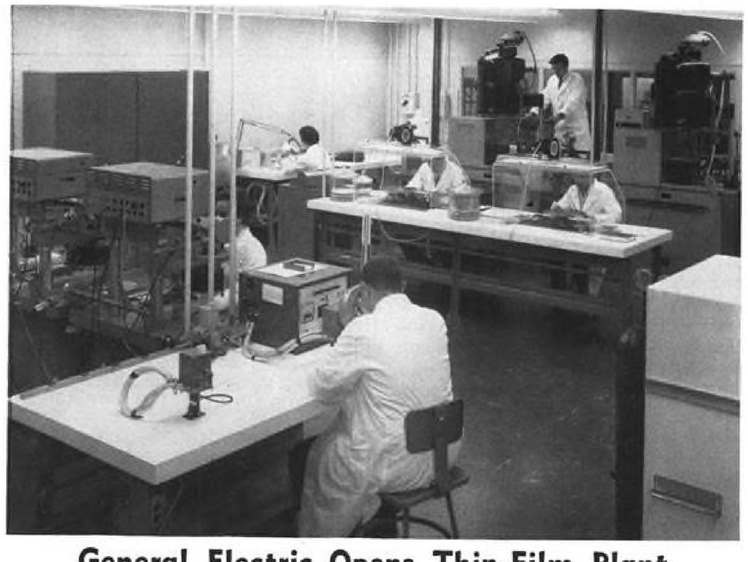
The Applied Physics Laboratory is evaluating 12 industry proposals for thin-film microcircuitry to be used in a decoder subsystem and expects to announce the winner within several weeks. The decoder employs 1,485 components including 225 transistors, 500 diodes, 600 resistors and 160 capacitors.

The APL thin-film microcircuit specification for the decoder requires that all passive components be of the deposited type except for capacitors larger than 0.01 mfd. Deposited components must be within 5% of design value without trimming, except for a digital/analog resistor ladder in which resistors must be within 0.5% of design value with trimming permitted, APL's Stanley Gordon reported.

Gordon said APL selected the thin-film approach in preference to semiconductor microcircuitry because it was more flexible for custom-design circuits, required no major circuit redesign, and could be obtained more quickly. Delivery within six months was requested. In addition, the thin-film approach permits faster computing speeds, "well above 1 mc.," required by the decoder, Gordon said.

The Applied Physics Laboratory intends to buy three of the thin-film decoders. If they pass extensive ground tests, one of the decoders will be installed in flight hardware, Gordon said. The present missile design uses welded cordwood type module construction. The thin-film decoder is expected to occupy only one-quarter as much volume, and in production even greater space saving appears possible, he said.

A thin-film microcircuit digital computer, designed for an undisclosed weapon-delivery system and scheduled for delivery to the Naval Avionics Facility, Indianapolis in mid-1963, was reported by W. N. Carroll of International Business Machines Corp. The computer, including memory, power supply and analog/digital converter, is expected to



General Electric Opens Thin-Film Plant

Thin-film factory, new facility opened by General Electric Light Military Electronics Dept., Utica, N. Y., has capacity for turning out 1,000 thin-film microcircuits a month. High-vacuum facilities can deposit resistors on 25 one-inch square glass substrates simultaneously and deposit conductors on 50 substrates at a time. Facility includes equipment for measuring cleanliness of substrates and uniformity of slits in masks.

Estimated Shipments of Electronic Components

First Quarter, 1962

Category	Quantity (Thousands of units) Total Military	Quantity (Thousands of units) (Military plus non-military)	Value (Thousands of dollars) Total Military	Value (Thousands of dollars) (Military plus non-military)
Capacitators	436,543	44,461	$86,299	$26,809
Complex Components	13,348	1,324	11,433	6,633
Connectors	30,198	15,106	56,297	35,497
Quartz Crystals	2,112	525	9,047	1,515
Relays (for electronic applications)	8,383	2,138	52,231	22,051
Resistors	729,492	85,263	85,420	34,296
Transformers and Reactors (by grades MIL-T-27A)	11,000	1,753	59,379	21,528
Power and Special Purpose Tubes	2,356.5	880.0	81,506	55,328
Receiving Tubes	99,224	11,196	86,388	15,580
Television Picture Tubes*	3,089	*	64,425	*
Semiconductor Devices	166,065	34,784	151,020	53,830
Total	.....	.....	$743,445	$273,121

* Shipments of TV picture tubes for military applications are small, and are combined with non-military shipments to avoid disclosure of proprietary information.

weigh 18.1 lb. and occupy a volume of 0.14 cu. ft., Carroll said.

The computer will be a general purpose synchronous machine, designed for parallel operation, using a 26-bit data word and a 13-bit memory word. The ferrite core memory will have a storage capacity of 1,024 words. Computer will operate at a 500 kc. clock rate.

A semi-automatic thin-film microcircuit production facility, capable of fabricating nearly 1,000 3¾ x 5⅛ in. microcircuits per hr., is now in use by International Business Machines Corp., F. L. Stutz of IBM reported. A similar thin-film production facility recently has been delivered by IBM to the Naval Avionics Facility, Indianapolis.

Tests are getting under way to evaluate the vulnerability of thin-film microcircuits to transient and permanent radiation damage using both a nuclear reactor and a linear accelerator, J. M. Lee, BuWeps Advanced Technology Branch reported. Plans call for side-by-side comparisons to evaluate the relative vulnerability of thin-film and semiconductor types of microcircuits. Lee said the Navy hopes to have complete data within six to eight months.

FILTER CENTER

► **Ultraviolet Laser Award**—Air Force's Space Systems Division will soon contract with Space Technology Laboratories for theoretical investigation of lasers operating in the ultraviolet region of the spectrum. Award is based on an unsolicited STL proposal.

► **NASA to Fund Thin-Film Solar Cell Activity**—Two separate approaches to achieving large area lightweight thin-film solar cells will be investigated by National Aeronautics and Space Administration during the current fiscal year. One of these efforts will be with the polycrystalline cadmium sulfide program at Harshaw Chemical Co. (AW July 31, 1961, p. 62; Oct. 17, 1960, p. 63) which has scored promising advances in recent months. Harshaw has made arrays which have a power density of 30 w. lb. even though the cells themselves have low efficiency. NASA is also expected to pick a contractor soon in a competition it held recently (AW May 28, p. 55) for a thin-film solar cell program.

► **Combination Radio-Radar Study Planned**—Investigation and demonstration of the feasibility of a dual-purpose modulator which can be used for both radar and communications is planned by Rome Air Development Center. Objective is to be able to operate as a communications facility during brief intervals between successive radar pulses. Earlier studies of the concept have been conducted by General Electric.

► **Wideband Endfire Antenna Developed**—Double-helix type of endfire antenna, which can be turned for maximum gain over a wide frequency range, unlike previous endfire antennas, was reported at Wescon by H. W. Ehrenspeck, AF Cambridge Research Laboratories. The new tunable design covers a bandwidth of at least 2:1 with optimum gain across the bandwidth. The tunable antenna can be constructed in several different configurations.

► **"Chirp" Signals for Communications**—Pulse compression techniques used in radar to obtain increased range, known as "chirp" pulses because of their resemblance to the sound made by a bird, offer attractive advantages for use in digital communications, Marion R. Winkler of Radio Corp. of America reported at Wescon. Winkler said that chirp technique is less affected by Doppler shift than conventional frequency shift keying, is less affected by man-made and natural interference and can be used with existing voice communications channels. A disadvantage is the relatively wide bandwidth required.

► **Letdown Computer for Boost-Gliders**—Sperry Gyroscope has been selected by USAF's Aeronautical Systems Division to design and build an airborne letdown computer for use in "advanced boost-glide vehicles," presumably the Dyna-Soar (X-20) or a follow-on program.

► **New Thin-Film Insulator Reported**—New technique for fabricating extremely thin, uniform layers of insulation on solid surfaces has been developed by International Business Machines Corp. at its Watson Research Center. Technique involves polymerization of butadiene, an organic gas, into a solid insulating layer by bombarding the gas with an election beam.

BUSINESS FLYING

General Aviation Told Of Financing Sources

Millville, N. J.—Poor financial management and failure to exploit fully the potential business aircraft market are holding back the growth rate of the general aviation industry, aviation businessmen were told at the recent Airwork Corp. symposium here.

Financial problems confronting the industry were outlined by Donald S. Bibbero, executive director of National Aviation Trades Assn., who called for application of the basic rules of finance used successfully by other private businessmen.

Henry Ryan, merchandising manager for Beech Aircraft Corp., presented the market picture, saying that studies have shown there has been less than 10% penetration of the potential general aviation market.

Pointing to the upward trend in aircraft and operating costs, Bibbero said general aviation has long neglected its finances, but that it is time the industry matured. The challenge, he said, is to follow the example of other industries in exchanging marketing and financing information so that individual operators can stay abreast of industry-wide developments.

"A seat-of-the-pants approach is no way to run a $4-billion business," Bibbero said.

Bibbero listed five principal sources of financing for the aviation businessman, suggesting how some could be more fully explored:

- **Banks**—In the past, bankers have been slow to understand the financial needs of the industry, but many could be made to understand if the importance of business aviation were explained to them.
- **Private investors**—General aviation users are some of the best sources. Many fixed-base operators, for example, could solve their financial problems by approaching their own customers.
- **Venture risk capital**—Investor syndicates are a source of money needed to meet emergencies, but again, a major effort must be made to sell the aviation story to outside investors.
- **Stock issues**—Because of the time and effort involved, stock issues should be reserved primarily for major financing needs. More aviation businessmen should explore the laws of their states, however, to determine if they allow simplified stock issues on an intrastate basis.
- **Small business investment corpora-**

tions—Federal Aviation Agency is considering a joint program with the Small Business Administration to provide assistance to general aviation operators.

Bibbero said many general aviation operators also fail to use their dollars properly once they have acquired them. The most important thing is to ensure a return on investment by good business practices, such as cash flow planning, use of standardized accounting methods and long-range budgeting.

General aviation operators cannot avoid these good business practices, Bibbero said. As long as they do, they will continue to depress the industry, instead of encouraging its growth.

In presenting his market projection, Ryan outlined the procedure used to determine the number of potential general aviation customers. He started with the total number of business firms in the U.S., approximately 5.5 million, and eliminated 4.5 million which he determined had neither the need nor the money for a business aircraft. Of the other one million, 610,000 had the need but not the money, Ryan said.

Remaining 390,000 companies with both the need and the money represent the potential market, according to Ryan. They were further qualified by the type of aircraft required for their operations. Of the total, 330,000 fell in the single-engine class and 60,000 in the twin-engine class. An overlapping 100,000 were listed in a separate category ranging from the heavy single to the light twin-engine class.

Business fleet of about 40,000 aircraft represents a less than 10% penetration of this potential market, Ryan said, because many firms own fleets of aircraft. This rate, compared with that of other industries, is very poor, he said.

Further, 75% of new aircraft sales are to individuals and companies already owning or using aircraft, leaving a large number of non-owners and non-users in the potential market category.

Ryan said the rising costs of general aviation aircraft and growing operating costs are not significant factors in discouraging new customers. He said the performance of many single-engine business planes compares with that of some World War 2 fighters.

Communications systems provided for them have increased capability, and airframe design and construction techniques are constantly improving. All these factors permit more utilization per unit and actually give the user a better return on his investment, Ryan noted.

Once general aviation can give the customer what he wants at a price he is willing to pay, the market will continue to expand at a steady rate, Ryan said. If that rate is to be accelerated, however, an effort must be made to tap the large potential market group of non-users and non-owners, he added.

WHO'S WHERE

(*Continued from page 23*)

Changes

William J. Corcoran, director, Research and Advanced Technology Division, United Technology Corp., Sunnyvale, Calif.

Dr. Nicholas Yaru, manager, Radar Division, Hughes Aircraft Co.'s Ground Systems Group, Fullerton, Calif.

A. J. Maki, director of manufacturing, Avco Corp.'s Research and Advanced Development Division, Wilmington, Mass.

Dr. David P. Chandler and **Dr. George A. Kachickas,** assistant chief engineers, Inertial Navigation Product Division of Autonetics, a division of North American Aviation, Inc., Downey, Calif., with Dr. Chandler responsible for research and new business and Dr. Kachickas for current programs.

Will M. Quinn, Jr., engineering manager, United Aircraft Corp.'s Norden Division, Norwalk, Conn., succeeding **Carl F. Schaefer,** now consulting engineer.

Herbert O. Patchel, manager of manufacturing, General Dynamics/Electronics, San Diego, Calif.

Emerson W. Conlon, formerly Assistant Director of Research for the National Aeronautics and Space Administration, appointed chief of the newly established Department of Advanced Technology at Douglas Aircraft Co.'s Long Beach (Calif.) Division.

Ted Kaslow, instrumentation planning engineer for Pan American's Guided Missiles Range Division, Patrick AFB, Fla.

Dr. Cheng Ling, principal staff engineer, Research and Advanced Technology Department, the Martin Co.'s Electronic Systems & Products Division, Baltimore, Md. Also: **Frank A. Schute,** director of sales and requirements, Electronic Systems & Products Division.

Arthur T. Cavanaugh, manager-Midwest region for General Electric Co.'s Defense Programs Operation, with offices in Midwest City, Okla.

T. L. Maltby, manager of weapon systems and missile engineering, Beech Aircraft Corp.'s Aerospace Division, Wichita.

Walter T. Banziger, site director-installation, Strategic Air Command Control System, SAC Eighth Air Force headquarters, Westover, Mass.

William B. Briggs, planning manager, Astronautics Division, Ling-Temco-Vought's Chance Vought Corp., Dallas, Tex.

Charles E. Harrison, head, Foreign Technology Office, The Mitre Corp., Bedford, Mass.

Robert L. Williams, supervisor of reliability analysis, Westinghouse Defense Center's Air Arm Division, Baltimore, Md.

Robert C. Ferguson, engineering manager, Indiana Gear Works division of The Buehler Corp., Indianapolis, Ind.

Arthur F. Naylor, chief engineer, Bowmar Instrument Corp., Fort Wayne, Ind.

Dr. Henry M. Watts, manager of systems engineering, Radio Corp. of America's Data Systems Division, Van Nuys, Calif.

Deloy G. Monroe, director of engineering, and **Barry C. Passman,** chief engineer, Sparton Electronics, division of Sparton Corp., Jackson, Mich.

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Multi Engine Jet Pilot 6 years, 1800 hours, age 28, COMSMEL and Instrument. Desires position with air carrier or as corporation pilot. References and resume on request. PW-9843, Aviation Week.

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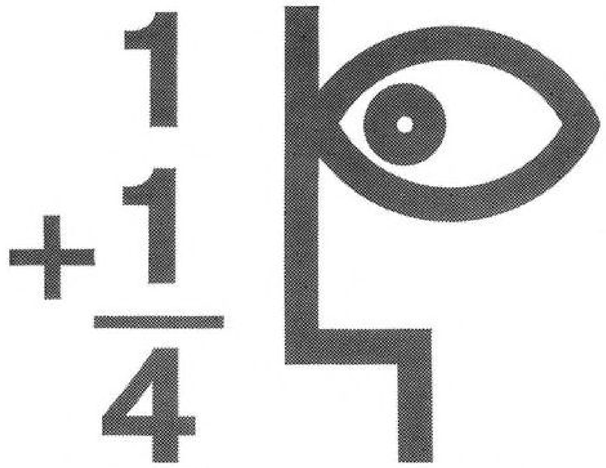

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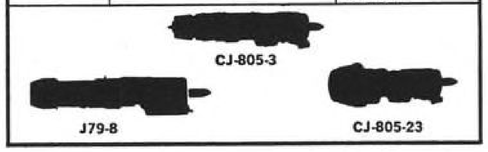

Even success generates its own kind of challenges, and at the Flight Propulsion Division of General Electric, improving already outstanding engine performance is one of them. As the box to the left attests, GE's jet engines have scored many world-wide records. Yet, today, the FPD engineers whose breakthroughs helped establish the original records are **engineering new ways to top them.** ■ That's where you come in. ■ We are looking for engineers who can see in these record-breaking engines, not just an achievement, but a point of departure for even greater performance, endurance and reliability. If you have this kind of mind and a high level capability in any of the areas listed, there's open-end opportunity waiting for you at Cincinnati, Ohio.

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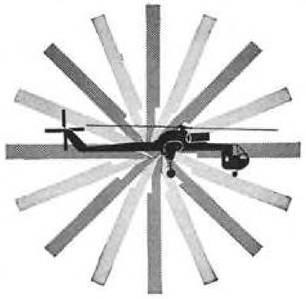

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Classified Advertising Division

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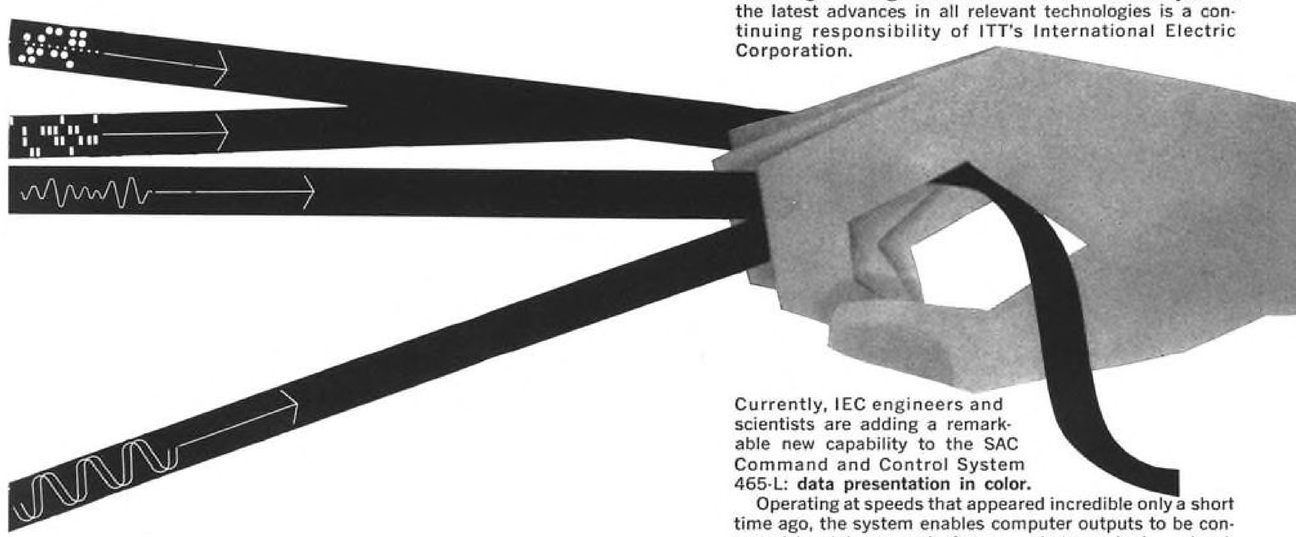
securing man's control of the complex weapons he has invented

Factoring into large scale command and control systems the latest advances in all relevant technologies is a continuing responsibility of ITT's International Electric Corporation.



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DIGITAL SYSTEMS ENGINEERS. Engineers with management ability to direct sub-systems engineering effort on a global command/control system. Experience is desired in message traffic control, data processing systems, data display and multi-sequencing techniques.

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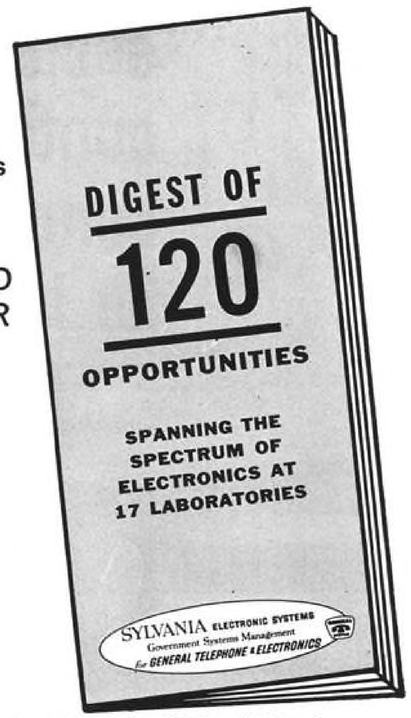
BULLETIN FROM SYLVANIA
FOR ENGINEERS & SCIENTISTS



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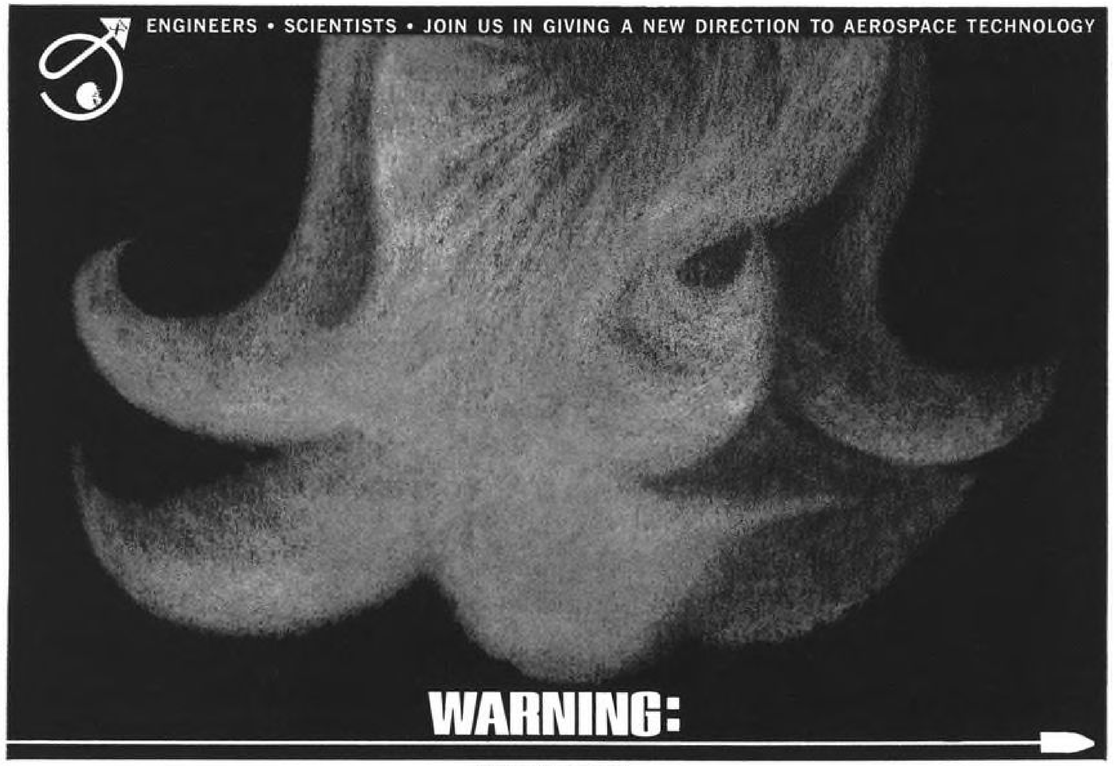

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Interested applicants are invited to write in confidence to Mr. George R. Hickman, Professional Employment Manager, Dept. IK-2

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AVIATION WEEK, OCTOBER 8, 1962

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Send complete resume in confidence to: Hugh L. Gordon, Professional Employment Manager, **Lockheed-Georgia Company, 834 West Peachtree Street, Atlanta 8, Georgia, Dept. G-75.**

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LETTERS

Slow Reaction

After reading the CAB Accident Investigation Report (AW Aug. 6, p. 111), concerning the TWA 720B #1 engine failure, with considerable interest in the highly professional investigative phase and the usual first class compilation of data, certain elements in the conclusions, I feel, represent cause for much serious concern.

First off, let me state that the probable cause cannot be faulted and is certainly the product of one of the smoothest working investigative structures extant. However, let's review some significant bits and happenings in the narrative:

"In the vicinity of Albany, New York (approximately 1536), a muffled explosion was felt and heard by the crew and the aircraft commenced a yaw to the left. The autopilot was immediately disengaged and the aircraft was brought back to a normal flight attitude. The flight engineer then advised that cabin pressure was dropping. Thereupon the crew went on emergency oxygen and activated the seat belt sign.

"Air Traffic Control was contacted and the flight was cleared to descend to and maintain 9,000 feet.

"It was noted at this time that the utility hydraulic system and the No. 1 generator had failed. The No. 1 engine was then shut down. . ."

The time of the explosion corresponds obviously to the time of the catastrophic turbine failure. For some ten seconds prior to this time the engine had been progressively failing—very likely in the sequence specified in the engineering analysis of the report. After more than two decades of engineering, production and maintenance test flying it is absolutely incomprehensible to me that no abnormal instrument indications were noted prior to the explosion and that, at least by the published description, the engine was shut down some time later after No. 1 generator was discovered to be off line. I submit that such things as oil pressure, fuel flow, EGT, RPM, differential pressure (pressure ratio) and associated gauges, lights and miscellaneous attention getters, must have been trying to reach somebody's consciousness prior to turbine disintegration and with increasing emphasis subsequent to failure. The appalling thing is that fuel metering devices have a nasty habit of increasing fuel flow to compensate for decreasing RPM, etc., and that there must have been a merry blaze for some time before the problem was analyzed as (1) not in the autopilot, (2) not a result of explosive decompression, (3) generator failure with a precautionary No. 1 engine shutdown, and (4) visual identification by the Second Officer of the actual problem and, not until this time, actuation of the firewall shutoff valve. It should be noted that the Second Officer is the only member of the crew with even minimum jet experience.

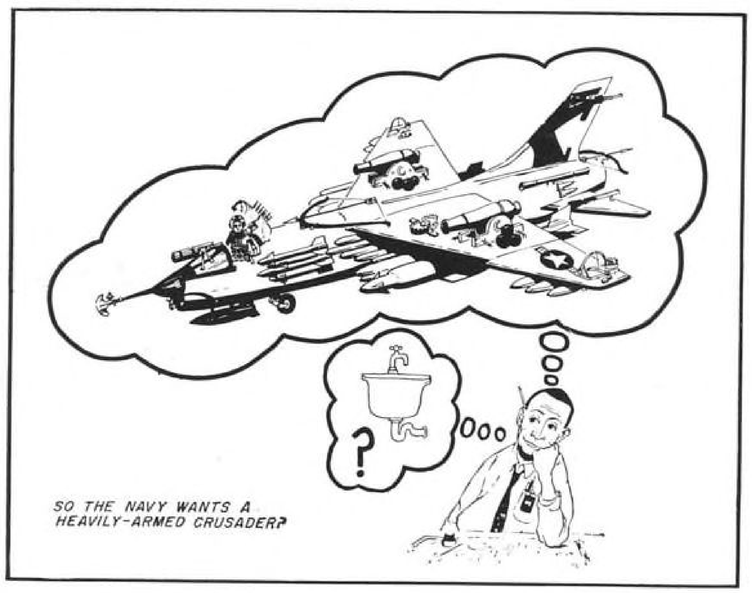
The three pilots, in spite of limited experience in the operation of turbine power plants, must have had some indication of engine failure prior to turbine disintegration; the flight engineer, even with severely limited experience, should certainly have been able to monitor the relatively simple to read, and limited number of, clocks required to trouble shoot a catastrophic turbine failure.

It is my opinion that the reaction to this emergency was too slow, and that the thinking of even federal regulatory agencies must adjust to the onerous fact that things have to be accomplished quickly in an even more professional manner than back on the props—and perhaps you can't use yesterday guys in tomorrow jobs.

I do not intend to be rabid on this subject, but it occurs to me that most of the guys I started flying with twenty-five years ago are dead for reasons related to this case in one way or another. The Air Force has given me excellent tools to reduce and eventually (we hope) eliminate this accident causing human factor. I would hope the CAB recognizes changing requirements in the jet age and applies new experience to accident analysis relating to the human factors.

WILLIAM C. REDEEN
Major, USAF
Flight Test Maintenance Officer

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



707 Landing Charges

The comparison tabulation for representative Boeing 707 landing charges on p. 115 of your Sept. 10 issue is interesting, but can also be misleading. This is due to different services for which the fees pay. It is apparent from the article's text that the landing fees pay proportionately for airport terminal facilities, accounting for cost increases.

Such is not the case at Tokyo International Airport and the two other principal airports in Japan. Here, the terminal building facilities are owned and operated by a private company. Its revenues are in no way related to the physical operation of the airport, under the administration of the Japan Civil Aeronautics Bureau. Public facilities provided by the terminal operating company are paid for by airline tenant and concession rentals, and admissions to the sightseeing galleries by visitors.

Actually, landing fees increased approximately 3% in May, 1960, and are now $218.33 plus an additional $6.94 for night landings. After 50 landings, this price decreases to $174.66 plus $5.55 respectively, and after 100 landings, to $131.00 and $4.17.

We trust this explanation will clear up a possible misconception about the landing costs and what they cover in Japan.

CHARLES H. BENNETT
Secretary
Airport Operators' Committee
Tokyo International Airport

Early Issues

This request may have little room in a space age publication, but I'm one of your readers that realizes that yours is one of the oldest, continuously published aviation magazines in the world, and I'd like to make this request. I would like to know if any of your readers have early issues that they would consider selling—some perhaps that are just taking up basement, attic or garage space. I hope, someday, to have one copy of every issue from 1916 to date!

DAVID D. JAMESON
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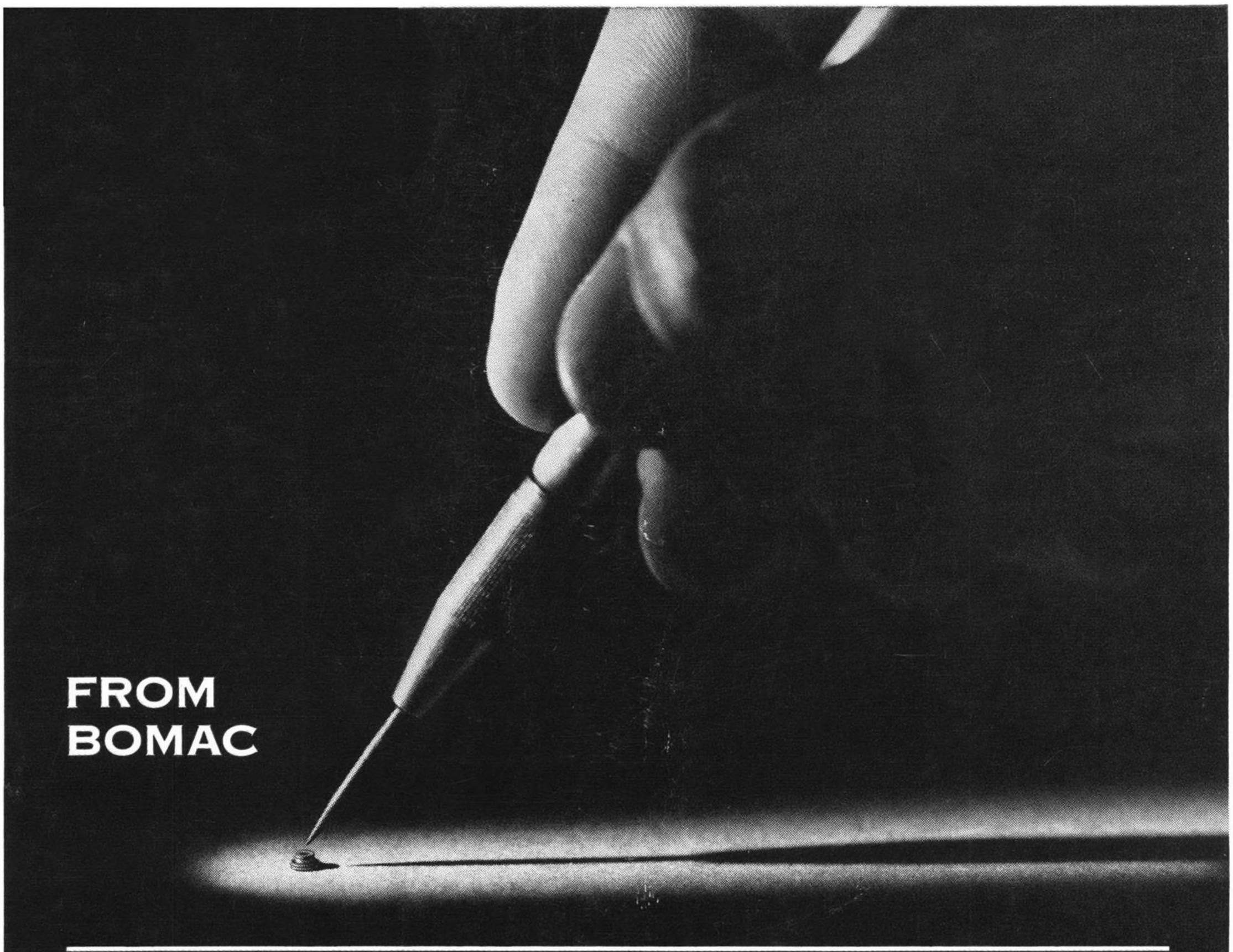

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Bomac Laboratories' new ThermoBond* silicon varactor diode provides the microwave designer with a subminiature silicon component offering great reliability, uniformity, packaging simplicity, and size advantages.

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Bomac ThermoBond silicon varactor diodes are designed for use in microwave limiters, sideband modulators, harmonic generators, low-noise parametric amplifiers, as tuning elements in voltage control oscillators, and in solid state duplexers.

Write for technical data on the ways in which ThermoBond diodes by Bomac can aid your microwave system design problems.

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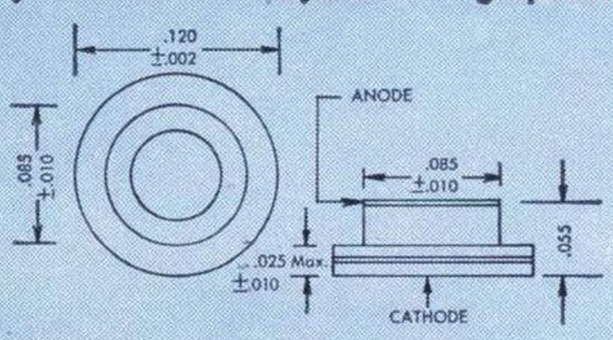

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