Aviation Week & Space Technology

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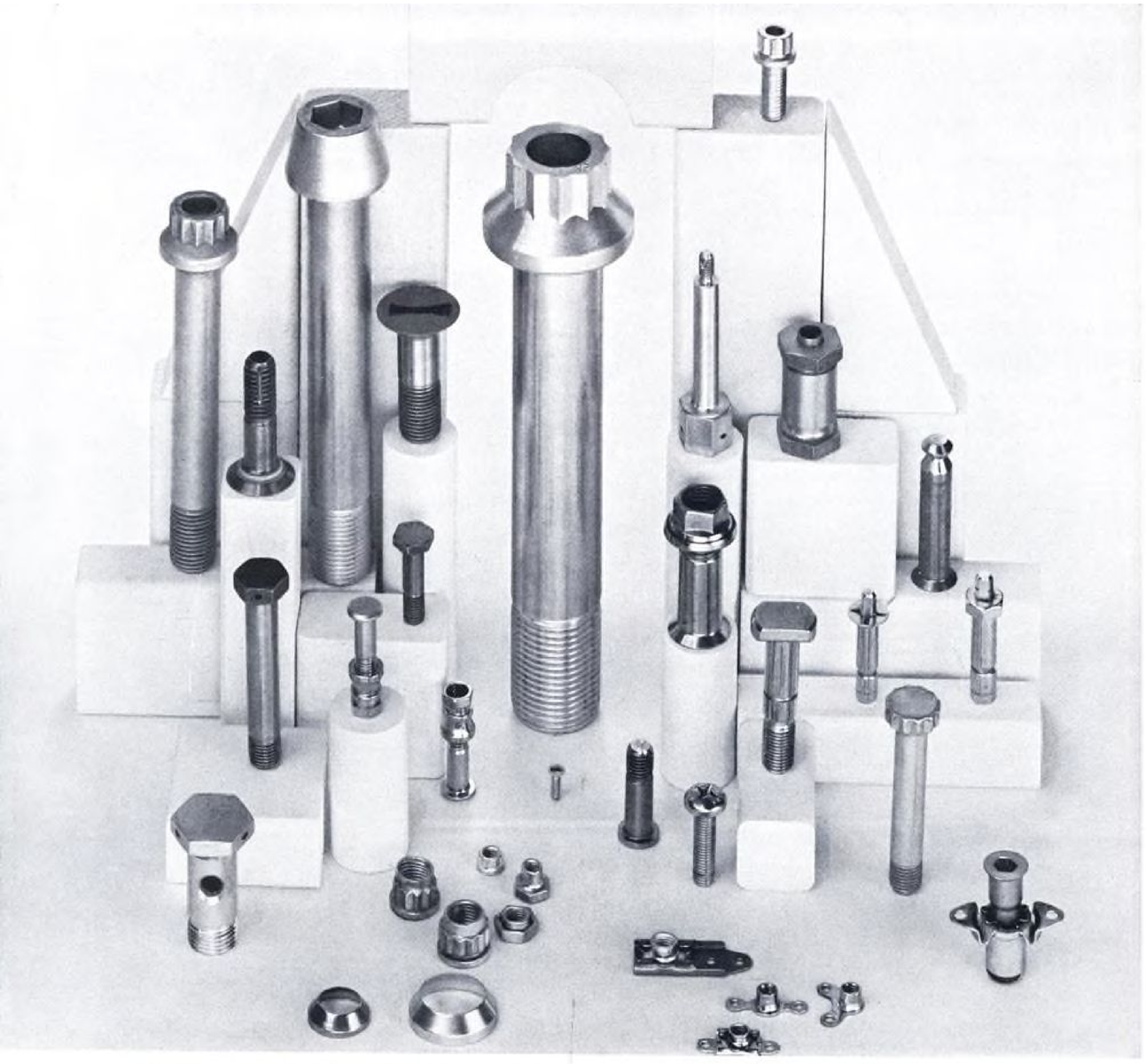
A McGraw-Hill Publication

August 27, 1962

Minuteman Motors Enter Production

McDonnell F4H Fighter On USS Forrestal





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Voi-Shan's acknowledged leadership in the sophisticated aerospace fastening field is maintained by the very high performance "built-in" to every quality product. From the procurement of raw material thru actual application of the product, every phase receives constant attention and control. To supply the widest range of proprietary fastening concepts, demands an unequalled metallurgical capability and a superior customer engineering service to fully complement the products:

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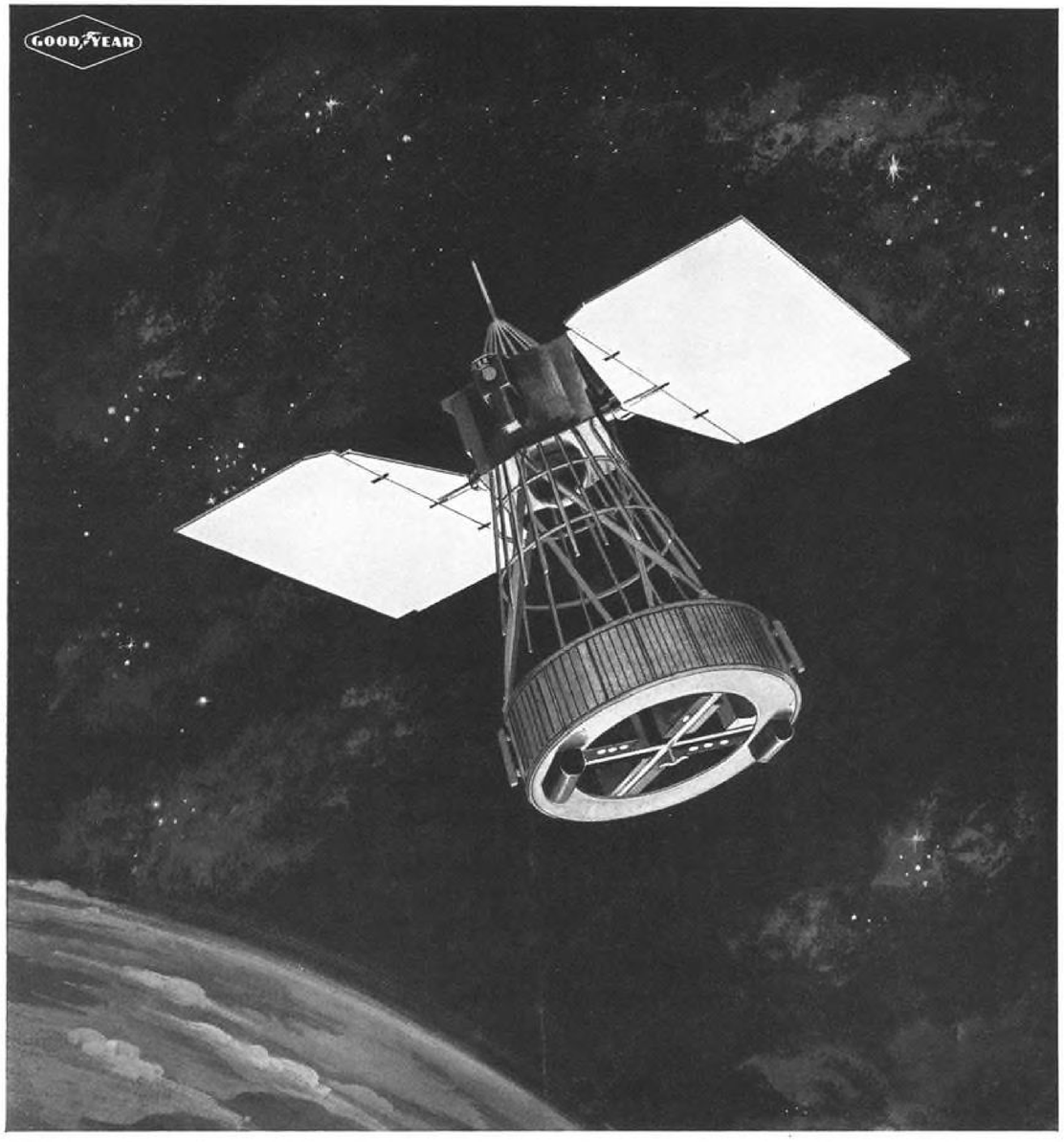
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Yet this panel fabricated by GAC – Goodyear Aircraft Corporation–weighs only 15 pounds.

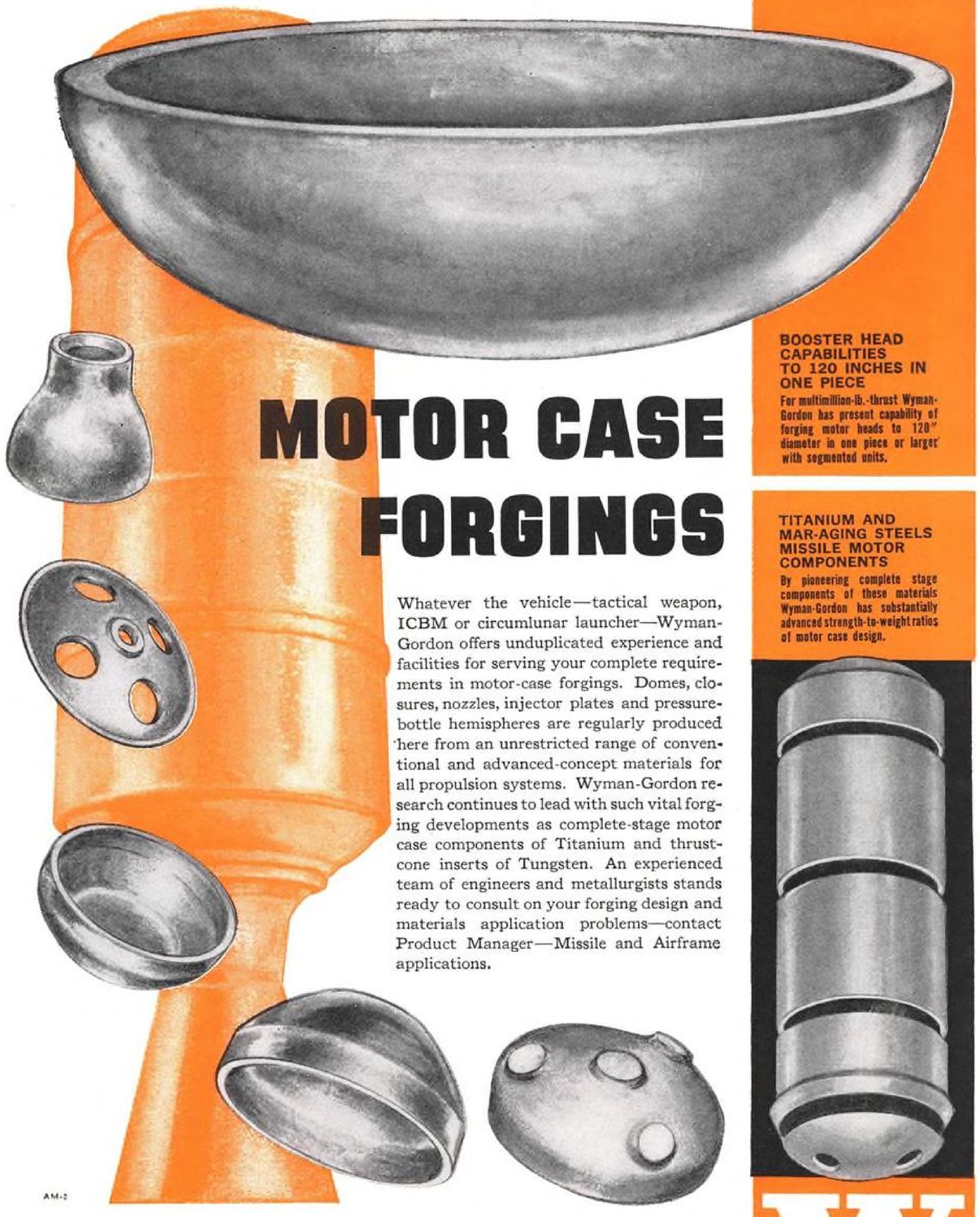
A pair of them will power Nimbus . . . NASA's Goddard Space Flight Center weather satellite which will orbit 600 miles above the earth. They were fabricated by GAC for RCA's Astro-Electronics Division, developer of the Nimbus power system.

And solar panels are just one of GAC's many capabilities. (We produce precision solar concentrators too.) And we can also help you with advanced systems and technology –aerospace support equipment–electronic subsystems–lightweight structures–or missile requirements. Write Goodyear Aircraft Corporation, Dept. 914AT, Akron 15, Ohio, or Litchfield Park, Arizona.

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AM-2

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WG

AEROSPACE CALENDAR

Sept. 3-7—National Advanced Technology Management Conference, Institute of Radio Engineers, Seattle, Wash.

Sept. 3-7—International Symposium on Information Theory, Institute of Radio Engineers, Brussels, Belgium.

Sept. 3-9—1962 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

Sept. 4-7—National Advanced-Technology Management Conference, Opera House, Seattle World's Fair grounds, Wash. Sponsors: University of Washington, professional engineering groups and technologically oriented business firms.

Sept. 5-7—Symposium on Measurement of Thermal Radiation Properties of Solids, Biltmore Hotel, Dayton, Ohio. Sponsors: Aeronautical Systems Division, USAF; National Bureau of Standards; NASA.

Sept. 5-7—Seminar on Automatic Checkout Techniques, Battelle Memorial Institute, Columbus, Ohio. Co-sponsors: Aeronautical Systems Division, USAF; Columbus, Ohio, Research Center.

Sept. 6-8—Second Annual Convention, Canadian Business Aircraft Assn., Queen Elizabeth Hotel, Montreal, Canada.

Sept. 10-14—Fourth National Conference on Applied Meteorology, American Meteorological Society, Hampton, Va.

Sept. 10-14—Annual General Meeting, International Air Transport Assn., Dublin.

Sept. 13-14—10th Annual Engineering Management Conference, IRE, Hotel Roosevelt, New Orleans, La.

(Continued on page 7)

AVIATION WEEK and Space Technology

August 27, 1962

Vol. 77, No. 9

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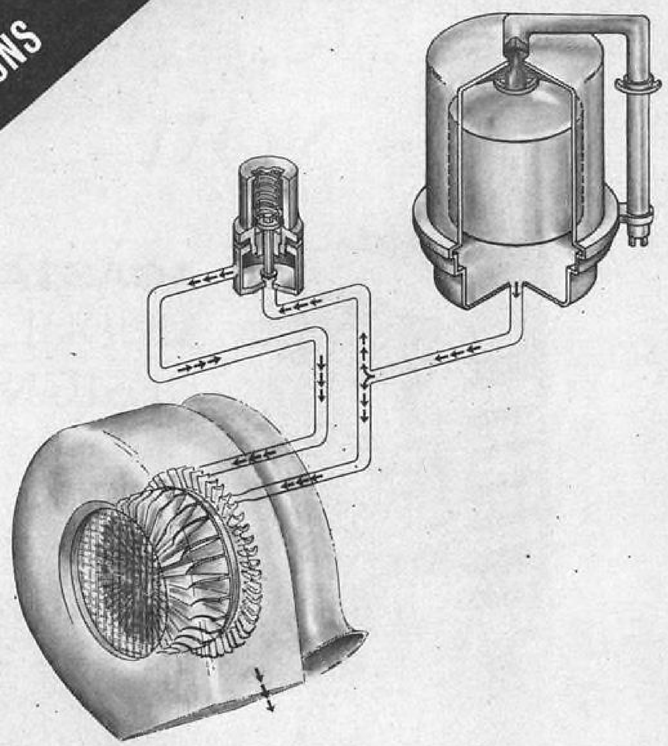
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Positive control of hot gas flow . . .

essential element in dependable cartridge starting

The Sundstrand Cartridge-Pneumatic Starter now being delivered to bases throughout the free world has been designed to provide complete operating safety consistent with the highest degree of reliability. The advanced design of these starters is a direct outgrowth of Sundstrand's research and development experience in hot gas technology related to various APU systems for missile and spacecraft.

The key to the successful development of this new concept has been the adoption of a modular design that incorporates positive control of hot gas flow. Since the ammonium nitrate cartridge propellant burn time varies with temperature and pressure, each of these variables must be closely controlled for efficient, reliable starting.

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The latest design advancement accomplishes positive control of hot gas in two separate successive stages. The first stage establishes and controls the burn rate of the cartridge, and delivers optimum mass flow of gases to the second stage for performance requirement. Through the use of correctly sized and shaped nozzles, the second stage pre-expands the flow delivered and establishes the optimum pressure ratio.

These advantages of hot gas control are realized . . . mass flow and burn time can be established independent of nozzle sizing . . . nozzle pressure can be varied from 1:1 to 41:1 without affecting burn time of cartridge . . . all cartridge gases are used to drive the turbine . . . variation in temperature from -65° to 160°F will cause only slight variation in nozzle pressure ratio.

This advancement in hot gas technology plus inherent turbine overspeed control and overpressure protection makes the use of the Sundstrand Cartridge-Pneumatic Starter the reliable and safe method to start aircraft engines. The modular design provides the configuration flexibility to adapt the basic starter to your aircraft installation requirements through minor alterations to the static elements. More detailed information is available at your nearest Sundstrand office.

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AEROSPACE CALENDAR

(*Continued from page 5*)

Sept. 17-18—Hydrofoil & Air Cushion Vehicles Meeting, Institute of the Aerospace Sciences, Shoreham Hotel, Washington.

Sept. 18-20—Ordnance Environmental Research Symposium, El Tropicano Hotel, San Antonio, Tex. Sponsor: Environmental Research Office of the Office of the Chief of Ordnance. Arranged by Southwest Research Institute.

Sept. 18-23—16th National Convention & Aerospace Panorama, Air Force Assn., Las Vegas, Nev.

Sept. 19-20—Technical Manpower Utilization Meeting, Institute of the Aerospace Sciences, Hotel Commodore, New York.

Sept. 19-20—Operations & Maintenance Symposium, Airwork Corp., Millville, N. J.

Sept. 19-20—11th Annual Industrial Electronics Symposium, Sheraton Hotel, Chicago, Ill. Sponsors: IRE; American Institute of Electrical Engineers; Instrument Society of America.

Sept. 19-21—Sixth National Conference on Tube Techniques, Western Union Auditorium, New York, N. Y. Sponsor: Advisory Group on Electron Devices.

Sept. 19-22—Second International Agricultural Aviation Congress, National Superior Agronomy School, Grignon, France.

Sept. 24-28—13th International Astronautical Congress, American Rocket Society, Sofia, Bulgaria.

Sept. 24-Oct. 12—International Air Transport Assn. Traffic Conferences, San Marcos Hotel, Chandler, Ariz.

Sept. 25-26—Conference: Navy Microelectronics Research & Development, Department of Interior Auditorium, Washington, D. C. Sponsor: Office of Naval Research.

Sept. 25-27—Third Annual Symposium on Helicopter Open Sea Rescue, Kaman Aircraft Corp., Bloomfield, Conn. Sponsor: Naval Air Material Center, Air Crew Equipment Laboratory.

Sept. 25-28—Space Power Systems Conference, American Rocket Society, Miramar Hotel, Santa Monica, Calif.

Sept. 26-27—Symposium on the Physics of Failure in Electronics, Illinois Institute of Technology, Chicago, Ill. Co-sponsors: Rome Air Development Center, USAF Systems Command; Armour Research Foundation.

Sept. 26-Oct. 2—1962 General Conference, Federation Aeronautique Internationale, Athens, Greece.

Sept. 27-28—Symposium on Dynamic Behavior of Materials, University of New Mexico, Albuquerque, N. M. Sponsors: University of New Mexico; American Society for Testing and Materials.

Sept. 27-28—Symposium on the Dynamic Behavior of Materials, American Society for Testing and Materials, University of New Mexico, Albuquerque, N. M.

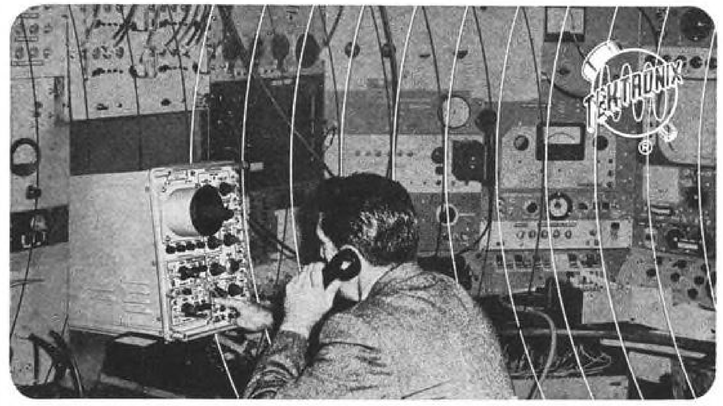
Sept. 28-29—Society of Experimental Test Pilots' Sixth Annual Awards Banquet & Symposium, Beverly-Hilton Hotel, Beverly Hills, Calif.

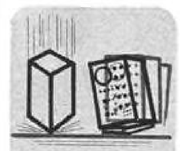
Sept. 30—Third Annual Aerospace Fair, Vandenberg AFB, Calif. Open to the public 10:00 a.m.-4:00 p.m.

(*Continued on page 9*)

*ENVIRONMENTALIZED

TEKTRONIX OSCILLOSCOPE





SHOCK



VIBRATION



HUMIDITY



TEMPERATURE

RADIO INTERFERENCE—With either of the environmentalized plug-in units, the Tektronix Type 945 Oscilloscope meets the Susceptibility Test of MIL-T-945A, 1 millivolt, 50 kc to 400 mc, and also meets the limit for Broadband Radiated and Conducted Interference of MIL-I-16910A, MIL-I-26600 and MIL-I-11748B from 14 kc to 1000 mc.

DC-TO-24 MC WITH DUAL-TRACE UNIT • DC-TO-30 MC WITH FAST-RISE UNIT • ELECTRICAL CHARACTERISTICS SIMILAR TO THE TEKTRONIX TYPE 545 OSCILLOSCOPE

*DEPENDABLE OPERATION WHILE SUBJECT TO THESE ENVIRONMENTS: TEMPERATURE from —40°C to +55°C/71°C • VIBRATION to 5 G's, 55 cps, 0.03" peak-to-peak • SHOCK of 400-pound hammer drop • ALTITUDE to 20,000 feet • RADIO INTERFERENCE from 15 kc to 400 mc.

*RELIABLE PERFORMANCE AFTER STORAGE IN THESE ENVIRONMENTS: TEMPERATURE from —65°C to +85°C • ALTITUDE to 50,000 feet • FUNGUS for 28 days • HUMIDITY for 10 days at 95% relative humidity from +18°C to +65°C • RAIN CONDITIONS of 5 minutes steady dripping.

For those applications not demanding such environmental capabilities, the Type 945 will perform with even greater reliability and flexibility.

The Type 945 will accept any of 17 Tektronix letter-series plug-ins for use in commercial applications.

Type 945 Oscilloscope (without plug-ins) $2850
Type MC Dual-Trace Plug-In Unit. . . . . $ 475
Type ML Fast-Rise Plug-In Unit . . . . . $ 425

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For complete specifications of the new environmentalized oscilloscope—*or a demonstration in your own environment*—please call your Tektronix Field Engineer.

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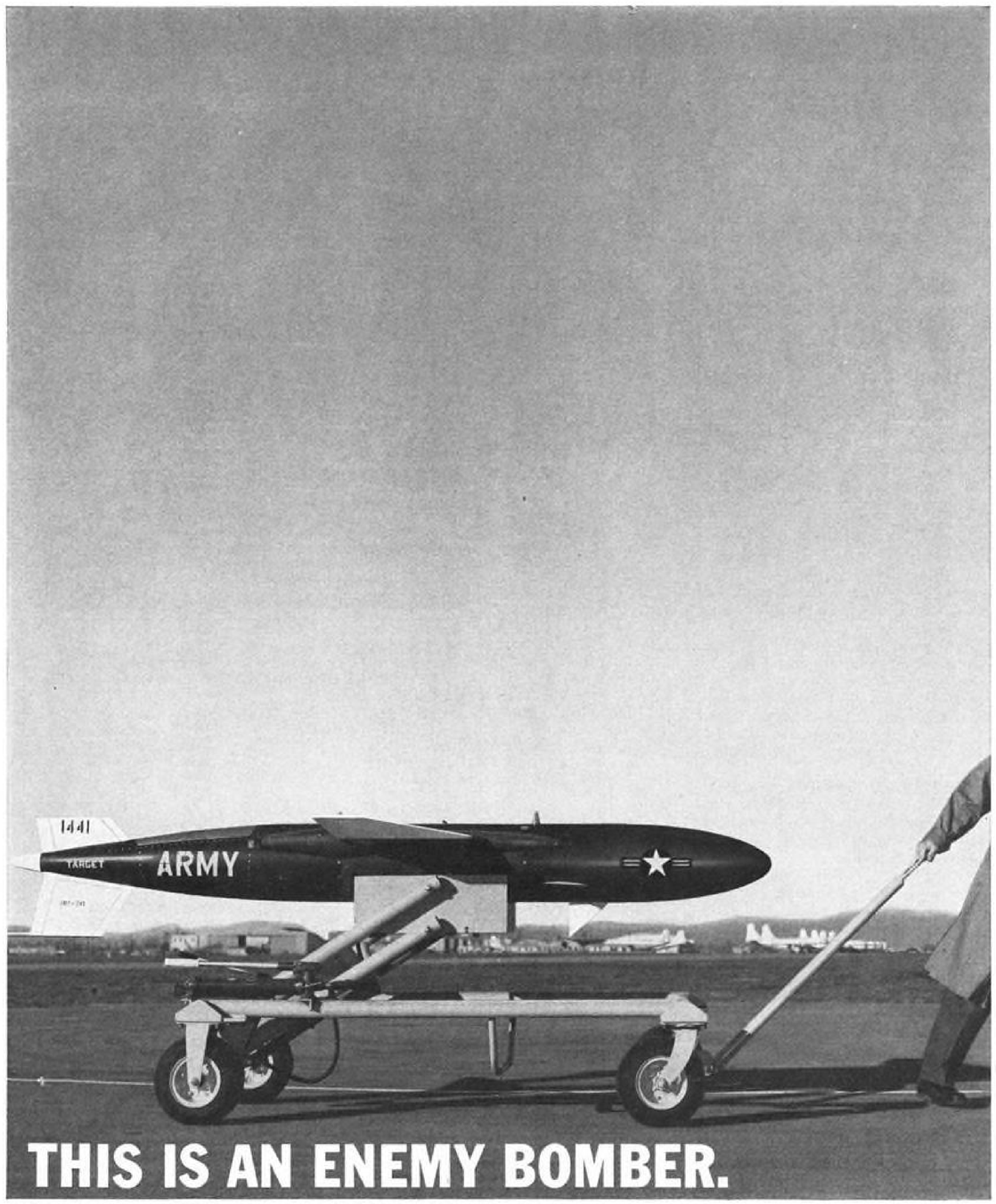
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AEROSPACE CALENDAR

(Continued from page 7)

Oct. 1-3—Seventh Annual Exposition & Symposium, Air Traffic Control Assn., Flamingo Hotel, Las Vegas, Nev.

Oct. 1-3—National Communications Symposium, Institute of Radio Engineers, Hotel Utica, Utica, N.Y.

Oct. 2-4—Symposium on Physics and Nondestructive Testing, Granada Hotel, San Antonio, Tex. Arranged by Southwest Research Institute.

Oct. 2-4—Third Symposium on Advanced Propulsion Concepts, Cincinnati, Ohio. Co-sponsors: AFOSR, General Electric.

Oct. 2-4—National Symposium on Space Electronics and Telemetry, IRE, Fontainebleau Hotel, Miami Beach, Fla.

Oct. 2-4—15th Annual Meeting and Convention, National Business Aircraft Assn., Penn-Sheraton Hotel, Pittsburgh, Pa.

Oct. 8-10—18th Annual National Electronics Conference & Exhibition, McCormick Place, Chicago, Ill.

Oct. 8-12—National Aeronautic & Space Engineering & Manufacturing Meeting & Display, Society of Automotive Engineers, The Ambassador, Los Angeles, Calif.

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

Oct. 15-17—ASW Meeting, Somerset Hotel, Boston, Mass. Sponsors: Institute of the Aerospace Sciences; U. S. Navy.

Oct. 15-18—International Symposium on Space Phenomena and Measurement, Statler-Hilton, Detroit, Mich. Ninth Annual Meeting: Institute of Radio Engineers, co-sponsored by NASA and AEC.

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

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

Oct. 30-31—National Conference on Spaceborne Computer Engineering, Institute of Radio Engineers, Disneyland Hotel, Anaheim, Calif.

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

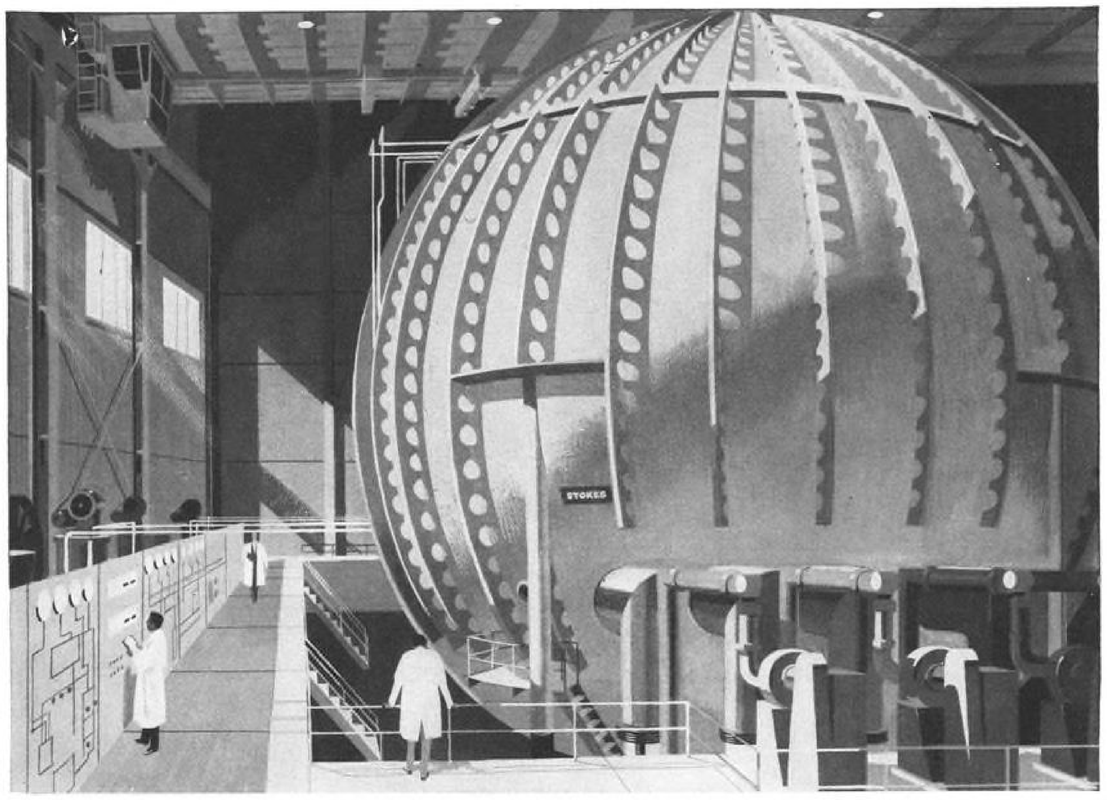
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For General Electric's Valley Forge Space Technology Center, Stokes designed and is currently installing three space environmental test chambers like the one shown above in an artist's sketch. The chambers, 38'6" in diameter, will be cryogenically pumped to ultra-high vacuum, and reproduce a variety of conditions encountered by satellites making lengthy missions into space.

EXPERIENCE IS WHAT COUNTS IN SPACE SIMULATION

While space simulation is a new and rapidly changing art, experience in designing and building equipment for its full-scale accomplishment is of the utmost importance. That is because no inaccuracies, no approximations are possible; reliability proving depends on ascertaining absolute values.

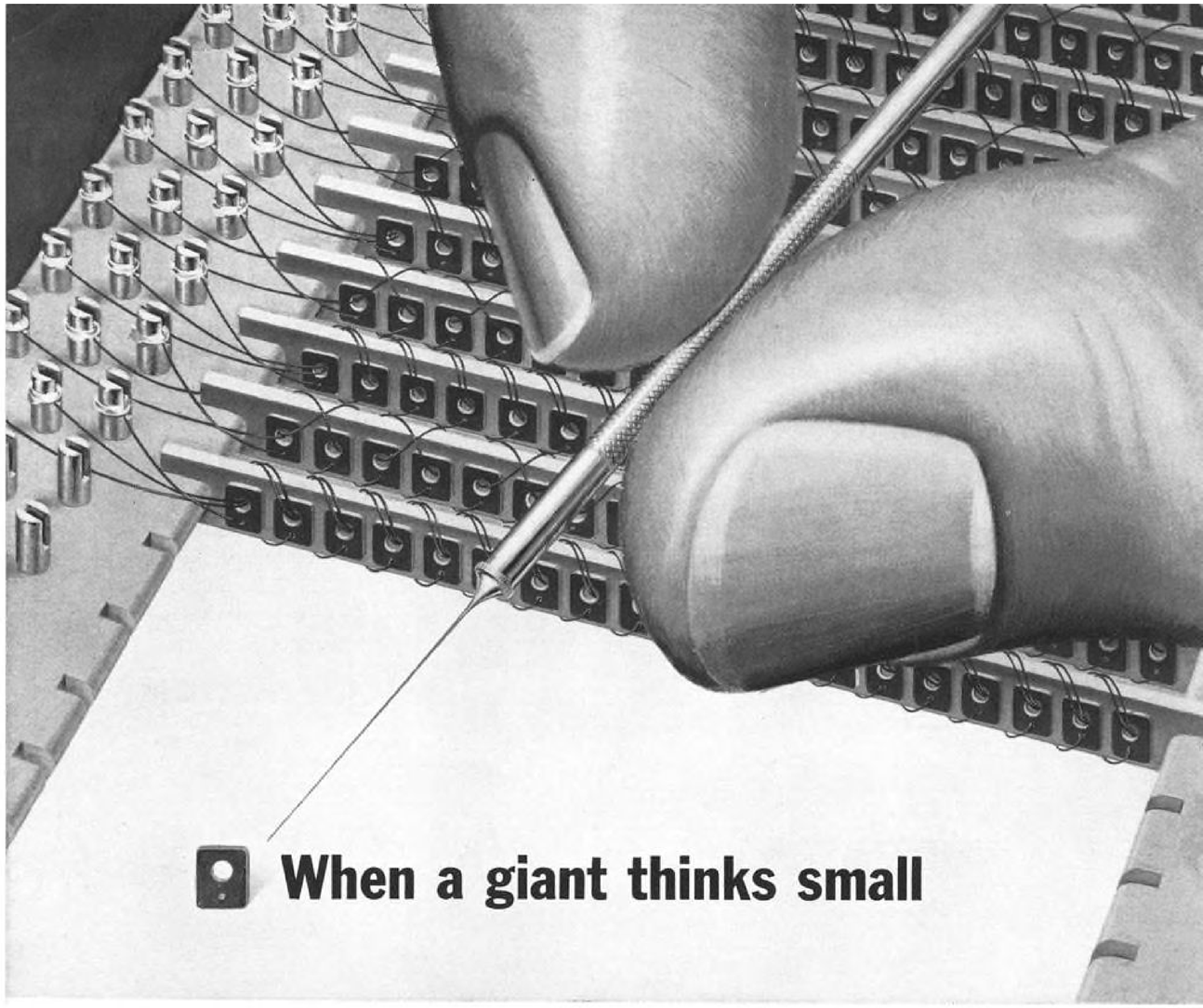
F. J. Stokes offers an impressive backlog of experience in supplying major space test facilities. The installation described above and others for General Electric, the vacuum and cryogenic systems for facilities at NASA's Goddard Space Flight Center, the test chamber for Bell Telephone Laboratories' Telstar project, reliability testing facilities for space-borne electronic components, and pumping systems for various aeronautical research centers stand as benchmarks in Stokes' progress in this specialized area.

Behind this specific activity stands half a century's experience as one of the world's leading manufacturers of high-vacuum industrial systems. Since vacuum is the common denominator of all space test equipment, it follows that Stokes' high-vacuum experience, unique engineering capabilities in this field, and extensive, heavy-duty fabrication facilities can be successfully applied to problems of space simulation.

If you are engaged in any phase of space test work, we will gladly explore the possibilities of putting Stokes space simulation and high-vacuum experience to work for you, on a project management, single-source, turnkey, or any other basis. **Space Systems Department, F. J. Stokes Corporation, Philadelphia 20, Pa.**

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STOKES



When a giant thinks small

Lockheed becomes a prime source for memory devices—from tiny ferrite cores to entire memory systems

When you think of Lockheed, major aerospace achievements usually come to mind. But within the giant Lockheed Corporation is a complete unit whose success was attained by the company's ability, also, to think small. The result: in record time the Lockheed Electronics Company has become a prime source of tiny computer and data processing components for industry and defense.

In an exceptional example of vertical integration, Lockheed Electronics is now producing a broad line of memory devices including single and multi-aperture cores; memory planes, stacks, and systems; printed circuitry; welded circuitry and computer modules. This under-one-roof operation has earned for Lockheed a reputation for quality, on-time delivery and versatility.

Lockheed's *inventive designers*, among other accomplishments, have achieved outstanding results in the development and manufacture of multi-aperture cores which permit high-speed, non-destruct memory readout.

Lockheed's *practical packagers* have produced advanced, ruggedized memory devices in dozens of customized configurations.

Lockheed's *engineering follow-through teams* work carefully with the nation's data processing equipment manufacturers to assure perfect integration into finished computer circuits.

The Avionics and Industrial Products group of Lockheed Electronics, 6201 E. Randolph St., Los Angeles 22, invites you to investigate the company's vertically integrated facilities as a "single source" of finest quality, mass-produced components and sub-systems. Lockheed Electronics is the gateway to several thousand scientists, engineers and technologists who work for Lockheed.

LOCKHEED ELECTRONICS COMPANY

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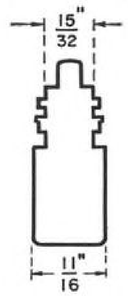
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MICRO SWITCH Precision Switches

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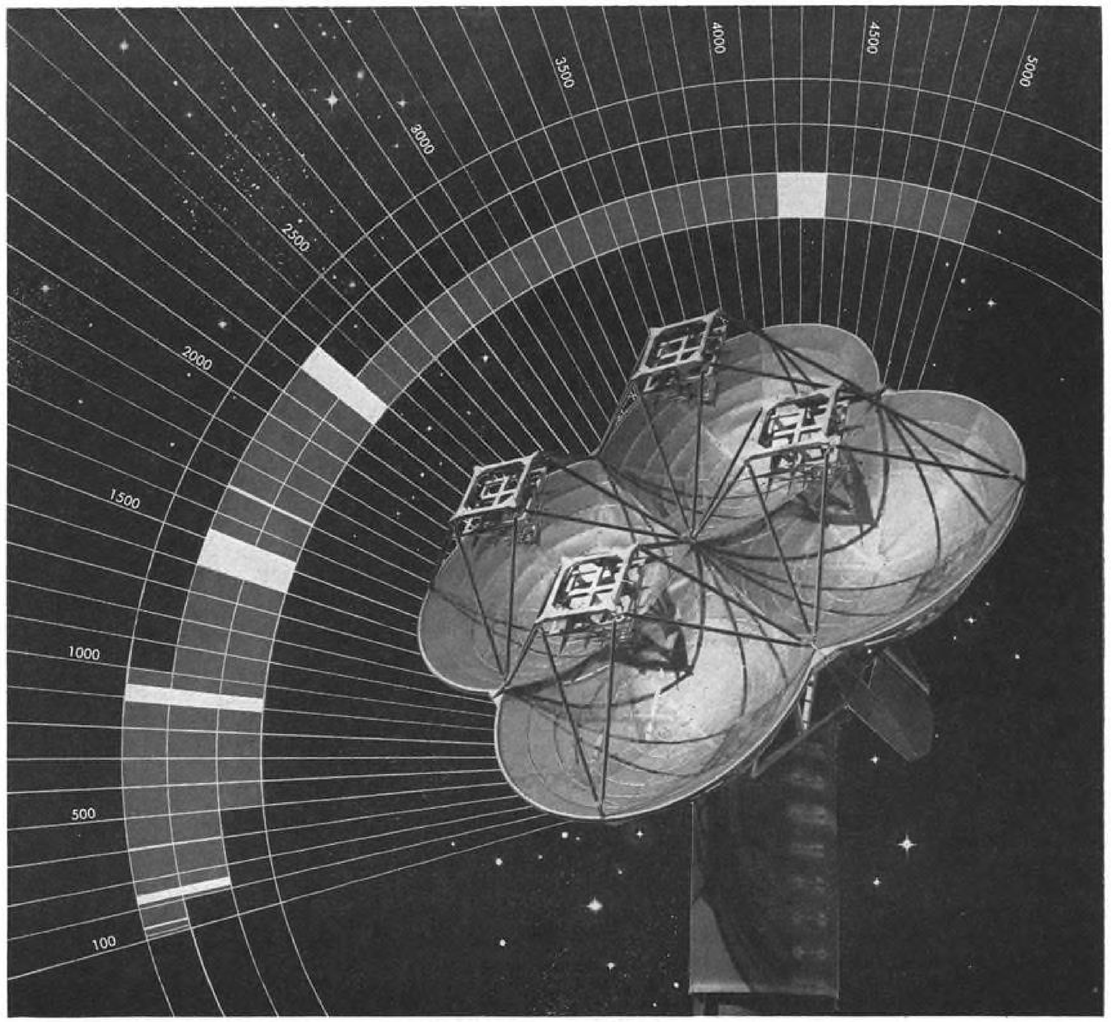
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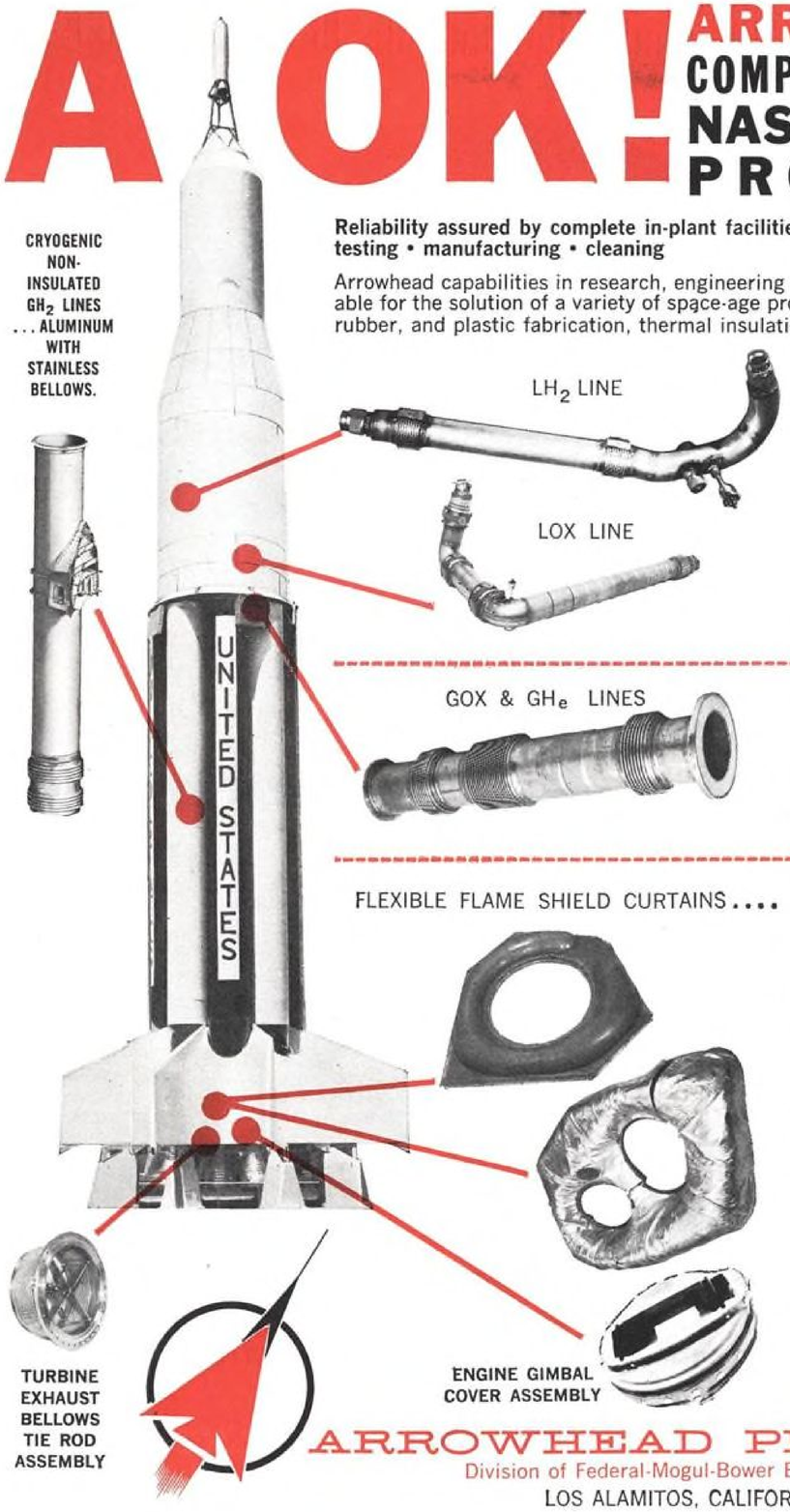
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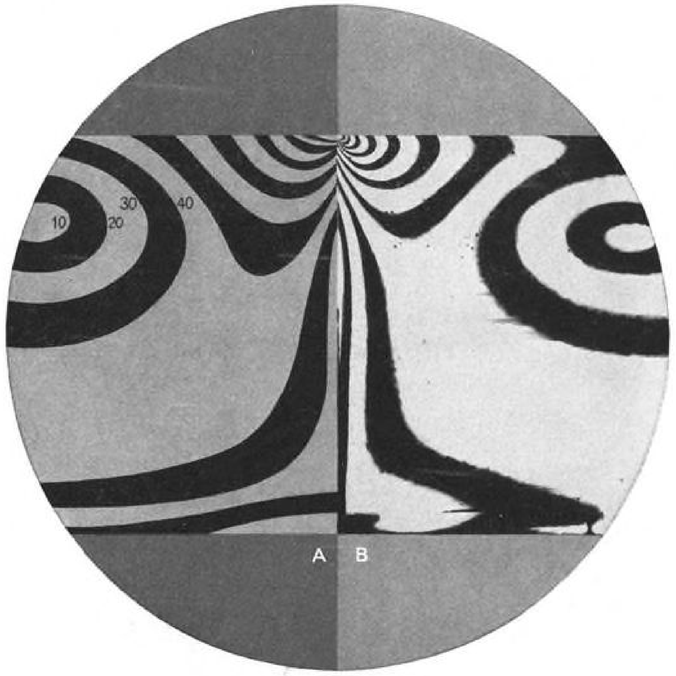
Environmental Conditions Applicable to the Engine Gimbal Cover Assembly are Similar to Those Described Above.

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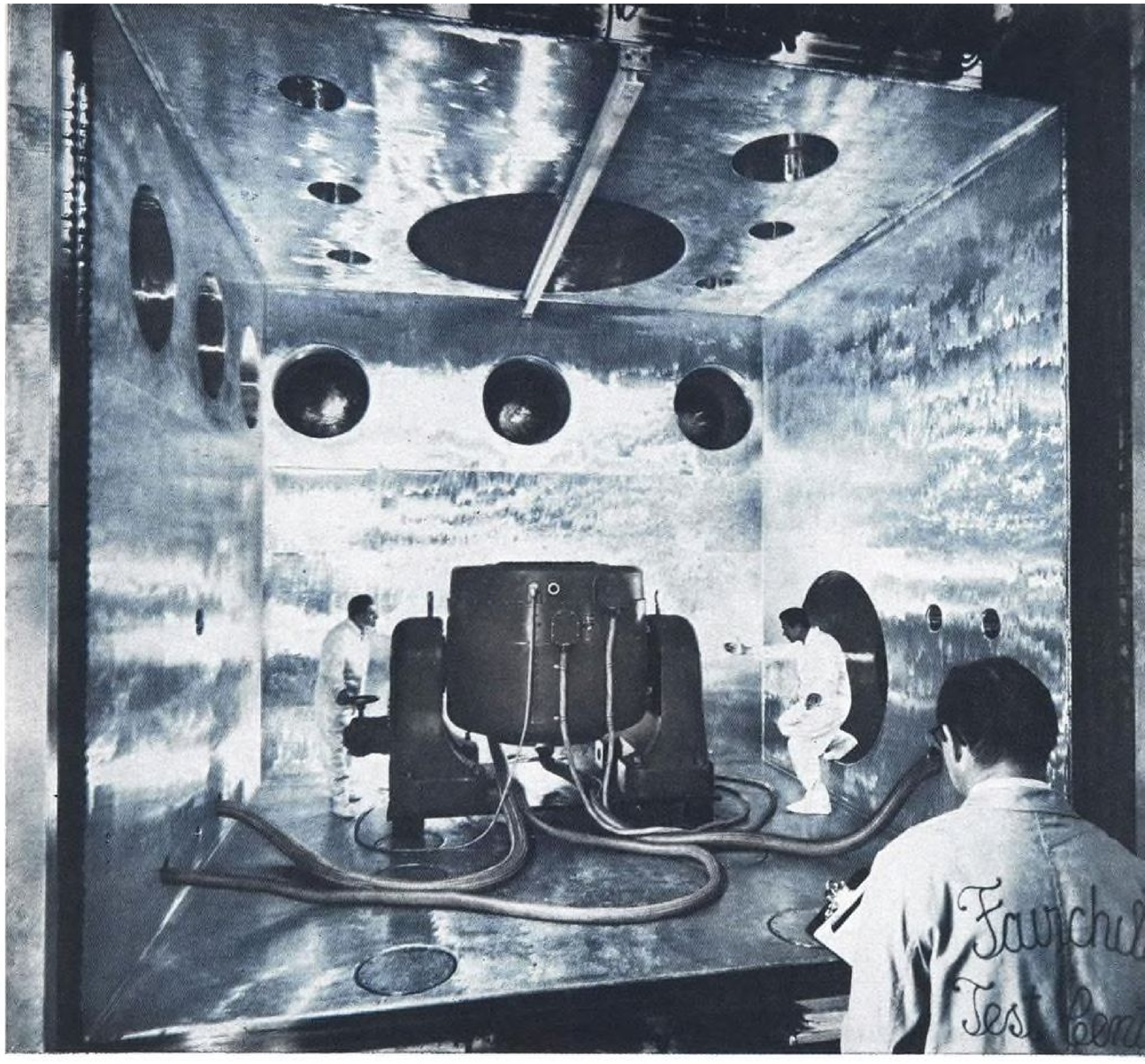
PHOTOELASTICITY



The analysis of stresses caused by thermal shrinkage has always been a knotty problem, especially in complex three-dimensional shapes. The two figures above compare the results of a complex analysis (A) with an experimental photoelastic study (B) so that even nonscientific members of the solid propellant community can see the progress we have made in three-dimensional stress analysis. The photoelastic picture shows the "fringes" from a slice of a thick-walled cylinder of photoelastic resin cast into a steel tube, with the resin shrinkage producing the same distribution of stresses that occur upon cooling a rocket motor. The analytical figure shows the calculated contours of tensile stress using the computer to handle the finite-length problem through the stress function technique. ■ The success demonstrated by these illustrations shows the progress that may be realized when scientists with diverse interests, such as stress analysts, grain designers, organic chemists, and rheologists, work toward a common goal in an environment conducive to research. Management people would say that we have improved our communication; we scientists say we have improved our ability to handle difficult design problems.

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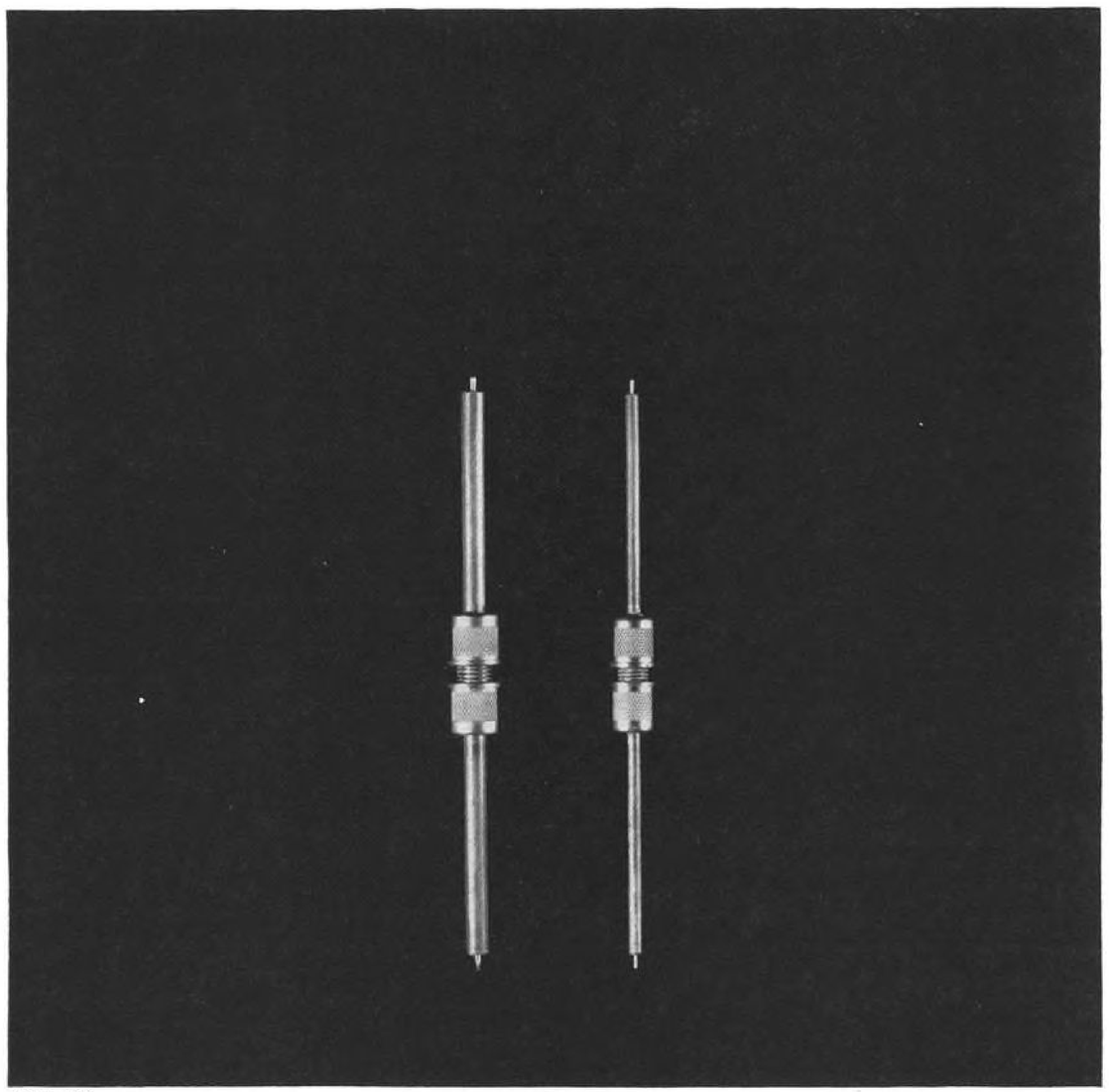
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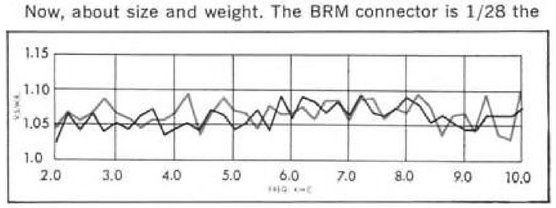
We have two new r-f connectors. They are wee ones.

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Scintilla Division

THE Bendix CORPORATION

August 27, 1962

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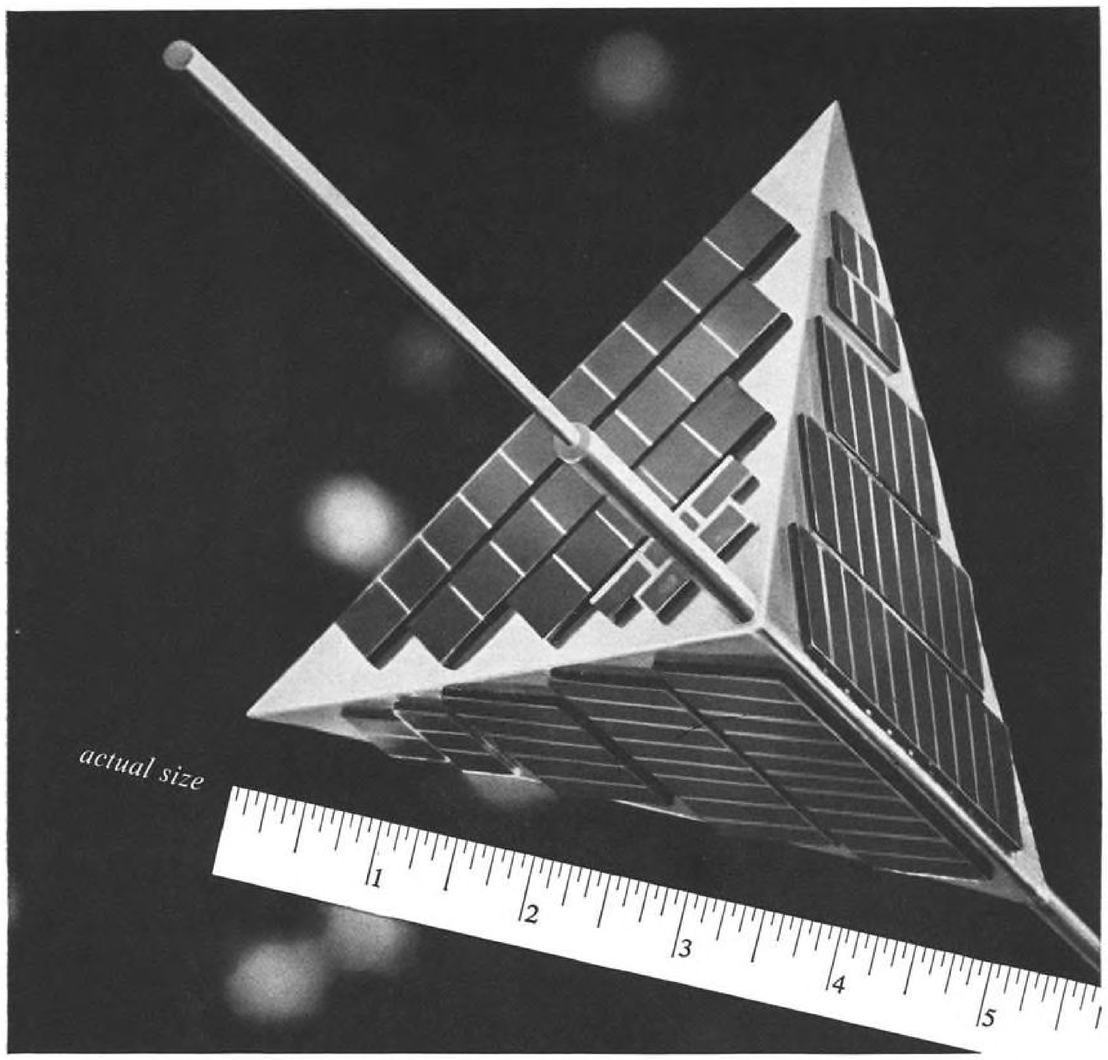
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COVER: McDonnell F4H-1 Phantom 2 two-place fighter, powered by two General Electric J79 engines, is now deployed overseas by the Navy and has been ordered in quantity by the Air Force, which calls it the F-110. The F4H-1 is the holder of numerous speed, time-to-climb and altitude records. It can act in the dual role of air superiority fighter and attack aircraft capable of delivering a variety of nuclear warheads and conventional weapons (AW July 30, p. 38).

PICTURE CREDITS

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EDITORIAL

Airlines and Airports

(Airport costs, rising faster than airline revenues, have become an increasing problem in airline operations. Some solutions to this and other airport-airline relationships were recommended to the Airport Operators Council annual meeting in Honolulu last week by Marshall D. Kochman, American Airlines vice president-properties and facilities, and key excerpts follow.)

How are we to work out airline-airport business and financial relationships? More precisely, how will landing fees and rentals be determined? Is there going to be some uniformly applied magic formula that considers depreciation, operating and maintenance costs, valuation of improvements, airlines revenues, prudent expenditures and consultants' expense accounts? I don't think so. Are fees and charges to be regulated by arbitrators, the CAB, the FAA, the State Public Service Commission or the Alcohol Control Board? I don't think so, although there is a good deal to be said for the proposition that airports and airlines must either work out their mutual problems or someone else will.

In my opinion, our financial relationships must still be worked out by individual airports and the airlines that serve them, for there is too much dissimilarity between airports, and, for that matter airlines, to permit pat or national solutions. This is not to say that there are not things we should be working on together on a national or industry basis, nor is it to say that we can't approach our individual airport problems in a more sophisticated and productive way, because we spend too much time arguing and we usually argue about the wrong things at the wrong time.

No matter how high you raise your rates, nor what arguments you use to justify increases, you cannot achieve self-sufficiency without activity and lots of it.

The airlines have one problem that you don't—excessive competition. But this problem will be solved, probably by mergers, and thereafter our financial stability and yours will depend on the continuing growth of air transportation, for only growth will increase activity and activity is the key to self-sufficiency.

Instead of haggling so long over rent and landing fees, we should first try to work out the airlines' role in your financial and construction plans. This isn't easy, but if we can reach an understanding on where you are going and what part you expect us to play, most of the delays, frustration and antagonism of later negotiations can be avoided.

I suggest that philosophical arguments about whole airports or unwhole airports, or cost and revenue allocations, have been developed by one or the other of us to support positions in individual negotiations, and offer no key to the solution of our problems. We both need cost accounting to manage our business, but cost accounting is a tool of management not a substitute for it.

If we ask for participation in your construction and financial planning, we must be able to participate responsibly and affirmatively. Many of our past problems arose from our inability as an industry to tell you what we needed. After all, you can't have a runway both 8,000 and 10,000 ft. long, nor can you provide gate departure rooms one day and not the next. This is our problem and many of us recognize it and are taking steps to solve it.

There is one element of tomorrow's costs that we can both do a lot to control. Every time you use net revenue bonds to finance improvements, you are getting 50 or 60, or at best, 70 cent dollars in return for the questionable advantage of withholding municipal credit.

There is another type of revenue bond financing that has been little used and is more complex to arrange, but will turn the 50 or 60, or 70 cent dollars back into whole dollars. These are gross revenue bonds. The difference is that the full faith and credit of the municipality is behind them.

For each $1,000,000 of 30 year net revenue bonds at 4½% interest with a 50% debt coverage, you have to repay $92,000 per year. For the same amount you could support $1,800,000 in gross revenue bonds. Entirely apart from debt service, the extra 1½% interest adds $340,000 to the cost of a 30 year $1,000,000 bond issue.

Aside from ease of issuance, do net revenue bonds have a real advantage to municipalities by permitting them to withhold their general credit? First, any airport financially sound enough to support net revenue bonds can support gross revenue bonds with less risk of default since the annual payments are smaller. But, it is argued, the taxpayers would have to come to the rescue if there was a default of gross revenue bonds and they would not in the case of default of net revenue bonds. How realistic is this argument? Would any major city stand by and watch the foreclosure of its principal airport? The price of this unlikely privilege is very high.

The Airport Operator's Council was born out of airline-airport controversy over fees and charges, yet this particular problem was soon to occupy very little of your time as you attacked the various mutual problems of the airports that had nothing to do with airlines, let alone airline landing fees and space rentals.

Yet this accident of birth has resulted in the Council and the airlines withdrawing from each other and this isolation has been to our mutual disadvantage. We have many areas of common interest and it is time we started working on them. To be specific:

• **Supersonic aircraft.** We all know what we went through on the jets. We will have to fly these aircraft into your airports so we'd better start looking at the problems now.

• **Aircraft noise.** Whether we talk about noisy airplanes or noisy airports our mutual concern about community noise problems is obvious.

• **Development of airport planning data.** Every time we want to know how much traffic a runway can handle or how many gate positions are required to accommodate a certain level of traffic, we seem to hire a consultant to tell us, but I suggest that a joint analysis of a representative number of existing airports might give us more accurate answers. Also, with the cost of airport improvements and aircraft operations so high we should find a way to measure the cost of delays and inefficiencies against the cost of corrective measures. Building new runways or even new airports is not necessarily the only answer to airport congestion.



WHO'S WHERE

In the Front Office

G. Howard Teeter, group vice president, Hoffman Electronics Corp., Los Angeles, Calif., responsible for the direction and coordination of the Military Products Division and Hoffman Science Center.

Maj. Gen. Robert B. Landry (USAF, ret.), a vice president, The Nuclear Corp. of America, Phoenix, Ariz. He formerly was aide to President Truman.

Dan T. Buist, president, Turco Products, Inc., Wilmington, Calif.

Stephan A. Keller, president, Telex, Inc., Minneapolis, Minn., succeeding **Arnold J. Ryden**, now board chairman.

Richard A. Fitzgerald, general counsel and corporate secretary, Frontier Airlines.

Earl P. Stevenson, former president and board chairman of Arthur D. Little, Inc., has been named chairman of the National Aeronautics and Space Administration's newly established Industrial Applications Advisory Committee.

Honors and Elections

James H. Kindelberger, deceased board chairman of North American Aviation, Inc., has been named the 1962 winner of the Daniel Guggenheim Medal, awarded by the American Society of Mechanical Engineers, Society of Automotive Engineers and the Institute of the Aerospace Sciences "for technical and industrial leadership in producing excellent aircraft and space equipment from early fighters to the X-15 space plane."

Changes

Donald Cotch, manager of the newly established Huntsville (Ala.) Office for Aircraft Armaments, Inc., and **Kenneth Daub**, assistant manager.

Arthur V. Sommer, executive assistant to the division manager, Arma Division, American Bosch Arma Corp., Garden City, N.Y. **Maurice J. Regan** succeeds Mr. Sommer as director of engineering and research.

Dr. James H. Guill, manager-advanced systems planning, Nuclear Space Programs Division, Lockheed Missiles & Space Co., Sunnyvale, Calif., responsible for all advanced nuclear space system studies and for exploring operational uses of the RIFT (Reactor in Flight Test) nuclear vehicle.

Andrew Kalitinsky, Nova program director, General Dynamics/Astronautics, San Diego, Calif.

W. Thomas Stark, aerospace product manager, Cleveland Pneumatic Industries, Inc., a subsidiary of PneumoDynamics Corp.

Edward L. Montgomery, assistant director, Space and Weapon Systems, Ford Motor Co.'s Aeronutronic Division.

William E. Goohs, manufacturing manager, Aircraft Engine Operations, Allison Division of General Motors Corp., Indianapolis, Ind., succeeding **Harold R. Laubach**, now assigned to the general manager's staff.

Dr. Charles H. Stockman, technical director, B. F. Goodrich Aerospace and Defense Products Division, Akron, Ohio.

(Continued on page 117)

INDUSTRY OBSERVER

► **Gemini engineering mockup review was held Aug. 15-16 at McDonnell Aircraft Corp. Major design change from configurations previously pictured was elimination of the ungula at the top of the capsule, which was designed to flip the capsule around if reaction jets failed. Wind tunnel tests showed the design would not work, and the small end of the spacecraft now is flat.**

► Installation of Sparrow 3 air-to-air missiles on West German air force Lockheed F-104G fighter aircraft has been studied by Raytheon and the Germans. The F-104G could carry a pair of the missiles with the necessary fire-control equipment housed in wing-tip pods. Cost considerations seem to be working against adoption of the missile.

► **Launch of the Anna-1B tri-service geodetic satellite, which was scheduled from Cape Canaveral Aug. 14 (AW Aug. 6, p. 32), will be delayed until the end of October because of difficulties with the payload. The Navy-managed program is scheduled to put the 355-lb. satellite into a 600-naut.-mi. circular orbit.**

► Air Force is considering the detonation of Minuteman ICBM stages in original test silos at Edwards AFB to determine blast effects in relation to safety requirements established for deployment of the missile at operational sites. Explosive effects of the first stage alone could be extrapolated to determine the hazard if all three stages were detonated in the silo. Edwards silos were built to test lift-out characteristics of tethered missiles.

► **Temporary interruption in receipt of telemetry signals from NASA's Orbiting Solar Observatory (OSO) earlier this summer, now is believed to be the result of nuclear testing over the Pacific. A failure in the UK-1 satellite also is attributed to effects of nuclear explosions.**

► Air Force has let three competitive development contracts for improved propellants for the Douglas Genie air-to-air nuclear-tipped missile motor. Recipients were Aerojet-General, Thiokol and Rocketdyne. After successful demonstration of the new Genie motors, production contracts covering a substantial quantity are expected to be let by the Procurement and Production Directorate of USAF's Ogden Air Materiel Area.

► **Project Orion, long-range Air Force-Atomic Energy Commission concept for propelling exceptionally large space vehicles with controlled nuclear explosions in space, may employ 300 to 400 nuclear device detonations for a single large spacecraft. The vehicle would measure about 80 ft. in diameter and 1,000 ft. in length. The aim is to harness about 30% of the energy released in the detonations for spacecraft propulsion.**

► Air Force Systems Command's Space Systems Division has dissolved its 698AN office, which had been responsible for administering a Martin-Marietta Co. contract for a manned space satellite surveillance system.

► **Revolving twin-barrel 20-mm. cannon is being considered by USAF as armament for the McDonnell F-110 and the later F-111 aircraft. The cannon, developed by Hughes Tool Co., is designated the Mark 11 and was originally designed for the Navy's A4D. The cannon is undergoing a reliability-development program and about 10,000 rounds are being fired each week. The weapon uses recoil gas energy to feed rounds to the firing chamber and is designed to be carried in a pod, which can be jettisoned.**

► University of Denver Research Institute's Industrial Economic Division is conducting a study of the commercial byproducts of the U.S. rocket and space programs for NASA. The survey includes a simple questionnaire sent to industry. Information submitted for the study will be confidential.

► **Space Technology Laboratories and International Electric Corp. are the leading contenders in Air Force Electronic Systems Division's competition to select study contractors for its range instrumentation planning study (AW Aug. 13, p. 75). The companies were among the top organizations in technical evaluation of proposals submitted last month.**

SILICOLOGY

REPORTING ON:

An Innovation in Silicone Technology

New OrganoFunctional Silicone Forms a Super-Thin Finish, Prevents Metal Corrosion

A new silicone metal protectant that *really* protects, without affecting dimensional tolerances or surface appearance, has been developed by Union Carbide scientists. Effective on all metals between magnesium and gold in the electromotive series, the new material prevents corrosion and tarnish indefinitely under a variety of service conditions.

Called UCAR 101 Silicone Metal Protectant, it is one of a whole family of OrganoFunctional Silicones that show unusually tenacious adhesion to metal surfaces when applied as films only 1/10,000 of an inch thin.



A copper conductive circuit board has been half-treated with UCAR 101 and then exposed to a sulphide atmosphere. While the unprotected half of the circuit board is greatly discolored, the treated portion retains its characteristic copper color.

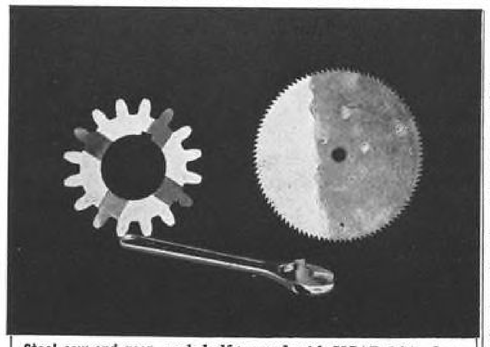
SPECIAL PROPERTIES

The UCAR 101 film offers greater protection than common commercial lacquers because it is absolutely free of pinholes that may become hidden sites for corrosive attack. And, because it is a truly non-porous coating that prevents moisture and oxygen from penetrating to the substrate metal, it is superior to plated coatings. It even surpasses the natural corrosion resistance of oxide films found on such metals as aluminum and stainless steel.

These benefits of UCAR 101 result from its extreme adhesion and exceptional continuity as an inert film. The bond it forms with a metal surface is far stronger than any organic film-to-metal bond observed previously. The bonding mechanism itself seems to be a form of chemisorption or hydrogen bonding that falls somewhere between a mechanical bond and a true chemical bond.

Although in the test tube UCAR 101 appears as an amber colored liquid, when it is applied to a metal surface its extreme and uniform thinness makes it virtually colorless. Since the film has no appreciable effect on dimensional characteristics, it is particularly useful on expensive parts machined to close tolerances. A corollary benefit of this thinness is high surface coverage, approximately 1,000 sq. ft. per gallon.

PERFORMANCE IS EXCEPTIONAL



Steel saw and gear, each half-treated with UCAR 101, show signs of corrosion on untreated portions after exposure for only 12 hours in an 85% relative humidity atmosphere.

Five years of laboratory testing show that UCAR 101 provides long-lasting protection against attack by environmental atmospheres containing sulphides and other corrosive materials in liquid, solid or gaseous form.

Copper, aluminum, brass, bronze, gold and other metals were coated with UCAR 101, immersed in hot detergents, and exposed to sodium sulphide. They showed no change in appearance. Yet similarly tested items, treated only with a common nitrocellulose lacquer, became tarnished and discolored. Other tests proved UCAR 101's ability to withstand continuous heat below 200°F and intermittent heat up to 250°F. UCAR 104, another version of this new silicone material, has been developed for use at higher temperatures.

VARIOUS WAYS TO APPLY

Application of UCAR 101 is simple. It can be sprayed, dipped, or wiped on. After 5 or 10 minutes of air drying, the treated object can be safely handled. Seven days of air drying, or 15 minutes of heating at 250°F, will completely cure the film. Immediate applications seem to be such items as electronics components, jewelry, hardware, household utensils, and machine parts.

Union Carbide is the leading innovator in silicones technology. New products, such as this metal protectant, are constantly developing. One reason for this is the great resource of technical capacities available within Union Carbide Corporation. To find out what's being done in silicones today (and tomorrow), contact your Silicones Man. He represents thousands of scientists and their coordinated abilities. Send in the coupon below for further information.

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Washington Roundup

McNamara's Approach

Defense Secretary Robert McNamara last week spent more than an hour with Sen. Howard Cannon discussing the senator's speech demanding an enlarged military space program (AW Aug. 20, p. 31).

McNamara agreed that many of Sen. Cannon's expressed fears about military space progress were justifiable but promised increased effort (see p. 34). The defense secretary told his press conference right after his meeting with Cannon that "I think it entirely appropriate that periodically the subject (of the military space program) be discussed."

Pentagon observers feel this statement by McNamara may help relax the restrictions on Defense officials who want to speak out on the military space program. McNamara also offered to meet with Pentagon correspondents on a more frequent basis, and invited them to complain if they felt they were not getting sufficient access to him.

In short, McNamara appears to realize that the military space role is becoming the primary defense issue, politically and otherwise—and he seems more disposed toward arguing his case in public. Sen. Cannon was pleased with McNamara's display of concern and said after the meeting: "I was somewhat reassured but still feel there is much more to be done than is now planned for enlarging the military's space role."

Military Space Potential

Sen. John Cooper, influential Kentucky Republican, has expressed concern that Russian superiority in military satellites might undercut the U.S. deterrent force. He shares the fear, held widely inside and out of government, that Russia may be perfecting rendezvous partly in order to knock down U.S. military satellites. Without the Samos satellites for reconnaissance and the Midas satellites for early warning of Soviet ballistic missile launchings, U.S. aircraft and missile forces would be robbed of much of their deterrent effect. Many U.S. observers believe Russia would not hesitate to knock down a Samos satellite if technical and political conditions were right—using the justification that it is a space-going U-2 and citing Russia's long-standing position that there is no upper limit to sovereignty in the air and space above a nation.

Next Soviet Spectacular

Some U.S. scientists believe the next Soviet space spectacular will be flown at an inclination to the equator of 49 deg. Because six of the eight Cosmos satellites have made extensive measurements on this trajectory. The other two, Cosmos 4 and 7, were launched on 65 deg. inclinations, apparently to sample the Vostok flight path environments.

Latest Cosmos, eighth in the series, was launched Aug. 18 at 49 deg. inclination. It is orbiting with a period of 92.9 min. between the altitudes of 375 and 159 mi.

Not only did the Vostoks' space rendezvous dim what President Kennedy last week called the "historic rendezvous" under the north polar ice cap of the U.S. nuclear submarines Skate and Sea Dragon, but this apocryphal story surfaced in the Pentagon—Cdr. Joseph L. Skoog of the Skate is supposed to have said to Cdr. Charles D. Summit of the Sea Dragon as they neared the meeting place: "Hello, Sea Dragon, is that you Charlie?" The reply: "Nyet."

USAF Management

Watch for Air Force Systems Command to begin shifting away from rigid observance of its special designated system "red line" project approach, in which a technical-management team is responsible for only one project. The projects are competing for technical and management talent, and there is not enough for this vertical approach. Result is that management of some of the red line systems is breaking down. In the future, management teams probably will be broken into specialty groups working on a number of projects rather than just one, except in a few high priority programs.

Systems office in NASA's Manned Space Flight Office is being expanded to include three directorates—studies, analyses and engineering. The latter will be headed by John A. Gautraud, manager of Avco's guidance and control department, beginning Sept. 1. Head of the systems office, Dr. Joseph F. Shea, is deputy to Brainerd Holmes, manned space flight director. Shea will have two deputies in the field, Richard J. Hayes at the Manned Spacecraft Center in Houston, Tex., and Dr. Arthur Rudolph at the Marshall Space Flight Center in Huntsville, Ala.

National Aeronautic Assn. is disputing claims of Col. Gen. Pyotr Braiko, Soviet Air Force chief of staff (see p. 36), about Russia's leading the U.S. in aviation records. The Association said Russia exaggerated the figures by including 63 parachute records and used Jan. 1, 1961, as the cut-off date—thus ignoring both 1961 and 1962, when the U.S. overtook Russia in certified aircraft records.

Navy Lt. Cdr. Scott Carpenter last week told NASA that he and his fellow astronauts have a suggestion for increasing booster reliability: **"Provide only canvas-covered blockhouses."**

—Washington Staff

Defense Management Policies Irk Services

Top Air Force, Navy, Army officers discuss united front to oppose the Pentagon's restrictive practices.

By Larry Booda

Washington—Possibility of presenting a united front against what are considered restrictive review practices by the Office of the Secretary of Defense in the study and development of new weapon systems is being discussed by top Air Force, Navy and Army officers.

Behind the move is increasing concern that no major weapon system has been permitted to move from the study phase to the development phase or from the development phase to production since the present Administration entered office in January, 1961. The services feel that the sense of urgency in important weapon programs is being weakened by a desire for economy.

These talks are aimed at exploring the best possible approach that could be made to Assistant Secretary of Defense (Comptroller) Charles J. Hitch and Director of Defense Research and Engineering Dr. Harold Brown to appeal for more speed in approving development and production of new weapon systems and release of funds for those purposes. There is no intention of making a massive assault on the program packaging concept, wherein similar forces, regardless of what service they belong to, are lumped together for the purposes of military requirements planning, budgeting and development.

Program Definition

The principal concern of senior military officers is an increasing tendency being shown by the Office of the Secretary of Defense to demand program definition to such a degree of perfection that this phase, also called Phase 1, is repeated or extended (AW Apr. 2, p. 22). This amounts, the officers say, to backing away from clear-cut decisions on development or production of a wide range of projects. It could also mean that by the time systems become operational, they will be obsolescent. Too much time is being traded for economy, these officers say. One officer remarked that if present programing and review practices had been applied to the ballistic missile development programs, they would have become operational in 35 years.

The principal tool being used by McNamara and his research and comptroller assistants to bring service procurement organizations into line is the statutory authority possessed by the Secretary of Defense to withhold or release part or all of funds appropriated by Congress for specific projects. It is being used widely now to withhold Fiscal 1963 money. Additional justifications are being demanded. In one sense, this power is being used as a lever to bring the services' Fiscal 1964 budget requests into line with Defense Department's preferences.

Until this year, Dr. Brown's office has concentrated on a wide variety of Air Force projects, demanding better management practices to prevent excessive cost overruns. Air Force officers say that as a result their project management has improved.

Close Scrutiny

The Army also was subjected to close scrutiny in its Nike Zeus anti-missile missile development program, which still lacks approval of concurrent production of long lead time components.

Because of Navy's success in making the Polaris submarine-launched ballistic missile system operational in five years, its projects had been relatively untouched until recently. Now it also finds what it considers important projects being delayed.

Several programs can be cited as the basis for the concern of the services. One is the USAF-Douglas Skybolt air-launched ballistic missile. Defense officials cite this program as their most glaring example of cost overruns and poor management by both the Air Force and the contractor.

The program was begun on a "crash" basis to provide a standoff nuclear weapon capability to the Boeing B-52 bomber in an increasingly hostile environment over Russia. It has been reviewed repeatedly by both the Air Force and defense officials. Its program cost goals have been shifted upward.

As of last July 1, a decision had been made to go ahead with production. Nevertheless, the project is still being delayed through incremental release of funds. The first increment enabled the project to continue through Aug. 15. Funds now have been provided for work through the end of this month.

Air Force officers say the program is suffering from the lack of a clear go-ahead approval. Release of funds in dribbles actually is increasing costs, they say, because no smooth flow of work can be planned. Attempts to separate the production phase from the development phase is unrealistic; waiting for development firing successes to make a final decision on production funds only aggravates the situation, they point out.

Another example is the Titan 3, or Standard Space Launch System 624A (see p. 27). This "workhorse" space booster has been the subject of discussion since last summer, when the joint National Aeronautics and Space Administration-Defense Golovin Committee first met to determine the basic configuration to be used. Last spring another group, the Brady Committee, re-evaluated the project (AW May 28, p. 29).

In the meantime, program definition studies were being made by selected subsystem contractors. An announcement of approval to begin development of the booster was expected last Aug. 15, as the Air Force had recommended. However, what amounts to another delay resulted. Funds for development will not be released until "definitive" contracts are signed. This can mean months of negotiations before actual development can begin. Under former rules, letter contracts could have been signed and work could have begun immediately.

Tri-Service Fighter

In February, 1961, Secretary of Defense Robert S. McNamara announced that a tri-service tactical fighter project (TFX) would be undertaken, combining the requirements of the Air Force, Navy and Army. The Air Force already had initiated a request for a tactical fighter program and Navy requirements were in the study phase.

In the intervening period, Army requirements were split off into another project, the varying requirements of the Air Force and Navy were compromised, and the proposals of six contractor teams for the Air Force-Navy project were evaluated. Two finalists were chosen early this year to make final proposals and were paid for their work. At the end of their restudy and re-evaluation periods, the two companies were sent back to redo their proposals. The earliest that a decision could be made would be Oct. 15, the end of the evaluation period. Defense officials maintain that the delays are due simply to their determination to keep competition in the study phase.

Air Force and Navy officers are privately betting that if the project enters development at all, it will be at least two years after the McNamara announcement of early last year. Air Force officers say that if they had been permitted to go ahead with their own TFX project, a prototype aircraft would have been flying in 1964. Estimates now range from 1966 to 1968.

Other Air Force projects which fall into the tightly controlled category are the North American RS-70 Mach 3 reconnaissance-strike aircraft, which is still in the study phase and is being evaluated by defense officials, and a number of space projects. A complete embargo was placed on advanced studies early last year by Defense, and only recently was permission granted to resume some of them (AW July 30, p. 16).

Many Air Force officers admit that their service has spread its talent too thinly over a wide variety of projects and that being restrained from initiating too many projects has been a good thing. But they stick to their basic premise that time is being wasted by requiring complete definition before contracts are let.

The Navy is feeling the pinch in one project, the North American A3J-3 supersonic reconnaissance aircraft, which is in the advanced stages of development (see p. 88). It would like to request funds for the production of 30 aircraft. Defense officials are inclined to demand demonstration of the system's capabilities before permitting production, however. The Navy would like to order production on long lead time components, at the least.

A similar situation exists with respect to the Grumman W2F-1.

The Navy also is feeling the effects of a close scrutiny of its Naval Tactical Data System, which would tie together all the elements of command and control for the fleets. The Typhon weapon system, a multi-purpose missile for ships, is also affected.

In addition to Nike Zeus, the Army has been forced to reduce the number of tactical missiles in its future inventory. Its plans to produce a follow-on to the de Havilland AC-1 STOL assault transport (AW July 23, p. 26) are also stalled in the defense secretary's office.

Anna Launch Delayed

Washington—Anna-1B geodetic satellite, scheduled for launch Aug. 14 (AW Aug. 6, p. 32), will not be launched until October because of a fear that the effects of the radiation belt caused by the July 9 U.S. high-altitude nuclear detonation (see p. 32) might prematurely degrade the payload solar cells. This is in addition to initial troubles with the payload (see p. 23).

The satellite is scheduled to be launched into a 600-mi. circular orbit, which is near the altitude of peak intensity of the new belt.

DOD Plans Changes in Systems Acquisition

Los Angeles—Use of a program definition phase in the development of major weapon systems prior to the firm selection of final contractors will permit expanded use of fixed price and cost-plus-incentive-fee type contracts, Assistant Secretary of Defense John H. Rubel told the Western Electronic Manufacturers Assn. here last week.

As a result of using the new technique on the Titan 3 program, Rubel said, about 70% of the dollar value of contracts for its development will be of the fixed price and incentive fee type. The technique also has been used in the mobile medium-range ballistic missile and the Army's new Marshall tactical missile.

"Proposals submitted by contractors will be an important factor in selecting contractors for the program definition phase," Rubel said, "but are not the only factor and not necessarily, in many cases, the decisive factor." During the program definition phase, the selected contractors will work together to accomplish those initial steps that have to be taken anyway before a development project can be accomplished, Rubel said. These include over-all system design and analysis, subsystem design and analysis, and descriptions of problems and requirements at the interfaces between major subsystems. In many cases, this will include the opening phases of laboratory experimentation and design.

During the program definition phase, the nucleus organization around which the full-scale project will grow is set up, Rubel said, and management mechanisms such as PERT and PERT/Cost are prepared and submitted for review.

Rubel conceded that some of these steps could be attempted without a formal program definition phase by individual prospective contractors or by management groups such as Aerospace Corp. But an important difference is that under the program definition phase the contractors who later will be responsible for the actual development are working together across the entire spectrum of project activities, he said. Those who hold project management during the initial phase have the opportunity to demonstrate how effectively or ineffectively they can manage the subsequent development.

In areas of higher-than-average technical risk or where it is difficult to choose between two approaches, Defense Department will support two contractors in competition throughout the program definition phase, selecting one for the subsequent development program based on performance and achievement, Rubel said. Support for development of advanced subsystems which are not earmarked for a specific weapon system is planned, Rubel said, to assure that the necessary building blocks will be available for weapon systems. One example, cited by Rubel will be a family of highly reliable components for guidance systems. Defense Department hopes to standardize on a few major subsystems, such as guidance, to achieve the reliability and economy which come from repetitive use, Rubel said.

Titan 3 Funds Await Negotiations

Washington—Funds for development of the Titan 3 space booster will not be released by Defense Secretary Robert S. McNamara until what are described as "definitized" contracts are signed by the Air Force and the major subsystem contractors. A Defense official says this will take four to six weeks.

What this amounts to is an extension of the Phase 1, or program definition phase of development, until contracts are negotiated. It could result in substantial changes being made to systems studies that already have been completed. Contractors were paid for program planning and are being paid small amounts through the negotiation phase.

Instead of announcing approval of the development phase of the 624A Standard Space Launching System, as had long been expected, the Defense Department simply announced that the Martin Co. has been chosen as the systems integration contractor. Congress has appropriated $204 million for the 624A system for Fiscal 1963. The entire program cost is estimated at $808 million.

Titan 3 will employ a modified version of the Titan 2 guidance system which is produced by the AC Spark Plug Division of General Motors Corp. Space Technology Laboratories, Inc., and American Bosch Arma Corp. were notified last May 2 that they would be chosen to develop a new guidance system.

Titan 2 System

The AC Spark Plug guidance system will be almost identical with the Titan 2 system except for minor modifications to the platform to accommodate it to the greater maneuverability requirements of the Titan 3. There will also be additional cooling equipment for the guidance package.

This change reveals thinking in the



De Havilland Red Top Mounted on Lightning

First photo of the de Havilland Red Top infrared homing missile shows it mounted on an English Electric Lightning. Missile is a second generation version of the de Havilland Firestreak, which the Royal Air Force says has had 85% operational success rate in firing tests, both in lethal near misses and in direct hits. Note blunt nose on Red Top in contrast to sharp nose previously shown on model of missile.

Office of the Director of Defense Research and Engineering which favored using a guidance system already in being. The opposite point of view, held by the Air Force, was that the existing system would have to be modified and that it is not easy to alter a highly sensitive system.

When they were notified last week that AC Spark Plug had been chosen to make a modified Titan 2 guidance system, STL and Arma were told that they were top contenders for an advanced system. This is unexplained, because there has been no announcement of possible development of a follow-on system.

STL was to have been the prime contractor, doing about 40% of the work in the form of the ground checkout equipment and accessory equipment. Arma was to furnish the same types of gyros and accelerometers used in the Atlas missile guidance system, a newly designed lightweight platform and a newly developed digital computer version which recently started laboratory tests but has not had flight tests. The proposed STL-Arma system weighs 100 lb. less than the Titan 2 system.

Arma, after the May 2 notification, began reorganizing its staff and doing some research using company funds. Unless Arma can obtain a contract for the guidance system of the planned mobile mid-range ballistic missile it will lose the money it has invested in miniaturized computers. Employment at Arma is dropping due to the phase-out of the Atlas production.

The Titan 3 program calls for development of an integrate-transfer-launch complex (ITL), which will permit it to be completely assembled and checked out in the assembly area, then moved intact to a simplified launch pad. This will reduce the time spent on the launch pad and consequently the number of pads required.

United Technology Corp. has been chosen to negotiate on development of the 120 in. five segment solid propellant motors, while Aerojet-General will provide the liquid fuel motors for the second, third and fourth stages.

Martin previously had been awarded a contract to complete a program definition Phase 1 study. Now, in addition to the systems integration task, it will be responsible for the airframe modifications of the Titan 2 core to enable it to take the strap-on solid-propellant engines and the structure for the fourth, or top stage.

Under the present definition, Titan 3 will have two basic configurations. One will be the four stage vehicle with the strap-on engines. The other will utilize the Titan 2 and upper stages, without the 120 in. engines.

Trading of Martin Marietta stock on the New York Stock Exchange Aug. 6 through 10 was very heavy—429,467 shares—but in a very narrow range between 20 and 20⅝. During the week after the Russian Vostok launches, but prior to the Titan 3 announcement, trading rose to 472,500 shares and the stock rose to 24⅜, outpacing most other aerospace company stocks.

Lunar Supply Studies Sought by 18 Bidders

Washington – Eighteen companies have submitted proposals to conduct three-month engineering studies on a lunar supply system consisting of two hardware items which may become a part of the Apollo manned lunar landing project (AW Aug. 13, p. 30).

Eleven companies are bidding on the spacecraft bus study, and 13 on the payload study. One of the bus proposals is from General Electric Co., and National Aeronautics and Space Administration's legal office is attempting to determine whether GE is eligible to compete for this study in view of the integration and checkout contract it has with NASA covering the entire manned space flight vehicle program.

Terms of the integration and checkout contract restrict GE to second-tier and lower subcontracts in manned flight systems, but whether this limitation includes studies has yet to be determined.

Invitations to bid on the payload study went to 28 firms. Spacecraft bids went to 24 companies. NASA has emphasized that success of the Apollo mission does not depend on developing the lunar logistics system, but says such a system will increase the value of the project. The agency expects to select two payload study contractors and a single bus study contractor in a month.

Companies submitting bids on both studies were General Dynamics, Hughes, Lockheed, Martin, North American Aviation and Northrop. Bidding on the payload study were Ford Aeronutronic, American Machine & Foundry, Bendix, General Motors, Grumman, Westinghouse, and Radio Corp. of America. Bidding on the bus study in addition to GE were Boeing, Douglas, Space Technology Laboratories and United Aircraft Corp.

Comsat Approval

Washington—Bitterly controversial legislation establishing a privately-financed corporation to develop and operate a communications satellite system probably will go to the President for signature this week or next.

Final hurdle to enactment was overcome when the Senate voted 66-11 to pass the measure, following a formidable talkathon and delaying tactics by opponents who favored government ownership and operation of the system, or government ownership and private operation under contract.

The House, which passed the legislation 354 to 9 last May, was under heavy pressure last week to agree to Senate changes, which were not substantial.

Navy Studies Management Reorganization

By Katherine Johnsen

Washington—Congressional circles expect a major reorganization of the management of Navy's weapons research, development and procurement next year, along the lines of Army's new Materiel Command and Air Force's Systems Command and Logistics Command, as an outcome of a comprehensive Navy management study launched by Secretary of Navy Fred Korth.

Navy's weapons research and procurement activities now are widely decentralized, with the major activities organized under the Bureau of Weapons and the Bureau of Ships.

Details of the top-to-bottom management study were presented last week to the House military operations subcommittee by James H. Wakelin, assistant secretary of the Navy for research and development. He told the subcommittee, headed by Rep. Chet Holifield (D.-Calif.), that Korth has directed that "this review must be comprehensive and in sufficient depth to encompass the management and interrelationships of all major programs directed by the department in the fulfillment of the requirements of the operating forces. . . ."

Six Areas

The review is under the general direction of John H. Dillon, administrative assistant to Korth, and is divided into six major areas: material management; facilities management; financial management; manpower management; planning, programing, budgeting, and appraisal management; and research and development management. The material area is under the supervision of Rear Adm. R. E. M. Ward, former chief of Navy legislative affairs. The research and development area is under Rear Adm. Rawson Bennett, retired, former chief of naval research.

The six major studies, together with a study of external relationships and specific component studies of internal organizations, are planned to provide "complete coverage" of department management processes, Wakelin said.

The research and development study, he said, is department-wide, cutting across all organizational lines, and includes a separate review of the organization and management processes of the Office of Naval Research, the research and development components of the Office of Chief of Naval Operations, and Navy bureaus and offices. It includes investigation of planning, budgeting, funding and reporting, organization and management, operations and procedures, and research and development personnel, Wakelin added.

Meanwhile, Navy has rejected further use of individual management and funding for its high-priority projects, Wakelin told the subcommittee.

Initially used by Navy with notable success in its nuclear submarine and Polaris programs, individual project management is now being used by Air Force in its major programs and has been adopted by the Army as the key to its new weapons research-development-procurement approach. Finn J. Larsen, assistant secretary of the Army for research and development, told the subcommittee earlier that Army has already selected 29 projects for individual management and funding and that eventually 50% of Army's materiel program will be under this type of management (AW Aug. 20, p. 36).

Weapons Development

Vice Adm. W. F. Raborn, deputy chief of naval operations for development and former project director for the Polaris program, who accompanied Wakelin, interjected: "May I say I admire very much the way the Army has taken an aggressive approach to the use of project offices for their many projects."

Wakelin said the Navy is taking these steps to improve weapons development:

- **Review of each major** development project on a regularly scheduled basis for the secretary of navy. "Each program manager is required to present problem areas and to discuss proposed courses of action," Wakelin said. "These continual reviews will expedite timely management decisions at important stages in the development program."
- **Increased emphasis** on formal detailed planning. The research development, test, and evaluation program will be regularly checked across-the-board for elimination of duplication, to take advantage of technical advances, and to adjust emphasis in programs.
- **Development and operation** of prototypes at in-house laboratories. "The desirability of having the scientific and technical personnel in our Navy laboratories deeply involved in the practical development and operation of the prototype systems is evident in terms of strengthening the laboratory as well as achieving an improved system and the requisite training for the Navy operators," Wakelin said.

Navy is now re-examining the missions and technical programs of each of its 45 laboratories—38 operated by Navy and 7 operated under contract.

As presented to the subcommittee, Navy's plan for operations research, technical direction and systems engineering by outside specialist organizations—while not as extensive—follows the general Air Force pattern.

Navy uses these three organizations:

- **Center of Naval Analyses,** recently organized by Franklin Institute Laboratories at Navy's request. All operations research for Navy was consolidated in CNA last July 1. This included activities formerly performed by the Operations Evaluation Group of Massachusetts Institute of Technology and the Institute of Naval Studies of the Institute for Defense Analyses. Its functions will be comparable to those of Rand Corp. for Air Force and Research Analysis Corp. for the Army.

The center will perform analyses of immediate and long-range naval warfare problems and, through operations research, interpret advances in science and technology in terms of naval hardware, weapons systems, long-range logistics and long-range strategic planning.

- **Applied Physics Laboratory** of Johns Hopkins University, which performs $40 million a year worth of systems design and engineering for Navy. APL's main projects are: typhon anti-air warfare system, which reflects 40% of its total effort; satellite navigation system, about 25% of total effort; Polaris strategic missile system, about 16%; and Terrier, Talos, and Tartar anti-air warfare missiles, about 15%.

Transit Navigation

APL initiated development of the Transit satellite navigation system, which was subsequently sponsored by Advanced Research Projects Agency and now by Navy. APL monitors Navy contractors and has had as many as 30 representatives at one time in a plant.

- **Silver Spring Laboratory** of Vitro Corp., which performs about $30 million a year in Navy business. Vitro begins its participation as systems engineering coordinator in Navy programs as projects advance from the development stage into production. It is now engineering coordinator for Terrier, Talos, Typhon, and Polaris.

Vitro also is a hardware development contractor with Navy in the area of underwater technology. Frank B. Jewett, Vitro president, told the subcommittee that in this area, the company has been involved in the full range of weapon systems development from concept, systems analysis and evaluation through hardware development to prototype fabrication, field testing and small-quantity production.

The functions of APL and Vitro are comparable to those of Space Technology Laboratories and Aerospace Corp. for Air Force. Army performs its systems engineering in-house.

MA-7 Proves Scientific Observer Value

Houston, Tex.—Second Mercury orbital flight is being evaluated by National Aeronautics and Space Administration as adding a new dimension to man's value in space—that of a highly effective scientific observer.

Growing indications of government and industry interest in the Mercury spacecraft as a scientific laboratory also was in evidence at NASA's report at the Manned Spacecraft Center here on Lt. Cdr. M. Scott Carpenter's MA-7 three orbit flight May 24.

The Center has set up a nine member Mercury Scientific Experiment Panel to sift what is termed an increasing number of requests, not only from within NASA, but also from industry and universities for experiments they want carried on Mercury missions.

Experiment panel is composed of Lewis R. Fisher, chairman, Mercury project office, John H. Boynton, Mercury project office, Karl F. Greil, Mercury project technical adviser, Paul R. Spencer, systems evaluation and development division, office of assistant director, research and development, Dr. Robert B. Voas, technical assistant to MSC director on human factors, Warren Gillespie, space physics division, office of research and development, Frank W. Casey, Jr., spacecraft research division, office of research and development, Arthur M. Busch, preflight operations division, MSC (Cape Canaveral) and John Hodge, flight operations division.

Final Decision

Final decision on which experiments are to be included is generally withheld until very close to flight date, with sponsors asked to fund their share of the program until go or no-go decision time by the panel. Astronauts are represented on the panel to ensure that experiment workload does not compromise operational safety aspects of the mission.

Specific examples of Carpenter's scientific observation capabilities were described by John A. O'Keefe, assistant chief of the theoretical division at Goddard Space Flight Center. The astronaut showed a great deal of skill and presence of mind in making measurements of the luminous layer at the horizon, O'Keefe said. This phenomena, reported by Col. John Glenn following his MA-6 flight, had been considered by scientists to be the result of a reflection of the horizon between the spacecraft's window layers. Glenn disagreed with this explanation.

Carpenter's observations made possible identification of three physical characteristics of this airglow layer: wavelength, brightness and height. Considered particularly ingenious was Carpenter's development of evidence of height—by making a direct estimate of from 8-10 deg., by noting the luminous layer is approximately twice the height of the twilight layer, by observing the star Phecda as it passed the middle of the luminous band, by noting the time when the star was halfway from the luminous band to the horizon, and by noting that when the cross of a reticle scribed in the spacecraft window is set diagonally, the horizontal bar just covers the distance from the band to the horizon.

Carpenter was also credited with improvising the decisive experiment of hitting the walls of his spacecraft with his hand. The appearance of large numbers of particles provided some clue to the Glenn Effect—at least indicating that those observed in the MA-7 flight were the result of something emanating from the spacecraft. O'Keefe believes the snowflake-like phenomenon is the result of condensation of steam from the life support system, probably occurring in the space between the heat shield and large pressure bulkhead, escaping into space through the ports, driven outward by the expanding vapor.

The astronaut noted that the horizon provided a good roll and pitch reference as long as it was visible through the window, but yaw reference was a problem. The best reference was obtained by pitching down 50 deg. to 70 deg. and looking through the window. The periscope also provided another good reference at nearly any attitude. The zero-pitch mark on the periscope was valuable as well for aligning the gyros. At night, yaw attitude is difficult to determine, he said, the best reference being a known star on the spacecraft's orbital path.

MA-7 achieved a total of 1 hr. 17 min. drift flight, of which 1 hr. 6 min. during the final orbit were continuous, primarily aimed at conserving fuel. Spacecraft attitude drift rates of 0.5 deg./sec. or less were generally typical of this drift period and Carpenter reported that drift flight was not disturbing and that he was not concerned when external references were temporarily unavailable. This indicated that drift flight, in addition to conserving fuel, will be valuable because it will permit an astronaut to accomplish a number of useful activities and experiments without concern to spacecraft orientation.

Other highlights of the presentations:

• **Only 1.6 lb. of control fuel** were used by Carpenter in manually performing turnaround of the MA-7 after separation of spacecraft from the launch vehicle. This compared with more than 4 lb. of fuel used in past flight experience using the automatic control system for this maneuver.

• **Although ground communications** network performance for MA-7 was considered generally better than for MA-6, ground-to-spacecraft HF and UHF communications were considered slightly inferior to MA-6. The signal level on the earlier mission was two to five times greater than for MA-7.

• **Astronaut's difficulty** in maintaining proper water flow setting for his suit cooling system was due primarily to a 30-min. lag in the cooling system in response to a change in the valve setting.

• **Pitch horizon scanner** circuit error, believed introduced during the launch, introduced a bias of some 20 deg. in comparing horizon scanner outputs in the automatic stabilization control system to spacecraft attitude. This resulted in failure of ASCS to maintain proper attitude when engaged by Carpenter over Hawaii in preparation for retrofire and the re-entry phase.

Rapid Pile-up

An indication of how occupation with scientific studies overtook the astronaut near the end of the flight resulting in rapid pile-up of tasks in brief remaining period is seen in resume of pilot performance. Resume notes that Carpenter had begun observing and photographing the space particles some 11 min. prior to retrofire, which delayed him in completing storage of on-board equipment and accomplishing the pre-retrosequence check list. A few minutes later, he engaged the manual system as back-up to the automatic system, then switched spacecraft control to the ASCS and almost immediately reported the discrepancy between indicated attitudes and those observed through the window. He then had five minutes remaining to analyze the ASCS failure problem and re-check his manual control mode. About 30 sec. before retrofire, he again checked the ASCS orientation mode and MA-7 went to excessively low-pitch attitude, so Carpenter quickly switched from automatic to fly-by-wire mode and manually realigned the spacecraft.

While making the switch in control systems, he inadvertently failed to disable the manual proportional system and thus used double-authority control during retrofire, rapidly depleting control fuel. He thus had some 15% of automatic system fuel to last out the 10 min. to 0.05g and to control the re-entry.

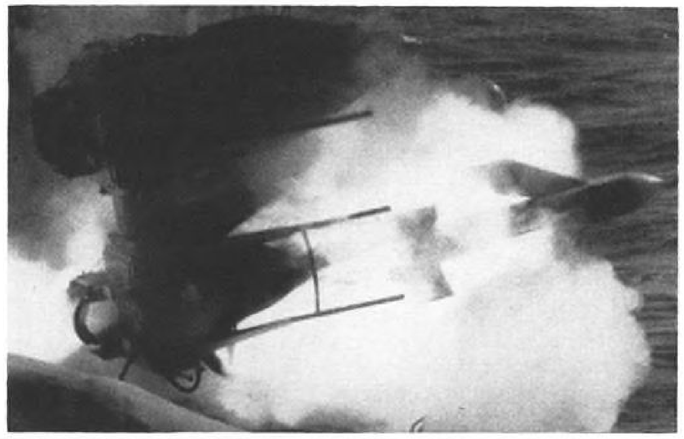


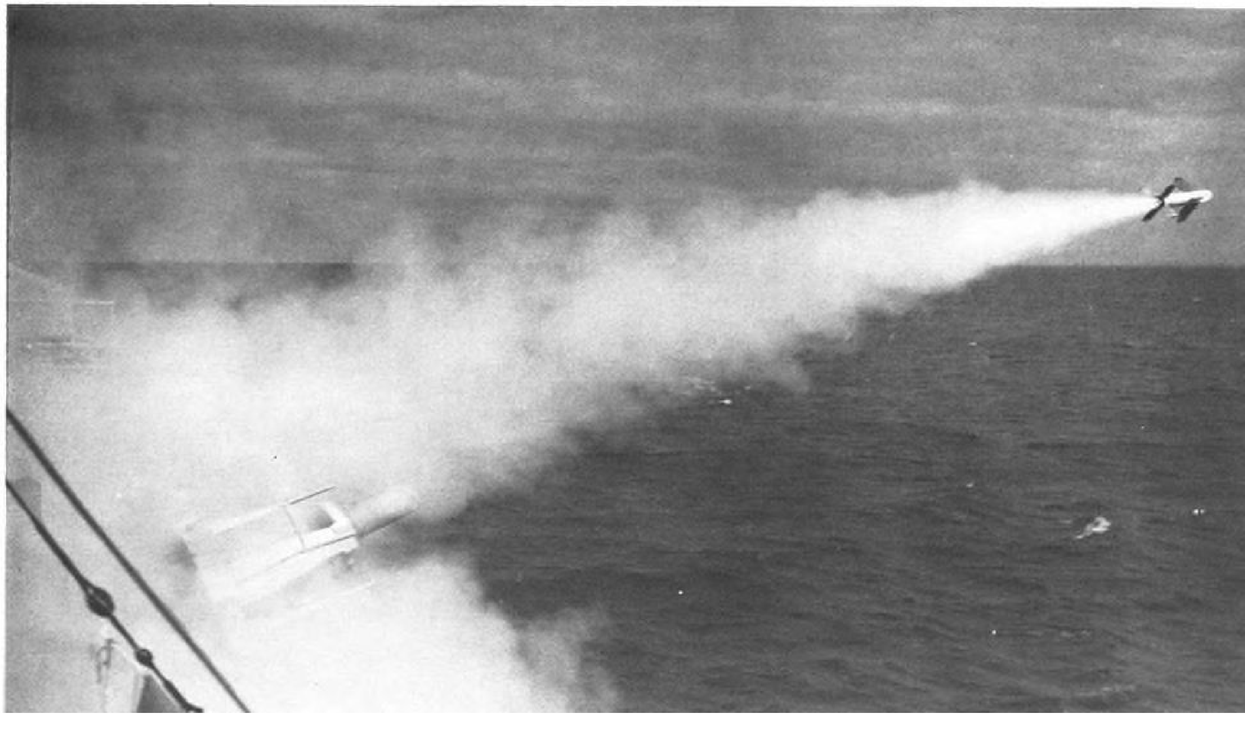


Short Seacat ship-to-air missile, in a protective canister, is loaded onto launching platform aboard HMS Decoy during acceptance tests. Fully loaded launcher is at right with four missiles in place. Control unit is in background.

Short Seacat Missile Firing From Ship Shown in Sequence

Missile leaves launcher, right, and is controlled by sweptback, movable wings. Seacat is 4 ft., 10 in. long. Below, Seacat departs ship on way to target. Development was begun four years ago and acceptance trials were completed in about 12 months. Seacat has been purchased by Sweden, West Germany, Australia and New Zealand in addition to British Royal Navy.





U.S. Atom Test Blamed for Vostok Delay

Washington—Soviet Russia has protested that the new belt of radiation caused by the U.S. high-altitude nuclear detonation last July 9 delayed the flights of Vostoks 3 and 4, but the U.S. maintains that the test produced no hazards to manned space flight.

The new belt is between the earth and the inner zone of the Van Allen belt, but is well above the trajectory planned for the Mercury flight of Cdr. Walter M. Schirra next month. Effects from the test are not expected to delay this launch.

The U.S. test over Johnston Island was made at an altitude of about 200 mi. The explosion was in the two-megaton yield class. The density of the lower edge of the Van Allen belt was increased by injection of high energy electrons immediately after the detonation. New lower limit of radiation is ragged. It begins at an altitude of about 200 mi. over the mid-latitudes in the southern hemisphere, and at an altitude of about 500 mi. over the equator.

The peak is believed to be at an altitude of 800 mi., where the flux is about 1.5 million electron volts (mev.). Inner zone of the belt is normally dominated by high-energy protons with fluxes greater than 30 mev., which peak at 700 mev. at an altitude of about 6,300 mi.

Dr. James A. Van Allen of the State University of Iowa, for whom the region of trapped radiation was named, confirmed last week that the existence of the new zone was known immediately after the detonation. On Aug. 21, during a Vostok 3 and 4 news conference, Mstislav V. Keldysh, president of the USSR Academy of Sciences, said: "It was impossible to send a man into space for a long time after the American explosion. At present, too, it is impossible to send a man into higher orbits in space. Our scientists and our cosmonauts believe that a disservice was rendered to space research by America's high-altitude explosion," he said.

Soviet Russia detonated a nuclear device with a yield of several megatons Aug. 20 and another Aug. 22.

These atmospheric tests by the Russians were not reported in the USSR.

Radiation monitoring instruments, probably Geiger tubes and scintillation counters, were carried aboard both Vostoks, and the Soviet cosmonauts had individual radiation detectors, Moscow said. In addition, the spacecraft carried bio-packs consisting of bacteria, fruit flies, chlorella, seeds and other biological specimens, with radiation detectors, Moscow said.

However, Soviet Russia gave no indication of concern over the effects of the July 9 test until after the presence of the new zone of trapped radiation was reported in the U.S. On Aug. 12, the day after the Vostok 3 launch, Russia officially requested that the U.S. halt nuclear testing while its manned flights were under way. The request was regarded as transparent propaganda, since Russia was aware that the Thor launch stand used for U.S. high-altitude tests had been damaged (AW Aug. 6, p. 35) and could not be used for 6-8 weeks. Russia apparently was satisfied from measurements returned by Cosmos 7 that the orbital paths planned for Vostoks 3 and 4 were safe.

Cosmos 7 was launched on July 28, 19 days after the test, at an inclination of 64.95 deg. to the equator. Apogee was 219 mi. and perigee was 126 mi. Apogee of Vostok 3 was 122.5 mi. and apogee of Vostok 4 was 129 mi.

Project Mercury

Concern over the effects of high-altitude nuclear explosions on manned flight plans has been expressed by the Project Mercury support force. But it centered on the delay that unannounced Soviet tests might cause if one occurred during a Mercury countdown and affected communications. In a joint Defense Department-Atomic Energy Commission statement last week, the U.S. took the position that the new belt presents no hazard on earth, in the atmosphere or to manned space flight—the latter because the new radiation is above the path of current manned flights.

Van Allen said, however, that the new zone is a potential hazard for manned flight. Defense Department, AEC and the National Aeronautics and Space Administration are making what they call a detailed study to determine any possible hazards.

Nature of the studies was not explained but they probably will consist of the assessment of data from satellites which pass through the zone and from radio telescopes able to determine the existence of high-energy particles. Data taken from radio telescopes since the test indicate fairly rapid particle decay.

Greatest hazard to manned flight is believed by Van Allen to be in X-ray emissions, which cannot be detected from the ground.

NASA is confident that the shielding provided by the Mercury capsule structure and pressure suit is sufficient to afford the astronaut protection during his flight.

Van Allen forecast last May 28 that nuclear detonation in the upper atmosphere would disrupt the inner zone of trapped radiation and cause a perturbation in the earth's magnetic field. As spokesman for a presidential advisory committee formed to review effects of high-altitude tests on natural radiation, Van Allen said any effects will be short-lived.

The Argus high-altitude nuclear experiments in mid-1958 proved that the earth's magnetic field is sufficiently strong to trap electrons and protons released from nuclear detonations.

Force field at an altitude of 200 mi. over the mid-latitudes in the southern hemisphere varies between 39,000 and 52,000 gammas, about 86% of that on the surface of the earth. At the equator, the force field is 20,000 to 30,000 gammas, about 70% of the field on the earth's surface.

Solar cells on several U.S. satellites showed some degradation after they flew through the new high-density radiation zone. Telstar was affected but is still operating satisfactorily.

Joint U.S.-British Ariel satellite was silent for a brief period, but has returned to satisfactory operation.

Solar cells on Navy's Transit 4 and TRAAC satellites also were affected.

ICBM Site Defense Studied

New series of parallel advanced studies aimed at developing a terminal ballistic missile defense system possibly built around an extremely high-acceleration version of Nike Zeus, called Nike Sprint (solid propellant rocket intercept) for the purpose of point defense of the nation's ICBM bases, are being conducted separately by the Army Ordnance Missile Command and Advanced Research Projects Agency.

Three-part contract for a system study, known as Hardpoint, currently is being negotiated with three aerospace companies by ARPA. The three are American Machine & Foundry, Hughes Aircraft Co. and Maxson Electronics.

Proposal requests for a study of a high-acceleration Zeus defense missile, which is expected to be capable of bettering the already high-acceleration of the Army's Nike Zeus anti-missile missile by a factor of five or six, are due to be issued by AOMC momentarily. This will be conducted under a program called Hardsite.

Essential idea behind both Hardsite and Hardpoint is to give the Air Force's hardened Atlas, Titan and Minuteman ICBM sites additional defense against ballistic missile attack with their own anti-missile missile system. Hence, the name Hardsite defense, or Hardpoint defense as it was known in original studies conducted nearly two years ago by many aerospace companies working under Air Force's Study Requirement 79813.

Under Hardsite or Hardpoint concepts, a small volume or corridor, which hostile missiles would have to penetrate in an assault against a hardened missile site, would be calculated and protected by detection and acquisition radar systems and special Nike Sprint sites. The intention would be to defend only the hardened sites or "hard points."

Against enemy warheads coming in through this narrow corridor, an extremely simplified guidance system could be used for Sprint missile compared with that required for Nike Zeus. The missiles would be designed to make an intercept 4-5 sec. after launch at an altitude above 50,000 ft., where explosion of a multi-megaton warhead would not produce sufficient overpressure to damage U.S. hardened missile sites. The Nike Sprint probably would not employ a nuclear warhead.

The Hardpoint studies began about two years ago as an outgrowth of SR 79813 which concerned hardened site equipment and its vulnerability. A series of studies, several of them funded, were conducted for Rome Air Development Center by a number of aerospace companies including Martin Marietta, United Aircraft, Hughes, Raytheon, General Dynamics and Republic Aviation. These efforts, then known as Hark (Hardened Re-entry Kill), were completed in 1961 and taken away from USAF on the ground that terminal ballistic missile defense is Army's responsibility.

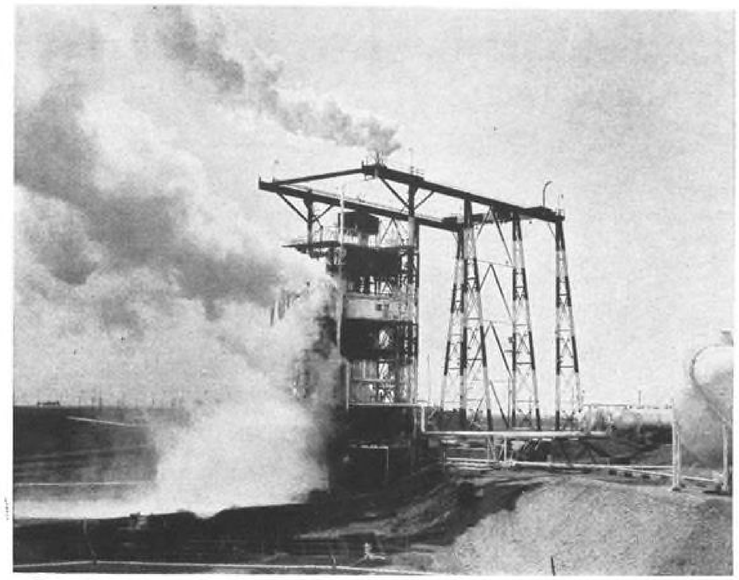
Russians Banned

London—Society of British Aircraft Constructors, sponsors of the annual Farnborough Air Show, have been enjoined by Ministry of Aviation from issuing invitations to Russian industry and air force representatives to attend the three private showings Sept. 3-5.

Edict banning the Russians dates back to last year's show when a tentative agreement was made to allow senior British engineers and executives to visit various Soviet aircraft centers on a reciprocal basis. Since then, nothing has been heard from the Russians, according to the ministry. Russian design team, led by Sergei Ilyushin, spent considerable time inspecting the Vickers VC. 10 line last year.

Soviet representatives, however, will be allowed to purchase tickets and attend the public showings Sept. 6-10, days which usually attract up to 100,000 persons. As one industry spokesman put it:

"All it means is that the Russians will have to queue up for sausage rolls and chips, instead of free-loading in the president's enclosure.



Six-Engine Saturn S-4 Undergoes Initial Firing

First full-scale firing of clustered liquid-hydrogen liquid-oxygen engines of Saturn S-4 occurred recently at Douglas Aircraft Co.'s Sacramento facility. Douglas Missile and Space Systems Division is the prime contractor for the S-4 which is the second stage of the C-1 rocket. Firing demonstrated feasibility of the S-4 advanced propulsion system. Six Pratt & Whitney RL-10 engines produce a total thrust of 90,000 lb.

Rolls Running Wind Tunnel Tests On RB. 175-Powered VTOL Model

London—Rolls-Royce is running wind tunnel tests on a VTOL transport model designed to use the company's front-fan RB.175 pure-lift engine, a development of the RB.162 which powers the Dassault Mirage 3V VTOL strike fighter (AW Aug. 6, p. 81).

The transport is an entry in the NATO NMBR-4 tactical transport competition. Powerplant configuration probably is a mixture of the RB.175 pure-lift engines packaged on the wings, and operating in tandem with vectored thrust propulsion jets.

First Stage

The RB.175 uses RB.162 as a gas generator first stage. Fan engine work at Rolls, done under Ministry of Aviation contract, is aimed at sound suppression, due to larger mass flow provided by the front fan, and tests have been under way for some time with a unit designated the RB.144. Ducting in the RB.175 also would include chambers for further sound suppression.

Rolls' chief competitor in the VTOL powerplant field, Bristol Siddeley, has been negotiating with Pratt & Whitney for license rights to its BS.53 Pegasus family of vectored thrust engines. The company also is developing the BS.59, a pure-lift engine aimed at the 8,000-lb.-thrust class.

Adrian L. Lombard, Rolls director of engineering, said the RB.162, designed for a 16:1 thrust/weight ratio, probably will be brought to a 20:1 ratio eventually.

Plastics Used

The engine uses glass-fiber-reinforced plastics extensively in about half its bulk. Plastic components include half of the casing around the cold section and inlet guide vanes and dome. The turbine wheel is made of titanium.

Engine pressure ratio is 4:1 and design thrust is 4,400 lb. Rolls has completed 500 starts and runs the engine for 5 min. on bench testing, although operational use will be on the order of 30 sec. The single-stage, single-shaft engine has been kept as simple as possible.

For instance, installation time is only 15 min. with connections needed only at mounting points, the bleed air inlet and the instrumentation plug-in.

The oil system, which provides a squirt on each of the two bearings at start-up, is designed from a turbopump system built for English Electric Lightning fighter afterburner system.

U.S. to Increase Military Space Funds

By George C. Wilson

Washington – Kennedy Administration will enlarge the military's space role in Fiscal 1964 in the hope of reducing the lead that Soviet Russia dramatized with the orbital flight and rendezvous of Vostoks 3 and 4.

President Kennedy, Secretary of Defense Robert S. McNamara and other Administration officials are stressing that the increases for military space activities planned for the budget to be requested from Congress next January were not prompted by the Russian achievement but are part of the continuing effort to win the space race.

But it is admitted privately within the Administration that the Vostok flights are helping to overcome the arguments against a substantially enlarged military space program. As one Administration official put it: "The Vostoks are breaking the complacency of people like Dr. Harold Brown," director of Defense Research and Engineering, who steadfastly has maintained that there currently are no demonstrable, unmet military requirements in space.

Significantly, McNamara early last week asked the Air Force for its program for space—a request which caught that service by surprise. Air Force officials did not have a comprehensive, agreed-upon program prepared, but rushed to draft one for McNamara's consideration.

Outside the Kennedy Administration, the Vostok flights are bringing demands for a revamped national space program featuring a larger military role. Sen. Alexander Wiley (R.-Wis.), ranking Republican on both the Senate Aeronautical and Space Sciences and the Foreign Relations committees, is asking for special congressional hearings because "the Soviet success in orbiting Vostok 3 and 4 raises new questions about the military dangers to free world security."

The Vostok flights also brought at least one charge that the nation was suffering from ultra-conservative leadership within the National Aeronautics and Space Administration. Robert C. Truax, advanced development director at Aerojet-General Corp.'s Liquid Rocket Plant at Sacramento, Calif., and a former Defense Department official, made this statement before the House space committee. "We have got to take bigger steps," he said in criticizing the NASA program.

Sen. Thomas J. Dodd (D.-Conn.), a member of the Senate space committee, late last week joined Sens. Howard W. Cannon (D.-Nev.) and Barry Goldwater (R.-Ariz.) in demanding a larger space role for the military. He said the nation cannot rely exclusively on NASA's manned space flight program, and said the Defense Department should undertake one of its own.

Chairman Robert S. Kerr (D.-Okla.) of the Senate space committee and Chairman George P. Miller (D.-Calif.) of the House space committee tried to still these and other fears expressed about the national space program by declaring that the U.S. was on a sensible course and should stick to it.

Rep. Miller is preparing a speech along this line for delivery soon. He said right after the Vostok flights: "I am not panicked by what was done . . . I don't think that this indicates any great breakthrough." He did tell AVIATION WEEK, however, that the Vostok flights did demonstrate that the U.S. was behind in bioastronautics—the science of keeping men alive in space for extended periods.

As the week drew to a close, it was clear that the question of the military's proper role in space was being discussed more heatedly than at any time since President Kennedy took office. One ironic twist is that the Kennedy Administration has clamped such a tight secrecy lid on military space activities that it may have difficulty rebutting charges that too little is being done in that field.

The major reactions to the Vostok flights:

• **President Kennedy.** "We are second to the Soviet Union in long-range boosters," he said at his Aug. 22 press conference. "I have said from the beginning we started late. We have been behind. It is a tremendous job to build a booster of the size that the Soviet Union is talking about, and also have it much larger size, which we are presently engaged in the Saturn program. So we are behind and we are going to be behind for a while. But I believe before the end of this decade is out, the United States will be ahead.

"But it is costing us a tremendous amount of money. We are presently making a tremendous effort in research and development. But we just might as well realize that when we started late—last year as you know—we made a decision to go to the moon, with bipartisan support, and it is going to take us quite a while to catch up with a very advanced program which the Soviets are directing, and there is no indication the Soviets are going to quit . . . So anybody who attempts to suggest that we are not behind misleads the American people. We are well behind, but we are making a tremendous effort."

Asked if the space program should be expanded to proceed on a crash basis, the President did not answer directly but indicated he felt this would be too costly. He noted that NASA was already building a large booster and that other efforts are currently concentrated on guidance and navigation systems.

"The fact of the matter is that 40% of the R&D funds in this country are being spent for space," the President said, "and that is a tremendous amount of money and a tremendous concentration of our scientific effort . . . There is a great interrelationship between space—military—and the peaceful use of space. But we are concentrating on the peaceful use of space, which will also help us protect our security if that becomes essential."

Asked if he planned any change in the division of funding between NASA and the Defense Department, he said Defense was considering "whether there are further steps that might be taken to protect our security. But I want to emphasize that the distinction [between civilian and military space spending] which is made by some does not seem to me to be wholly applicable. The important things at the present time, as I said, are the size of the booster and the size of the satellite and the navigational control. Now, those are carried on by both the Defense Department and by NASA, but of course the information is interrelated and also whatever skills we acquire in those three areas are interrelated and serve many purposes."

Asked if he saw any military significance in the Vostok flights, the President said: "Well of course. We are not quite clear as to what the military significance will be because at the present time it is possible to send a missile from one country to another with a warhead, and with a great degree of accuracy. But it is very possible that there will develop military significance, and it is for that reason that the military program is being carried on at $1.5 billion. And there is also of course the benefits we get from the civilian space program which we are spending many billions of dollars on in these three areas, which can tie in, if necessary, into the military field."

• **Secretary McNamara.** He said Aug. 21 that "the recent launching of the cosmonauts does not by itself cause us to change our Fis. l 1964 program. The Fiscal 1964 program when initially developed a year ago, and as it will be changed before it is presented to Congress, took account of the fact that the Soviets were substantially ahead of us in certain aspects, particularly the large booster capability."

In a subsequent television interview, McNamara said no additional space projects would be added to the Fiscal 1963 military budget, "but we do need some for Fiscal 1964 . . . By that time we will have learned enough to add new projects."

McNamara called the Fiscal 1963 military space budget of $1.5 billion "a very substantial amount of money" which is about triple the Fiscal 1960 and double the Fiscal 1961 budget figures. Ever since President Kennedy last year asked for supplemental military space funds for Fiscal 1962, "we have been working on an accelerated military space program," he said.

Asked about the military implications of the Vostok flights, McNamara said the Soviets used "boosters with capacities far in excess of those which we have at the present time. And I think it has been known for some time that they had that capability. And it is an important capability . . . Their thrust is far larger than ours and it is to correct this deficiency in our launch vehicle program that we have carried out the series of projects that culminated in yesterday's announcement of the placement of the initial contracts on Titan 3 . . . I think they [the Russians] have demonstrated sophisticated guidance and control capability, which we assumed previously they had and which was not therefore new information to us. I think we aren't able to match the Soviet feat until we have larger and different types of boosters and it's for that purpose that we are designing the advance booster family of which Titan 3 is one illustration."

U. S. Missiles

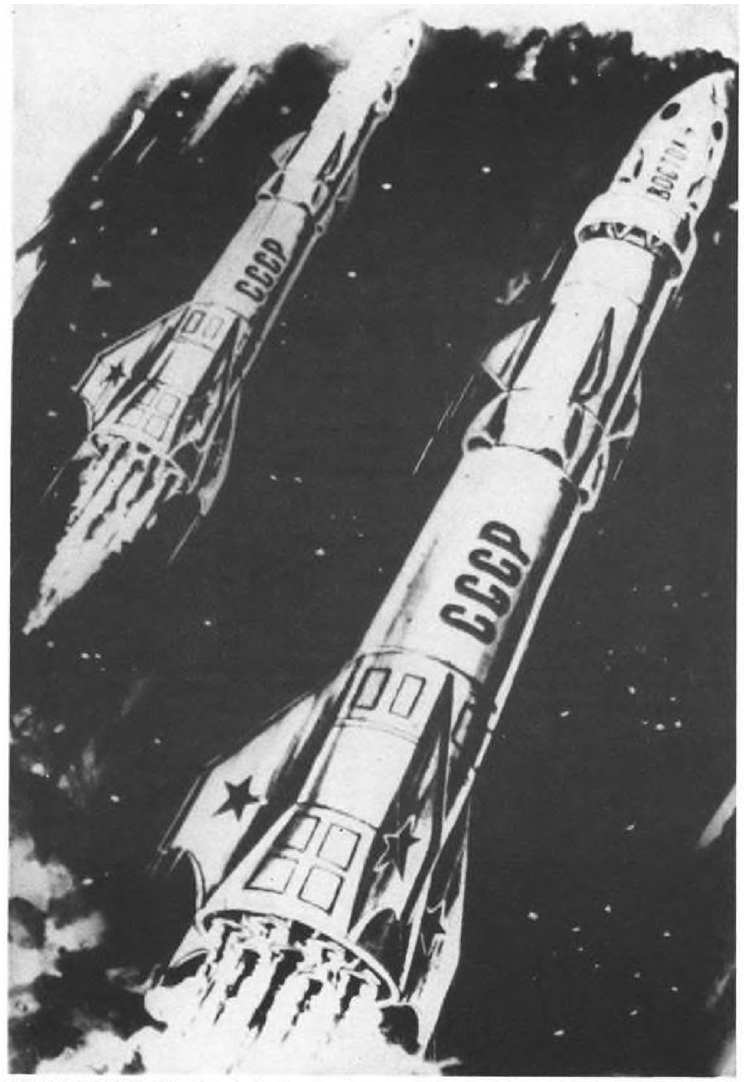
As for fears over the possibility that Russian space ships could confuse the guidance system of U.S. missiles, McNamara said: "The history of technology in technical and scientific development is that the inconceivable becomes the conceivable at a later time. Therefore, I don't want to say categorically that any particular scientific or technological development is impossible.

"But I see no immediate possibility of the Soviets being able in any way to restrict the performance of our missile systems. Quite the contrary. We have very carefully and very recently reviewed this, and we think our command and control of those weapons and the procedures and systems associated with the command and control are invulnerable."

• **Sen. Dodd.** He said in a speech prepared for delivery Aug. 24 that the U.S. should "at the earliest possible date" build a manned space laboratory for testing weapons and develop manned military space vehicles which "hold the key to ultimate supremacy in space." He said the armed services as well as NASA should be given the vehicles, developed by the space agency. He recommended further that representatives of the armed services sit in as advisers during meetings of the National Aeronautics and Space Council. The Secretary of Defense is a member of the council.

• **Truax,** a former Navy pilot who served as military staff assistant to the head of Defense's Advanced Research Projects Agency, said NASA's leaders are not taking big enough steps. For example, he said the space program would have been farther along if the initial manned flight had been designed to orbit a capsule containing two astronauts and boosted by an Atlas-Agena. If we had "gone for the big step, looked a little farther downstream, we could have done many things such as rendezvous, getting out of the capsule, things which would give us a larger range capability and would contribute more to a really full capability in space," Truax said.

• **Dr. Arthur Kantrowitz,** director of the Avco-Everett Research Laboratory. He said last week before the National Rocket Club that "the elaboration of space technology will lead to new decisive weapons and the most likely way in which the ICBM stalemate will finally be broken is by space-based weapons. If we wait until it is demonstrated that a weapon can be space based it will be too late. Those who make the claim of demonstration must eventually bear the blame."



SOVIET DRAWING in Pravda by "one at the scene" purportedly is Vostok 3 (right) and 4. Capsules have circular section similar to that on mockup at Tushino (AW July 17, 1961, p. 30), but appear to have two hatches or ports instead of the one on the mockup. Booster first stage has seven engines, one at the center and six on the perimeter.

U.S., Soviets Disagree on Rendezvous

Significance of the latest Soviet manned space flights deepened last week when Russia claimed that Vostoks 3 and 4 came within 3.1 mi. of each other—a distance that contrasted sharply with the official public stand taken by the U.S. that the two spacecraft were never closer than 75-100 mi.

Defense Department would not make public any figure of the minimum distance between the two Vostoks by late last week.

U.S. had evidence shortly after the launch of Vostok 4 that the two spacecraft rendezvoused and docked, but after considerable discussion decided not to make this information public (AW Aug. 20, p. 26).

The only U.S. agency which has made a public statement on the distance between the two Vostoks is the National Aeronautics and Space Administration, which does not track foreign satellites but depends on information supplied by the Air Force for comments it makes regarding orbital elements of these flights. NASA said the two Vostoks were never closer than 75 mi., and added that a better estimate is 100 mi. The agency maintained this position late last week, despite the Soviet claim of Aug. 21 and the earlier information on the docking.

Defense Secretary Robert S. McNamara said last week he has "no information that would lead me to believe that they rendezvoused and docked." Asked to comment on the discrepancy between the Russian statement and the official U.S. position, McNamara said: "I personally haven't seen the final results of the analysis of tracking data and therefore I can't speak authoritatively on it. But I did talk to the Air Force this morning [Aug. 21] in connection with some other matters. Do we have any indication—is there any evidence at all that they rendezvoused and/or docked? And the answer definitely was, No. I cannot, however, answer your question as to the specific minimum interval between them in terms of miles."

Sir Bernard Lovell of Jodrell Bank Observatory in Great Britain said he cannot determine point of closest approach of the Vostoks because the two spacecraft on Aug. 12 "were too close for us [the Jodrell Bank antenna] to separate, that is, the separation was only a few miles at most. If a rendezvous took place," he said, "it was probably during the first few orbits after the [Vostok 4] launching."

He said Jodrell Bank obtained a voice recording of Lt. Col. Pavel Popovich, pilot of Vostok 4, early in his flight in which he stated "that he was turning and maneuvering his space ship. From our contacts on Aug. 13," Lovell said, "the spaceships were moving apart in accordance with their differing orbital paths."

One tracking plot obtained in the U.S. indicates the point of closest approach was about 3 mi., the same reported by the Russians. The plot did not indicate maneuvering. During the joint flight, the plot was confused by interference that later was attributed to the decaying orbit of the spent vehicle used to launch Vostok 3.

In Moscow, meanwhile, the Vostok cosmonauts maintained the usual Soviet pattern of declining to respond to questions on details of their flights, spacecraft or launch vehicles. They supplied this new information at a series of public appearances that included a four-hour press conference at Moscow University:

• **Rendezvous:** Maj. Andrian Nikolayev, pilot of Vostok 3, said " . . . Vostok 4 spaceship, piloted by my friend, appeared on the orbit next to my spaceship. We immediately established two-way radio communications. . . . " Lt. Col. Popovich, the Vostok 4 pilot, said Vostok 3 looked to him "like a small moon." Nikolayev said the flight program did not provide for bringing the spacecraft closer together, but he commented "we were ready to shake each other's hand."

• **Landing:** Accomplished by personal parachutes in a technique similar to that used by Maj. Gherman Titov in Vostok 2. Russia had said earlier that both Nikolayev and Popovich came down in their spacecraft, but the cosmonauts revealed that they parachuted to earth about 124 mi. apart near Karaganda.

• **Launch vehicle and spacecraft:** No information was provided about launch vehicles. Mstislav Keldysh, president of the USSR Academy of Sciences, said rockets are necessary for defense and are therefore considered secret. Spacecraft were only vaguely described as similar to Vostoks 1 and 2, weighing about five tons (see box below). They were said to be more advanced and more comfortable than the earlier craft.

There is a belief that Russia used an improved version of its earlier launch vehicle for Vostoks 3 and 4, and that this version was man-rated on the first seven Cosmos satellite launchings. Russia has always provided satellite weight figures at the time of launch until the Cosmos series began last Mar. 16. No weight for Vostoks 3 and 4 was given until a week after the manned missions was completed. Figure of five metric tons would be about the same as the weights of Vostoks 1 and 2, which were 10,434 and 10,408 lb. respectively.

• **Medical and biological findings:** No pathological changes discovered. No nystagmus, or involuntary eye movement associated with vertigo. Pulse and respiration figures were reported as: Nikolayev, 70-75 beats/min. and 10-12 breaths/min. four hours before flight. Popovich figures were 78-82 pulse and 14-16 breathing rates.

Five minutes before flight, Nikolayev's pulse had risen to 115 and breath rate was 12. Popovich recorded pulse rate of 110 and breath rate of 28.

During launch and boost, Nikolayev's pulse ranged between 105-120 and breathing was 10; Popovich's pulse frequency was 105-130 and his breathing had dropped to 10.

During orbital flight, pulses of both stabilized at a rate of 60-70, and their breath rates at 10-15.

In a Pravda article Aug. 20, A. A. Genin and O. O. Gazenko, identified as doctors of biological sciences, said most of the medical research program was devoted to studying the cosmonauts' ability to work by comparing conditions, volume and quality of the way they performed in space.

One of the psychological tests involved arithmetic exercises with groups of figures from their logbooks. They were programed to call out geometric figures in some cases, read lists of figures in horizontal and vertical columns, add, subtract, multiply and divide.

Another test was assessment of the vestibular apparatus, which caused severe illness to Titov during his flight (AW May 14, p. 29). Both Nikolayev and Popovich deliberately made rapid head movements, as did U. S. Astronauts Lt. Col. John H. Glenn and Lt. Cdr. Scott Carpenter.

Both Soviet pilots said they did not dream while they slept in orbit. Nikolayev said he awoke three times during his first night in space, once on his second night and then overslept 10 min. on his fourth night.

Nikolayev admitted to momentary concern on re-entry, when g-forces exceeded six and smoke and flame were visible through his port. He described the flame as red, orange, yellow, green and blue. He said he heard crackling of flames from the ablative heat shield and felt oscillations during the final stages of re-entry.

During their press conference, Nikolayev and Popovich repeatedly stressed the theme that their flights were made for peaceful, scientific purposes, but Soviet Defense Minister Marshal Rodion Malinovsky said in a message congratulating the two that their flights "should serve as a warning to the enemies of the Soviet Union."

Three days after landing, Nikolayev and Popovich were brought to Moscow for a Red Square celebration. Soviet Air Force Day was celebrated on Aug. 19, a day earlier than it had been scheduled, to coincide with their reception. The militant Soviet theme continued, with the air force chief of staff, Col. Gen. Pyotr Braiko serving as spokesman:

"The Soviet Union," he said, "continues leading confidently in development of aviation and cosmonautics, outstripping the strongest capitalistic air force power—the United States."

Braiko said Russia holds 228 of 502 world records in aviation, "while the United States holds only 134 records." He said Russia has set 60 new world aviation records this year.

The cosmonauts' news conference was opened by Keldysh, who said the ground network in the Soviet Union permitted communications with the pilots at distances in excess of 6,200 mi. He added that valuable data has been obtained on the propagation of radio waves where laws governing such propagation are not known.

Prof. Vladimir Yazdovsky summarized the biological findings, and a Ukrainian academician, Yevginy Babsky earlier explained the purpose of the unusual nystagmus experiment. Nikolayev apparently was the research subject and Popovich the control subject in this experiment, and silver electrodes were attached to the corners of Nikolayev's eyes.

Photographs released of this pilot in flight appeared to be retouched to remove the instruments.

Babsky implied that it has been theorized that long-term flights will upset the vestibular apparatus, and eye movements are indicators of these changes. Both pilots said during the conference that they experienced no nausea.

Comments by Academician Leonid Sedov and Prof. Karl Gilzon indicated that re-entry and landing maneuvers of the Vostoks are ground-controlled. Sedov said the most difficult task of safe satellite recovery had been solved ". . . thanks to the creation in the USSR of a powerful rocket of exceptional reliability and precision of automatic control."

Gilzon said re-entry is assured, no matter what the spacecraft attitude. He said if retrorockets fail, the Vostoks have enough food and life support consumables to last through a natural decay, which would occur sometime within 5-12 days.

Titov's spacecraft, he said, contained supplies sufficient for a 12-day flight.

Soviet news agency Tass said Nikolayev will claim records for orbital and non-orbital altitude, orbital flight duration, orbital and non-orbital distance traveled and orbital and non-orbital weight (see box, p. 36). Tass did not differentiate between Soviet and world record claims, however, and it is unlikely that the pilot will claim the altitude mark. Mercury flights of Glenn and Carpenter were higher than the Vostoks—160 mi. for Glenn, 164 mi. for Carpenter, and 157 mi. for both Nikolayev and Popovich.

Vostok 3 Weight

Washington—Soviet news agency Tass said Maj. Andrian Nikolayev will claim a record for orbital and non-orbital payloads, which lends credence to the belief that the Vostok 3 spacecraft was larger than earlier Vostoks. Weight given for Vostok 3 at a news conference in Moscow (see story) was "about 5 tons."

Vostok 1 weighed 10,434 lb., and Federation Aeronautique Internationale will consider only those claims which are at least 10% greater than existing records. This means that Vostok 3 would have to have had an orbital weight of 11,477.4 lb. for the claim to be made, whether it is a national or a world record claim.

Origin of Space Particles

Moscow—Soviet Cosmonauts Andrian Nikolayev and Pavel Popovich last week said they saw luminous particles, first reported by U. S. Astronaut John Glenn, but the Russian pilots said the particles are engine exhaust gases. They did not specify whether they referred to an attitude control system or on-board propulsion.

Extensive U. S. laboratory tests indicate the particles are caused either by snow formed by condensation of water vapor from the life support system or by small particles of dust, waste, bits of insulation or other sweepings. Dr. John A. O'Keefe of Goddard Space Flight Center, reporting at the Mercury Atlas-7 technical conference in Houston (see p. 30), believes the particles are ice crystals.

Cosmonaut Radiation

Moscow—Only traces of radiation were received by Maj. Andrian Nikolayev and Lt. Col. Pavel Popovich during their space flights in Vostoks 3 and 4, in spite of the Soviet claim that the U. S. had contaminated space with July 9 high altitude nuclear explosion (see p. 32). Total radiation dose during the flights was 50 millirad for Nikolayev and 36 millirad for Popovich.

Rad is a Roentgen unit dose for ionizing radiation. U. S. has calculated that transit through the Van Allen radiation belts would result in doses of under 6 rads. Man has survived doses of several hundred rads.

News Digest

Hughes Aircraft Co. has won Army competition for development of tube-launched, optically-tracked, wire-guided anti-tank assault weapon system. Martin Marietta and McDonnell were the other two competitors.

Crash of a London-bound DC-8 last week in Rio de Janeiro, Brazil, occurred when the aircraft did not rotate during takeoff roll, swerved off a 10,000 ft. runway at Galeao International Airport and sank in Guanabara Bay. At least 13 of the 104 persons aboard were killed. Pilot used full reverse thrust in attempting to stop the takeoff roll. Aircraft had made a hard landing three weeks earlier and damaged an engine pylon.

India will build the Russian RD-9 turbojet engine as powerplant for the Indian HF-24 supersonic fighter, Defense Minister Krishna Menon told the Indian parliament. Manufacture will be carried out at the Hindustan Aircraft plant at Bangalore (AW July 23, p. 24).

Three Lockheed U-2 reconnaissance planes last week began upper altitude sampling flights from the Royal Air Force station at Upper Heyford. The planes were flown to England from the U.S. Air Force base at Plattsburgh, N.Y.

Litton Industries first LN-3 inertial navigation system for the NATO F-104G was recently delivered to West Germany's Federal Ministry of Defense (AW Aug. 13, p. 92).

Goddard Space Flight Center has awarded $100,000 solar observatory study contracts to Ball Brothers, Republic Aviation and Space Technology Laboratories. Center also awarded $1.3 million contract to Dalmo-Victor and Amelco for 10 satellite automatic tracking antenna systems, called Satan. Norair Co. won a $2 million contract to construct a space sciences laboratory at Goddard.

Northrop N-156 fighter has been redesignated the F-5A by USAF. AVIATION WEEK incorrectly reported that the trainer version, the T-38, had been given the F-5A designation (Aug. 13, p. 35).

George Hedman, vice president of public relations for Scandinavian Airlines System, died last week at the age of 60. Hedman joined the airline when it was founded in 1946.

Supplementals Face Strict Renewal Policy

First eight applications rejected for violations; CAB dispenses with usual lengthy legal procedures.

By Robert H. Cook

Washington—Fewer than half of the supplemental airlines seeking two-year extensions of their operating rights under a recent congressional compromise bill are expected to be in operation by the end of Civil Aeronautics Board hearings, which must be concluded by early October (AW July 9, p. 30).

Lengthy legal procedures usually employed by CAB in certificate renewal cases have been swept aside by congressional demands that the Board act on all individual applications for supplemental authority no later than 90 days after passage of the bill.

Supplementals were given a 30-day deadline for filing of certificate renewals that would permit them to continue carrying individually ticketed passengers for a two-year period, after which their operations would be limited to charter flights.

CAB attorneys, relying primarily on a voluminous list of both CAB and Federal Aviation Agency violations committed in the past by supplementals, last week rejected the first eight applications filed and indicated that more rejections may be expected. Those rejected within 10 days of their filing, primarily on grounds of "flagrant disregard" of economic and safety regulations as well as financial incompetence, were: United States Overseas Airways, Standard Airways, Sourdough Air Transport, Paramount Airlines, Admiral Airways, Air Cargo Express, Associated Air Transport and Blatz Airlines. Each carrier has 10 days to reply to any opposition registered against their applications.

Trunk airlines are unanimous in their objections to the supplemental applications. They contend that it is "unthinkable" that the Board would grant certificate approvals to any supplementals that have earned a reputation as known regulation violators. They also told the Board they are opposed to any approval for supplementals that have earned and retained a good operations reputation on the grounds that many of these airlines have now asked permission to conduct individually ticketed flights, although they have not previously provided this service.

If the CAB approves these applications on the basis of the carriers' acceptable qualifications, the trunks maintain, these supplementals should be restricted to a limit of only 10 round trips a month for individually ticketed passengers between any two points. Under the present legislation, supplementals approved by the Board will be granted temporary authority for this type of service for 30- to 90-day periods, whenever CAB determines that the scheduled airlines can not handle all the passengers.

Another objection voiced by the trunks is that several of the supplemental airlines which have been granted authority only for domestic operations have now filed for either or both domestic and foreign operating rights.

Board spokesmen expect some unusually fast CAB action on the supplemental applications, since "we've been preparing for this a long time." In an obvious reference to the long list of supplemental airline violators and the Board's frustrating attempts to take punitive action against them, one source indicated that top preference in approving or rejecting the applications will be given to the past performance records of the carriers.

Once the acceptable carriers have been chosen, they will be required to carry liability insurance, post performance bonds and meet stringent minimum service and financial requirements, under a new regulation now being completed. They also will be subject to a civil penalty ranging to $1,000 a day for violations of both CAB and FAA regulations. Each day the violation remains uncorrected will be considered a new and separate offense, CAB said.



990s Await Varig-Convair Settlement

Two of the three Convair 990s built for Varig Airlines of Brazil are shown on the ramp at the General Dynamics plant in San Diego, Calif., awaiting settlement of the status of the order. Varig refused to accept the aircraft when delivery was tendered late last year and is continuing to refuse delivery on grounds the aircraft do not meet specifications (AW Mar. 19, p. 42). General Dynamics is maintaining the validity of the order, originally made by Real Airlines before its acquisition by Varig, and no early settlement is in sight.

Attorneys for the CAB's Bureau of Economic Regulations cite the past violation history of United States Overseas Airways as an example of grounds on which they based many rejections of other applications.

Between Jan. 1, 1960 and Jan. 1, 1962, a total of 91 informal complaints were filed with the Bureau of Enforcement against USOA. The complaints involved delayed ticket refunds, misrepresentation of services provided, undue flight delays, failure to notify passengers of flight cancellations, unscheduled stops and the substitution of inferior flight equipment for what was advertised. The attorneys also said that the Military Air Transport Service suspended its contract with USOA earlier this year because the airline failed to correct poor maintenance, training and service procedures.

Show Cause Order

Attorneys representing six major trunk carriers also objected to CAB that USOA was found unfit to conduct operations by the Board in a show cause order only three months ago. In one three-month period in 1959, USOA exceeded its 10-trip-a-month limitation by a total of 29 flights and FAA records extending back 11 years show a long list of violations including the overloading of flights and the exceeding of monthly flight time limitations for pilots, imposed by FAA, the airline attorneys said. At one point, the attorneys said, USOA was grounded by FAA for an 11-day period following a series of overloaded flights between California and Hawaii.

Anglo-French Supersonic Transport

London—Supersonic transport designed by Anglo-French team will have a slim delta wing with four engines partially buried in nacelles fitted to aft wing section. Single tailfin will be sharply swept back. Capacity will be 100 passengers.

First details probably will be revealed by British Aircraft Corp. at next week's Society of British Aircraft Constructors annual display at Farnborough, England. British government has not yet allocated development funds, aside from a BAC design study contract to keep the team intact, pending a final decision on cabinet level.

Meanwhile, six new British airplanes will be shown publicly at Farnborough. They are:

- Vickers VC.10 four-jet transport, now undergoing initial test flights toward certification.
- De Havilland Trident three-jet transport, also in flight trials.
- De Havilland DH-125 executive jet, which recently made its first flight.
- Bristol T.188 stainless steel Mach 3 research plane, designed for use in the supersonic transport program. It will team with the Handley Page HP.115 slim delta research plane first shown at Farnborough last year.
- Beagle 206Y, an enlarged version of the twin-engine executive plane first flown a year-and-one-half ago.
- Beagle 218, another twin produced by the Miles design team which has made extensive use of plastics. The 218 made its first flight last week. Both are powered by Rolls-Royce Continental engines.

As another phase of the British interest in joint construction of a supersonic transport, the Royal Air Force will fly an Avro Vulcan fitted with a supersonic version of the Bristol Siddeley Olympus engine.

Service flying will include flybys of the Mk. 3 and Mk. 5 English Electric Lightning jet fighters, both fitted with de Havilland Red Top infrared missiles, and RAF 74 Squadron Lightning Aerobatic Team. Hawker Hunters from No. 92 Squadron also will do exhibition flying.

Royal Navy will be represented by Blackburn Buccaneers, and de Havilland Sea Vixen fighters. Buccaneer recently entered fleet service.

Primary interest will be in first public showing of the Hawker P.1127 VTOL strike fighter, of which three airplanes now are in the flight test program for British, United States and West German evaluation.

In the helicopter display, Westland Wessex and Scout will demonstrate in-flight refueling.

FAA, CAB Publish Crash Role Agreement

Washington — Federal Aviation Agency and the Civil Aeronautics Board last week moved to end their long-standing feud over major civil aircraft accident investigations by jointly issuing a policy guideline that defines the roles each will play.

The statement called for close cooperation in the investigation of accidents but emphasized that the CAB, under the Federal Aviation Act of 1958, holds the direct, all-inclusive responsibility for investigating and determining the probable cause of civil air accidents.

On several occasions in the past, members of the CAB Bureau of Safety have felt that FAA officials had overstepped the bounds of their responsibility in actions or public statements regarding accidents.

Bureau members have been miffed over specific instances in which FAA personnel announced probable causes of accidents even before CAB investigations had been launched.

The joint statement stressed that any cooperative arrangement between the two agencies must in no way impair the ability of the CAB to fulfill the responsibility granted it by law. The announcement admitted that in the past, there had been confusion in the public mind as "to which agency said what, and for what purpose, during the course of an accident investigation."

But it failed to delineate which agency would be responsible for issuing public statements in the future. It merely said that when joint statements are made, they should be labeled as such, and added:

"On the other hand, in the absence of a firm agreement for a joint CAB-FAA statement or release of information, extreme caution should be used to avoid confusion by clear identification of the particular agency releasing a statement or information, together with an indication of the purpose of such release."

Other points brought out in the statement:

- **Accident investigations** will be under the control and direction of a CAB investigator-in-charge, who will provide for full and active participation of FAA specialists on every investigating team.
- **FAA will appoint** a principal representative who will be on hand throughout an investigation. He will hold enough authority to permit him to obtain all needed FAA personnel, facilities and records. CAB will make available to the FAA through this representative all documents, reports and other evidence during the investigation, together with any recommended corrective measures.
- **FAA's Washington, D. C.,** communications center will be operated on a 24-hr. basis to ensure rapid reporting of accidents. The center also will provide communication facilities between the sites of accidents and the interested CAB and FAA offices.
- **Aircraft assigned** to both agencies will be used to get FAA and CAB personnel to the scene of an accident. The statement noted that fast transportation of investigating personnel is essential to the CAB "in establishing tight federal security control over the wreckage at the earliest possible moment."
- **Effort should be made** to integrate and extend individual training programs of the two agencies. Such programs will be instituted and conducted under the "leadership and guidance" of the CAB.



LOS ANGELES AIRWAYS' largest increase in volume with the S-61L has been the run between International Airport-Anaheim/Disneyland. Five round trips are flown daily between these two points. Five more runs are made daily between Newport Beach and the airport.

S-61L Stimulates LAA Passenger Traffic

Los Angeles—Increased capacity of the 28-passenger Sikorsky S-61L is stimulating intensified passenger promotion efforts by Los Angeles Airways and has resulted in monthly traffic rises as high as 73% over comparable 1961 periods.

Payload limitations of its S-55 helicopters, and the attendant priority given mail, resulted in the carrier turning away two passengers for every one it accommodated. Now the line is moving to recapture some of these passengers.

Capacity Increase

Capacity has been increased more than four times by the introduction of the S-61Ls and traffic has climbed accordingly. In March, the first month of S-61 operation, a 6.5% increase in passenger traffic was recorded. This has climbed rapidly. Compared with figures recorded for the same months last year, in April, a 15% increase was recorded; in May, a 58% increase; in June, 60% and in July, 8,051 passengers were carried for a 73% increase.

The helicopter airline credits the traffic increase to another factor besides increased capacity: passenger acceptance of the new twin turbine-powered aircraft. The traffic increase has resulted solely from the increased payload of the S-61 because fewer flights have been flown in 1962 than in a comparable period last year.

No new traffic market has been tapped by the S-61. Rather, the backlog of traffic once turned away now is being accommodated. Sales Manager Robert Hubley reports that the line's passengers still are 94% continuing airline passengers. Fares are too high for the service to be practical for commuters except on an occasional basis. From San Berdardino/Riverside, 71 mi., the fare is $8.00 one way including 10% tax. Lowest fare on the airline is $6.00, too much for commuting on any sort of daily or regular basis.

Los Angeles Airways' largest increase in volume has been the run between International Airport and the Anaheim/Disneyland heliport. Five round trips are flown daily from 5.55 a.m. to 10.13 p.m. between these two points. Five more round trips are made daily between Newport Beach and the airport, each leg of which has a stop at Anaheim/Disneyland. Thus, there are 10 arrivals and departures between these two points daily. The airline stands to benefit more from the Anaheim/Disneyland run than it does from the airport to Riverside/San Bernardino route. The fare is $6.36 for each passenger on the 29-mi. run between the airport and Disneyland and $7.27 for the 71 mi. run to Riverside.

LAA Service Area

There is apparently no reason to believe that Los Angeles Airways will suffer the same sort of traffic decline which has arisen to confront Chicago Helicopter Airways. With the virtual closing of Chicago's Midway Airport, CHA lost a great deal of revenue because of the decline of inter airport traffic. No such situation faces the Los Angeles carrier because they are building intra-Metropolitan traffic and the closing of Burbank or Ontario airports, unlikely in any event, would not measurably affect traffic. The area served by Los Angeles Airways embraces 300 cities and communities and 7 million people living in an area of 5,000 sq. mi. Only a minute portion of the potential traffic in this rapidly expanding area has been tapped and the market is not likely to shrink.

Los Angeles Airways has taken delivery of four S-61s. Fourth and final helicopter was delivered to Los Angeles in mid-July. Traffic increases were recorded on the basis of utilization of two of the three ships in service, and with the arrival of the fourth S-61, three are used in daily service. Throughout the period in which the S-61 has been operated here, one helicopter has been kept out of service for scheduled maintenance and training. Throughout June and July, 5 hr./day utilization was scheduled for each aircraft.

In flight, the S-61 closely approaches the smoothness and noise level of a small turbine-powered, fixed-wing aircraft. The noise and vibration created by a piston engine and associated cooling fan are absent. All that is apparent is the rather high-pitched whine of the turbine compressors and some transmission noise.

Even the familiar vibration of the helicopter due to main rotor blade rotation has been attenuated, resulting in much greater comfort. The light, decorated cabin resembles an airliner cabin more than an austerely furnished commuter bus as was the case with the older S-55s.

One case of inflight engine failure has occurred since Los Angeles Airways placed the S-61 into service but the occurrence did not result in an emergency landing as was the case with a New York Airways Vertol 107 which made an unscheduled landing in New York Harbor, July 16 (AW July 23, p. 33). A Los Angeles Airways S-61 experienced an overtemperature condition on one engine during a passenger flight and the engine was shut down. The remaining engine afforded sufficient power to enable the flight to continue and the passengers were unaware a failure had occurred.

Daily utilization has been described by the helicopter airline as spotty but has been as high as 8 hr. Equipment Director Fred W. Milam reports that airframe performance has been good. Some difficulty has been encountered with the General Electric CT58-110 engines, largely because of service bulletin modifications. Since the helicopters have been in service, it has been necessary to replace solid fuel lines with flex lines and a recent service bulletin called for the replacement of the No. 5 bearing in all engines.

Another problem affecting availability has been cracking of engine case castings in the turbine section. A day of down time on the entire fleet resulted in one instance, and another case led to an engine inspection made 8 hr. earlier than programed.

Cracking has been caused by vibration, and both Sikorsky and General Electric are checking engine mounts, shafts and components to isolate the source.

Major problem the helicopter airline has been contending with is what Los Angeles Airways' president, C. M. Belinn, calls fixed-wing thinking on the part of regulatory agencies. Civil Air Regulations which govern the operation of helicopters as well as fixed-wing aircraft have been patched up to fit rotary-wing machines, Belinn says, with the result that helicopters cannot operate to their natural advantage. One example is the requirement for cargo tiedown which, while written to fit fixed-wing aircraft, automatically is applied to helicopters although the same accelerations are not experienced in the latter. Belinn, whose complaints on this score are echoed by other operators and manufacturers, also contends that the passenger-carrying helicopter should not be required to mount the same communications gear carried by fixed-wing transports. Dual radios should not be required, he contends, because his helicopters operate under visual flight rules.

The line also believes that duplication of flight instruments is unnecessary in its operation and is at odds with the Federal Aviation Agency over these requirements. The FAA has stated that all equipment installed on the aircraft which was necessary for the certification program must be in working order before it can be dispatched for passenger flights. This means that virtually all the gear carried by the S-61, which is certificated for instrument flight, must be operating even though the airline flies VFR. The Go/No-Go list of equipment approved by the FAA says that the aircraft may not be flown unless the following are operating: two windshield wipers, two landing lights, two airspeed indicators, two turn and slip indicators, two directional gyros, two vertical gyros (gyro horizon), one clock, two torquemeters and two fuel quantity gages. Even though the inoperative flight instruments may be on the copilot's instrument panel, the helicopter would not be considered flyable. Nor can either pilot substitute his personal wristwatch for the panel-mounted clock, despite the fact his

S-61L Specifications

Main Rotor Dia.	62 ft.
Fuselage Length	58 ft. 11 in.
Over-all Length	72 ft. 10.5 in.
Empty Weight	10,875 lb.
Max. Gross Weight	19,000 lb.
Useful Load	8,125 lb.
Fuel Capacity	410 Gal.
Horsepower, 2 GE CT58-110-1	
Maximum power	1,250 eshp. each
Normal rated power	1,050 eshp. each

Performance

Max. Speed at Sea Level (Average weight)	147 mph.
Cruise Speed at Sea Level (Average weight)	136 mph.
Rate of Climb at Sea Level	1,600 fpm.
Range, Maximum fuel with reserve	280 stat. mi.



LAA has taken delivery of four S-61Ls. Three of the aircraft are used in daily service, one helicopter is kept out of service for scheduled maintenance and training.

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INTEGRATED CIRCUIT APPLICATIONS

SCIENTISTS AND ENGINEERS: Today Motorola is pacing a scientific revolution in electronics with a disciplined approach to integrated circuit applications. Under the personal leadership of Dr. Daniel E. Noble, the men of the Military Electronics Division are synthesizing the process technology and device design capabilities of Motorola's Semiconductor Products and Solid State Systems Divisions with military and space requirements. This coordinated effort, unique in the electronics industry, is yielding a new breed of reliable integrated circuit devices resulting from Motorola's broad range of jointly funded contracts with each of the three services, JPL/NASA and other government agencies. To implement programs such as these, marrying the frontier processing techniques of diffusion, epitaxial growth, electronic ceramics and thin films to practical electronic hardware applications, we can offer immediate opportunities to both systems and equipment design engineers experienced in the following areas.

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watch may have a far better history of operation.

Operations Chief R. L. Bromberger says that despite the instrumentation required, and the greater reliability and safety of the S-61, weather minimums imposed by the FAA are higher than for those of the single-engine S-55. En route ceilings for both aircraft are 500 ft., with 300 ft. at designated heliports. Visibility requirements are ¼ mi. for the older S-55 but are 1 mi. for the S-61.

Los Angeles Airways does not feel that the requirement for IFR instrumentation is all bad since ultimately the airline plans to become an all-weather operator. But its officials do not believe that during a strictly VFR operation the schedule should be disrupted if an IFR-required instrument becomes inoperative, such as one of the copilot's gyro instruments.

The helicopters are never more than 4 min. from a designated heliport or airport, Bromberger says, and are generally directly over, or only seconds away from, an adequate emergency landing spot. Such a situation has no parallel in fixed-wing transport operation and Bromberger believes the regulations should reflect the helicopter's differing capability.

Through the month of July, Los Angeles Airways' schedule calls for 90 flights per week day, and half that many on Sunday. Schedules are lighter on Sunday primarily because of the reduction in freight and mail requirements. More than half the schedule, or 53 flights per day, are conducted with the S-61. Two S-55s are still in the schedule, mainly for freight and mail and for operations into heliports not cleared for the S-61 such as the downtown pad atop the post office.

Sixteen out of 22 pilots have been qualified in the S-61. Training will continue, giving each pilot an average of 7 hr. of transition time, until all are qualified. Bromberger says that operation of the Sikorsky S-62, an eight passenger, single turbine helicopter which the airline operated under lease from the factory last year (AW Apr. 3, 1961, p. 40), served to familiarize the pilots with turbine equipment and reduce transition time.

Most of the maintenance problems of introducing the S-61 into service have been in the ship's electrical system. New equipment debugging and trouble spots have not formed into a pattern. If any one item has caused the most difficulty, according to Milam, it has been that of electrical connectors. One example of a connector problem was the cancellation of a flight because of activation of a red warning light on the copilot's turn and slip indicator, not a critical instrument for VFR flight. The trouble was located in the connector between the power supply and the instrument. The instrument itself was working properly. Other problems, traced generally to faulty connectors, have manifested themselves in an inverter failure, inoperative starter and a malfunctioning battery toggle switch.

The airframe in general, Milam reports, has been trouble-free. One upcoming modification will be the addition of a larger "beanie" or fairing on the main rotor hub. Present fairing will be replaced by one 5 in. larger in diameter to reduce turbulent flow at the hub during forward flight. With the present fairing, turbulent flow from the hub impinges on the tail rotor and causes the aft section of the helicopter to shake in a manner similar to a fixed-wing aircraft having a yaw damper into which random transients are introduced. The larger fairing will effectively reduce the shaking which, although it is not a hazard to flight, detracts from passenger comfort.

Arrival of the fourth S-61 has placed Los Angeles Airways in the position of having even greater load-carrying capability than that which produced July's 73% increase in passenger traffic. Belinn wants to expand and modify the flight route structure and increase frequency on some routes and has petitioned for Civil Aeronautics Board approval. Most recent change in the schedule has been the addition of service five times daily to the community of Newport Beach, 36 mi. south of International Airport. Application also has been made to serve Santa Barbara, 89 mi. northwest; Chula Vista, 118 mi. south; (near San Diego) Catalina Island, 38 mi. southwest; Edwards AFB, 72 mi. north and Barstow, 101 mi. northeast. Belinn particularly would like authorization to serve Catalina Island and its high volume of summer tourist traffic. Another high potential traffic spot would be authorization to serve Palm Springs which has a high volume of winter traffic and would offset and complement the Catalina summer traffic. Belinn believes the S-61 will be a profitable aircraft for passenger, mail and freight service up to a 100 mi. radius. How far the CAB will permit the helicopter line to range is a controversial point because service to San Diego, Santa Barbara, Palm Springs and some of the other points would put the helicopters in competition with both local service airlines and trunk airlines.

Change in route structure and/or frequency of service will be necessary if Los Angeles Airways is to approach full utilization and profitable operation, the airline believes. Making a profit looms more and more important especially in view of the recent CAB decision limiting subsidy of all three helicopter airlines to $6 million split equally three ways. Los Angeles Airways recently canceled the option it held on a fifth S-61 largely due to the subsidy limitation. The airline had expected to finance the fifth helicopter out of cash flow, largely from depreciation and amortization. Position with regard to subsidy possibly might improve despite the $6 million limitation. If the subsidy is split equally between Chicago Helicopter Airways, New York Airways and Los Angeles Airways, the latter's total may increase. A check of subsidy payments made to all three helicopter operators shows that the Los Angeles share has been running less than 25% of the total, largely because the airline elected not to buy new equipment until the S-61 was ready.

So far, enough experience has not been accumulated with the S-61 for a clear assessment of operating costs. Fuel consumption is averaging 160 gph. compared with 45 gph. for the S-55. Fuel costs for the S-55 are 13.5 cents/mi. and for the S-61, 15 cents/mi. Fuel cost per seat mile therefor is roughly 2 cents per mi. for the S-55 and only about one-quarter that, or ¼ cent/mile, for the S-61.

Valid maintenance costs also must await more experience. As of mid-July, the high time S-61 had 669 hr., and all three had accumulated 1,764 hr.

Overhaul life on the engines, main rotor head and main gear box is 1,000 hr. and intermediate and tail rotor gear boxes are overhauled at 3,000 hr.

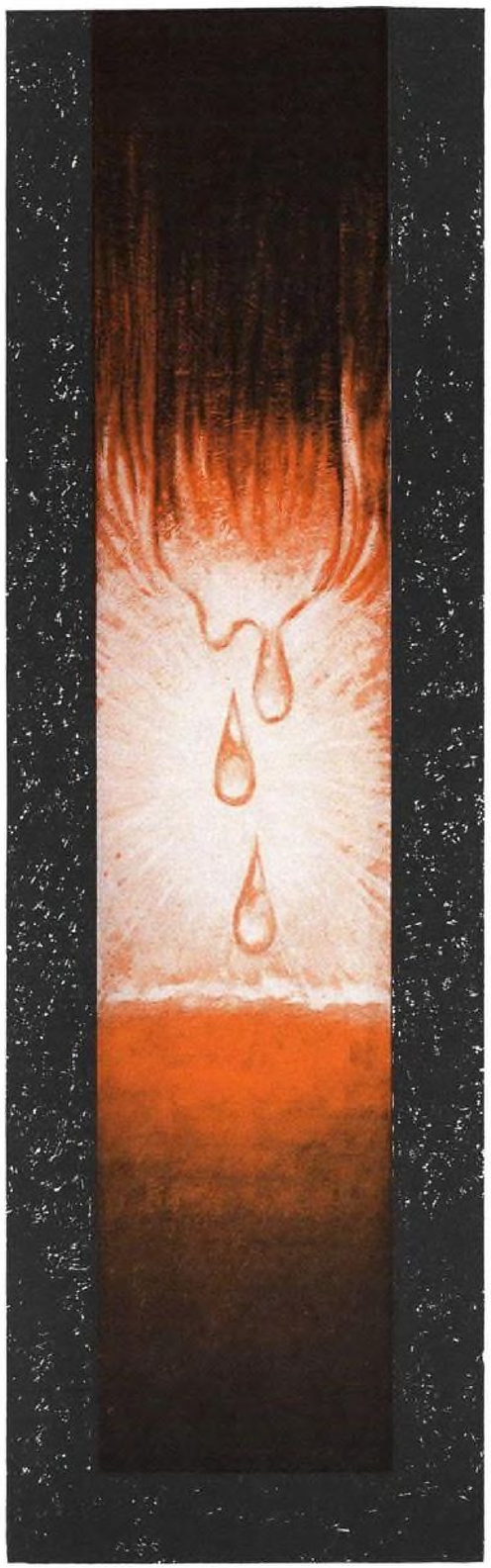
Braniff Earnings

Net income in six months ended June 30 for Braniff Airways, Inc., totaled $1,610,481, equal to 54.6 cents per share.

This was an improvement of $2,189,905 over the same period last year and exceeded all of last year's earnings by the carrier.

Net income breakdown shows that $700,595 was received from operations compared with a loss of $650,985 for the same period in 1961. The sale of surplus aircraft, principally Convairliners, produced $909,886. The domestic division provided earnings of $2,134,070 while the International Division sustained a $523,589 loss.

Traffic in the first half of the current year was up in all areas, from 7.82% in revenue passenger-miles to 32% in air freight ton-miles. Passenger revenues, totaling $42,324,067, gained 8.19%, mail revenues gained 17.4% and cargo revenues increased 19.4%. Braniff executives said long term debt has been reduced to $38,624,999 and book value per share as of June 30 was $13.28, an all-time high for the airline.



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Eastern May Cut Total Schedules When Full Service Is Resumed

By James R. Ashlock

New York—Enough pilot engineers are becoming available to Eastern Air Lines for the carrier to meet its Sept. 13 target date for resumption of service to most cities on its routes, Eastern spokesmen said last week.

Engineers who have returned and pilots qualifying for engineer duties total approximately two-thirds of the 574-man pre-strike flight engineer force.

Malcolm A. MacIntyre, Eastern president, said more than 10% of the regular flight engineers responded to the company's return-to-work offer and are being trained as pilot-engineers. Approximately 250 co-pilots are also undergoing engineer training. Eastern says a majority of 300 senior pilots, furloughed by the airline's discontinuance of service with 34 Martin 404 twin-engine aircraft, have also signed up for pilot-engineer training.

Using three-man jet crews, and reinstating some Convair twin-engine service, Eastern last week began operating 64 jet and 54 Convair flights daily. Its 64 daily Boston-New York-Washington shuttle flights also continued.

Newark service has been resumed with 10 daily jet departures and arrivals. It includes DC-8 nonstop flights between Newark and Miami, and Boeing 720 service to Charlotte, Atlanta, New Orleans, Houston, San Antonio, Louisville, Jacksonville, West Palm Beach and Boston. Eastern says that on Sept. 13, it will resume its no-reservations shuttle between Newark, Boston and Washington.

Before the strike, Eastern offered 1,424 daily flights. There is a question as to whether the airline plans ever to return to such frequency. Retirement of the Martins, and company admission that it proposes a more "streamlined" operation, indicates planning toward a permanent trimming of service outside major markets.

Steps toward removal of another handicap in Eastern's efforts to expand service were taken last week when the company and the International Assn. of Machinists agreed on the pattern for recalling maintenance personnel.

The company agreed to bring back IAM members laid off by the strike according to their seniority. Following the agreement, IAM headquarters gave its Eastern members clearance to return to work Friday. However, under contract provisions, IAM members had the individual right to honor the flight engineers' picket lines if they chose.

The IAM's dispute with Eastern arose over the manner in which maintenance personnel were laid off following the strike. Their contract provides that they will receive two weeks notice of work stoppage, or two weeks pay in lieu of notice. In case of bad weather, which could close an airport, the IAM also requires 16 hours notice of temporary no-work conditions.

IAM spokesmen said neither of these requirements were honored when the strike occurred, and the matter of the two weeks pay in lieu of notice may still come up for arbitration. The union is also restless over indications that Eastern may only recall about 4,600 of its 6,000 machinists.

Concern over the pattern by which Eastern would recall IAM members prompted a strike threat by the union earlier (AW Aug. 20, p. 40). The recall-by-seniority agreement was attained last week following two days of meetings by airline and union officials in Miami and Washington.

As to operations, Eastern spokesmen say schedule reliability of those flights operating has been good. Since July 22, when Eastern first resumed service with four jet flights daily between New York and Miami, departures have been 94% on time, the airline claims.

All 984 flights scheduled through the first part of last week were completed, and passenger response has been such that 88 extra Air Shuttle and six extra New York-San Juan jet flights were operated. Load factors on the shuttle have returned to pre-strike levels, the airline said.

On another strike front, the contract dispute between Pan American World Airways and the Transport Workers Union will be presented before a Presidential Emergency Board starting tomorrow.

TWU threatened earlier to call its 9,630 Pan Am employes out on strike, claiming the company was failing to bargain in good faith for a contract to replace the one that expired June 1 (AW Aug. 6, p. 39). Pan Am obtained a temporary restraining order, but was refused a permanent injunction on Aug. 14. The same day, President Kennedy appointed the emergency board. Its report, which must be made within 30 days after the appointment, will be followed by a 30-day cooling off period.

Judge John F. Dooling, Jr., of Brooklyn Federal Court, in refusing Pan Am the permanent injunction, said the carrier "has not exerted every effort to make agreements with the TWU concerning rates of pay, rules and working conditions."

Dallas-Ft. Worth Probe

Washington—Investigation of the Dallas-Ft. Worth airport complex was ordered by the Civil Aeronautics Board last week, opening a case that could set new standards for the use of one airport to serve several adjacent communities.

The CAB pointed out that the Dallas-Ft. Worth airport problem rightfully belongs within the Board's national program of airport consolidation, but that the plans of both cities to invest substantial funds in airport improvement justified an immediate investigation (AW Aug. 20, p. 50).

Dallas and Ft. Worth are 31 mi. apart. Dallas is served by Love Field, 12 mi. from Amon Carter Field, which serves Ft. Worth. Although the U.S. government has repeatedly urged the two cities to use a joint airport, bitter inter-city rivalry has prevented such a union.

The Board order was served on the two cities and their chambers of commerce, American Airlines, Braniff Airways, Central Airlines, Continental Air Lines, Delta Air Lines, Eastern Air Lines and Trans-Texas Airways. CAB said jet costs could affect service received by a community close to another city.

"With jet airlines almost doubling the capacity of piston-type aircraft, it is fundamental that . . . the same frequency of service cannot be operated to every point as . . . in the past," CAB said.

Emergency Landings To Cost, Defense Says

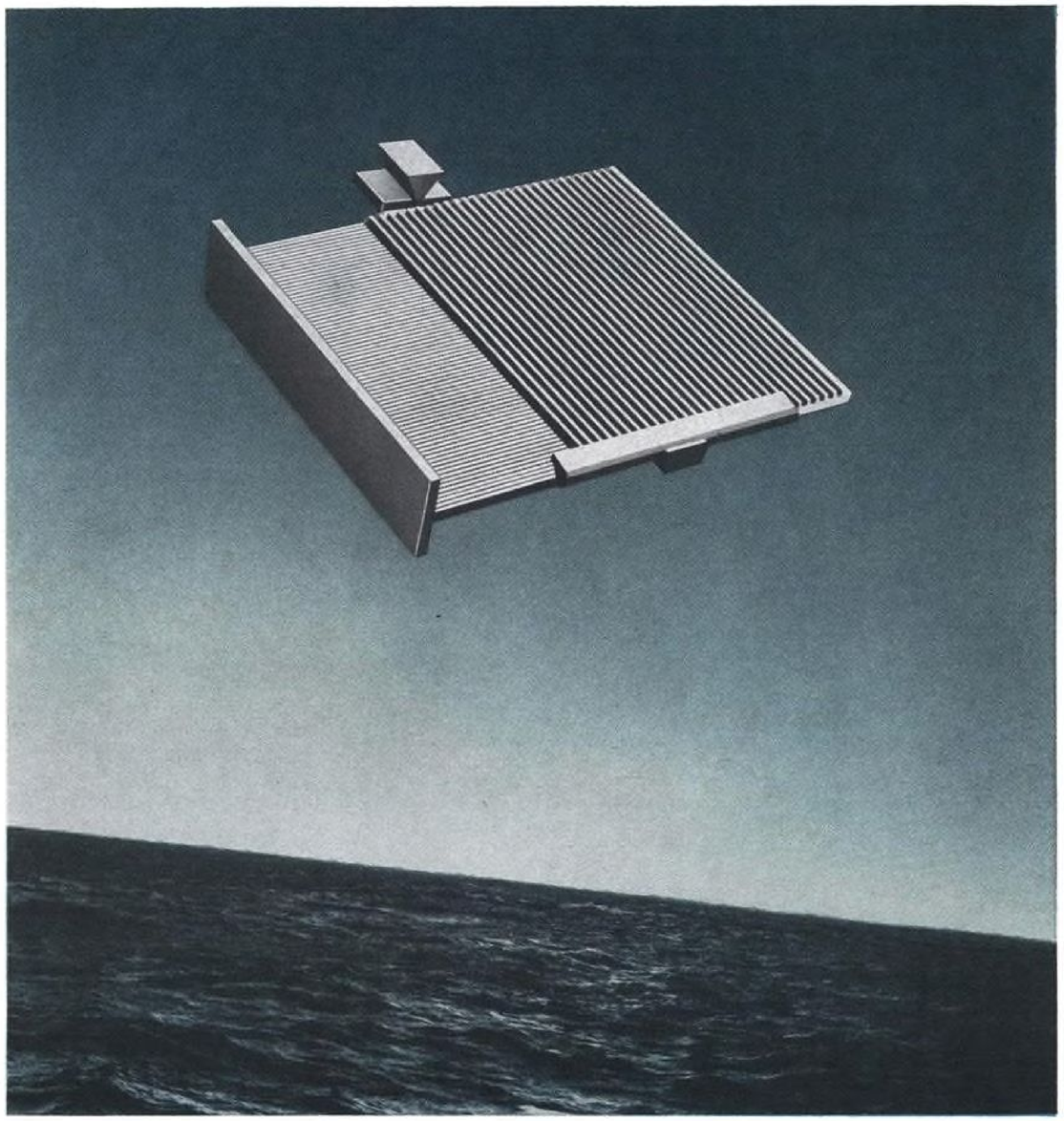
Washington—Defense Department last week told the Federal Aviation Agency it will bill any civil aircraft operator for costs involved in handling emergency landings of civil aircraft at military installations.

In a letter to the FAA, Defense said it felt concern that civil airlines have been increasingly selecting military airports for any type of emergency, even though it has been apparent that civil airports could have been used.

Defense emphasized that regulations require that military airports are available to any aircraft in distress without restriction. But it listed these problems created by the use of military installations for emergency civil landings:

- **Such landings interfere** with tactical operations and "sterilize" runways vital to takeoff and landings of mission aircraft.
- **Civil emergencies** transfer the responsibility of handling such emergencies on the ground from civil to military authorities.
- **Defense has been absorbing** the direct and indirect costs of handling civil emergency actions.

As a result, Defense has established



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Gilfillan Corporation
Los Angeles, California

a new policy that will require pilots making an emergency landing to file a written report with the base commander.

No aircraft involved in an emergency endangering the safety of passengers or the aircraft will be denied permission to land at a military airport. But Defense will reserve the right to use any necessary method to clear a runway of an aircraft or wreckage. The U.S. will be held harmless by the civil user, and military personnel will not be responsible for any loss or damage caused by negligent acts or omissions of acts, under the new policy.

All direct costs arising from the emergency will be borne by the civil operator. Such costs will include labor, material, equipment, the spreading of foam on the runway, use of fire and crash rescue equipment, movement and storage of aircraft or wreckage and any damage to runway, lights or navigation aids.

Two Air Carriers Plan Protests of Fare Cuts

London—At least two European-based airlines, British Overseas Airways Corp. and Middle East Airlines, will enter strong protests with International Air Transport Assn. against illegal price cutting.

Objections to price cuts under IATA fares, reportedly up to 30%, have come from Sir Basil Smallpeice, BOAC managing director, and Sheikh Najib Alamuddin, chairman and managing director of Middle East Airlines.

The latter, in ME's annual report, issued here last week, warned against what he called "a menacing threat which comes from illegal price cutting in our area by the majority of international airlines who give substantial rebates on Middle East-European travel. The market situation is deteriorating rapidly and an open fare war is setting in."

Alamuddin told stockholders he has already appealed through IATA to all the airlines concerned, but did not name them. In particular, he called for an end to malpractice and to rationalize capacity on routes where the increase of capacity has been many times more than the available traffic.

He also issued a veiled warning to competing airlines, saying "I hope that my appeals through IATA will produce the required results. I would very much prefer this method to the only other alternative, which would be government protection. . . ."

BOAC, which is concerned about the political ramifications of price cutting, plans another IATA protest when the association holds its annual meeting Sept. 10 in Dublin.

Airlines Fear Traffic Diversion During Continental Fare Trial

New York—Speculation has arisen among airline officials that the cycle of over-capacity and diversion may repeat itself in the business class fare experiment on routes between Chicago and Los Angeles (AW July 30, p. 28).

Continental Air Lines, original proponent of the test, initiated the service Friday following approval of the revised fares by Civil Aeronautics Board.

However, American Airlines, United Air Lines and Trans World Airlines are matching Continental's service, and industry sources wonder if this won't provide a profitless proportion of business seats to business travelers, plus diversion of regular travelers to lower priced seats.

The three-class service being offered features business class fares 12-15% lower than first class, and new economy coach fares 20% below existing coach rates. First-class fares remain the same. Business class will have three-two seating, with standard six abreast in economy coach.

American, which joined with TWA and United in strong opposition to the experiment (AW Aug. 13, p. 37), says the conversion of its Boeings to three-class configuration will cause unnecessary problems.

"For one thing, we're going to be flying empty business class seats from New York to Chicago before we can begin selling them," an American official said. "It will also cut into our transcontinental revenues, because first-class or coach travelers will be tempted to switch to the cheaper fares at Chicago."

TWA has abandoned its earlier plan to convert one Boeing to 160-seat all-coach configuration on the route, and is adopting the three-class pattern. However, curtains will be used instead of a bulkhead to separate the sections.

One advantage TWA had in challenging Continental was that its Convair 880s, with three-two seating in the coach sections, were already flying the Chicago-Los Angeles run. TWA improved its meal and liquor service to a level it felt businessmen prefer and retained coach fares, which are still $21.10 less on a Chicago-Los Angeles round-trip than the fares for the new business class (AW Aug. 20, p. 50).

Continental is confident, however, that opponents' complaints are groundless, and that the new service will not only attract business travel out of the coach sections but also will generate new revenue.

"Interest in this has been such that several of our initial flights have been sold out in business and economy coach class," a Continental official said.

He said the lower priced economy coach shows signs of cracking the long-sought family travel market. More revenue also will come from businessmen shifting to the new class designed for them, Continental feels.

"We are simply tailoring the product to appeal to a larger proportion of the public," the Continental official said. "Hotels don't offer only one or two prices for rooms, and auto manufacturers don't limit their product to a single priced car."

Continental is not concerned about TWA's Convairs as competitors, since the 880's coach seats are narrower and spaced closer than the first-class seats being installed in the Boeings' business class.

The spokesman said Continental is also pleased at other carriers adopting the plan, since it will provide a better test of Continental's theory.

IATA Move May Force BOAC Britannia Sale

London—Future of British Overseas Airways Corp. 17-plane Bristol Britannia 312 turboprop fleet appears to rest on actions to be taken on propeller fare differential rates at the International Air Transport Assn. conference next month in Dublin.

Britannia 312s are the long-range version of the Britannia 102 and are being used on the North Atlantic routes.

Currently for sale are 14 Britannia 102s, first put into BOAC service in February, 1957. Decision to sell them was made last fall when Sir Basil Smallpeice, BOAC managing director, said the airplanes were no longer making a substantial contribution. At the same time, BOAC decided to sell its eight Douglas DC-7C transports, retaining two DC-7F freighter conversions.

Contributory cause for selling the 102s and the piston-engine freighters, in addition to low load factors experienced last year, is a BOAC decision to limit route expansion to 6% this year, thus making the fleet redundant (AW Apr. 9, p. 49).

BOAC spokesmen here, referring to the Britannia 312 version, said the North Atlantic routes on which the 312s are operating are showing a profit.

IATA convention discussions are expected to center on BOAC's success with its turboprop differential. Sum involved is $35.98 less than jet fare on a round-trip ticket.

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Mr. Robert E. Peach,
President of Mohawk Airlines Inc, says:

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AIRLINE OBSERVER

► White House next year will recommend to Congress that the U. S. ratify the Hague Protocol of the Warsaw Convention (AW Jan. 1, p. 26) and pass legislation requiring U. S. flag carriers to carry compulsory insurance covering each passenger on international flights for $50,000 for death resulting from an aircraft accident, and up to $50,000 for injuries received in accidents. The Hague Protocol limits liability of airlines to $16,000 for each passenger killed or injured on an international flight. Recommendations are based on studies conducted by the Interagency Group on International Aviation.

► **American Airlines' marketing research department has found that 16 million U. S. adults have never taken a trip 200 mi. away from home by any means of transportation. The research also indicated that in 1961, only 38% of the adult population left home for as much as one night on a vacation. Only 10% of U. S. travelers consider flying when they plan to travel 200 mi. or more, American said.**

► British government has been paid about $3 million by de Havilland Aircraft Co., Ltd., in royalties from the sale of 71 Comet jet transports. Earlier the government collected $12 million spent in development aid. Company reached the breakeven point at 57 airplanes, and another sale for 10 Comets is now being negotiated.

► **Civil Aeronautics Board has found that substantial progress has been made by Trans World Airlines in the training and recruiting of Ethiopian personnel in the operation of Ethiopian Airlines. But the Board approved an extension of the technical assistance agreement between TWA and the Ethiopian government to July, 1966 on the grounds that expansion of Ethiopian Airlines and the planned introduction of jet equipment have increased problems of recruiting and training skilled personnel.**

► Despite a prolonged labor strike, Eastern Air Lines' common stock has held at a steady level on the New York Stock Exchange and remained within the price range of common stock of American Airlines, its proposed merger partner.

► **Senate commerce committee last week approved an amendment to the guaranteed loan bill that will authorize guaranteed loans up to $15 million for the purchase of all-cargo aircraft by any U. S. scheduled airline. The committee also approved an extension of the local service airline guaranteed loan legislation for another five years, beginning Sept. 7, and increased the loan ceiling from $5 million to $10 million.**

► State Department has received a number of unsolicited proposals for a U. S. policy on international air transportation, presumably submitted in the hope that they would influence final recommendations, which are scheduled to be sent to the White House by special study groups this week (AW Aug. 6, p. 50). Proposals are coming from industry groups and pilots of international carriers.

► **Eastern Air Lines last week filed with the Civil Aeronautics Board a joint tariff which will provide free or reduced-cost transportation on New York Airways helicopter connections between the three New York metropolitan airports. Free transportation will generally apply for Eastern passengers flying one-way distances of 800 mi. or more. Passengers on shorter trips may use the helicopter service at reduced rates.**

► United Air Lines flight planning and weather forecasting electronic computer systems will be moved from Denver to Chicago next month.

► **Alitalia Airlines has ordered a DC-8 from Douglas Aircraft for delivery in May, 1963. It has also taken options, which must be picked up by October, 1963, for two more DC-8s. Alitalia had been considering orders for DC-8Fs, but placed none. Douglas is also in negotiation with Trans Caribbean Airways for three DC-8Fs.**

SHORTLINES

► **Air Transport Assn.** said written baggage declaration will no longer be required of passengers flying between the islands of Nassau and Bermuda and the U. S. The U. S. Bureau of Customs now will accept oral declarations from outbound or inbound passengers on these routes. The action could lead to similar arrangements at other U. S. gateway locations.

► **Civil Aeronautics Board** Chairman Alan S. Boyd is heading the U. S. delegation to the International Civil Aviation Organization assembly now meeting in Rome. Edward Bolster of the State Department is vice chairman of the delegation. Other members include Nelson B. David, U. S. representative on the ICAO council; Raymond B. Malloy, Federal Aviation Agency; and Clarence D. Martin, Jr., Department of Commerce.

► **Delta Air Lines** increased its jet fleet to 25 aircraft during July by accepting delivery of four Convair 880s in the first two weeks of the month.

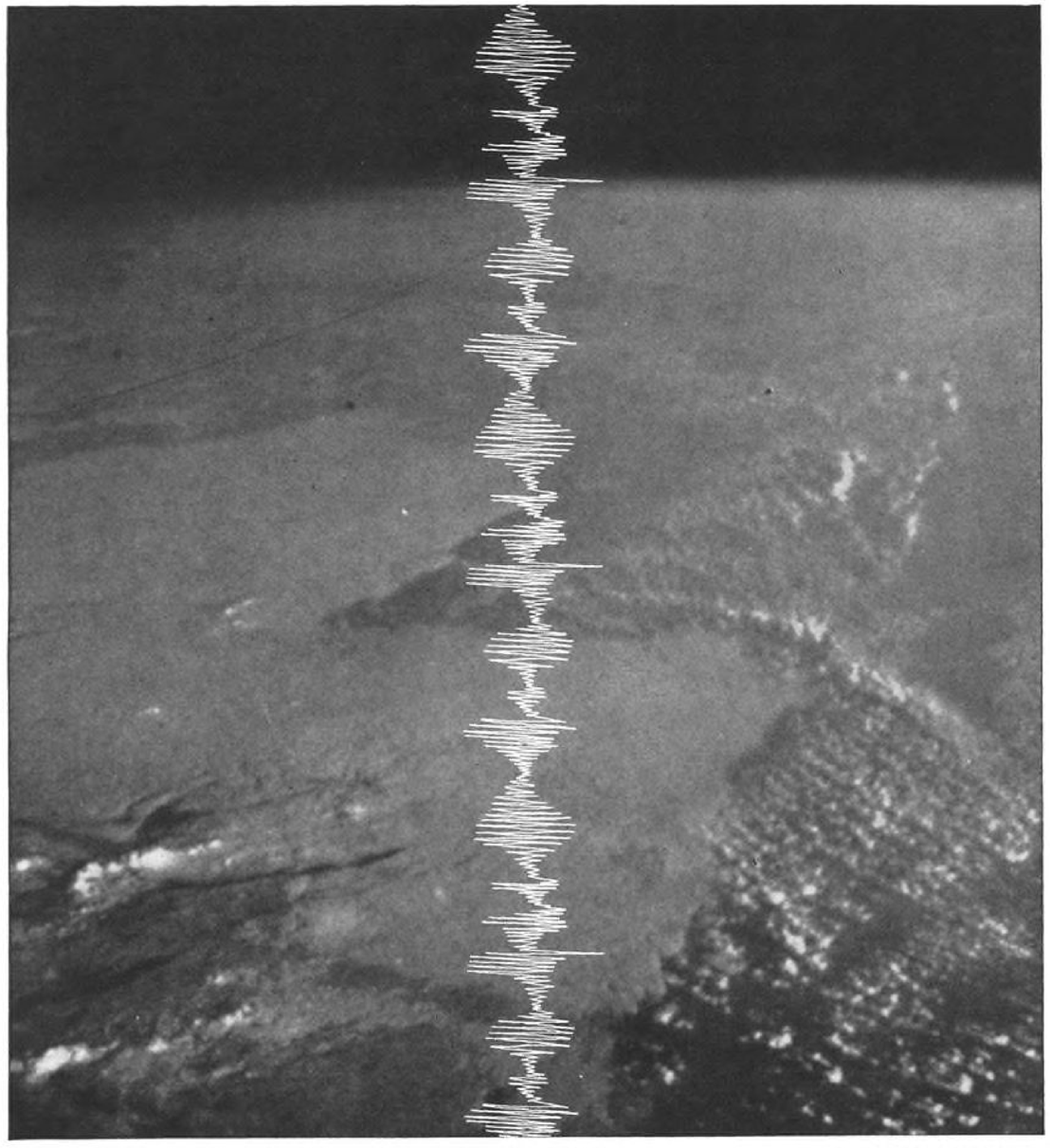
► **Eastern Air Lines** plans to reopen its Falcon Lounges at its Miami, Atlanta, and Idlewild terminals on Aug. 23 to coincide with jet service expansion to these cities. The private clubs will be available for EAL passengers holding first-class tickets and their guests.

► **Federal Aviation Agency** will transfer the authority for its programs and facilities in Montana from its Western Region to its Central Region on Sept. 30. Reason for the move is to bring three Sage centers in Montana under supervisory control of one region.

► **Flying Tiger** credits an increase of more than 100% in ton miles flown last month over the July, 1961 figure to the full use of 10 new Canadair CL-44 swingtail airfreighters. The line flew 26,307,000 ton miles in July, compared with 12,500,000 ton miles in July a year ago.

► **Middle East Airlines** announced purchase of two French Caravelle jetliners for April, 1963 delivery. MEA will use the new planes on short and medium routes within its present system. The Beirut-based airline connects Europe with 17 cities in the Middle East.

► **New York Airways** asked the Senate appropriations committee for full approval of the $5,850,000 subsidy requested for it by the Civil Aeronautics Board so that growth of helicopter service will not be brought to a standstill.

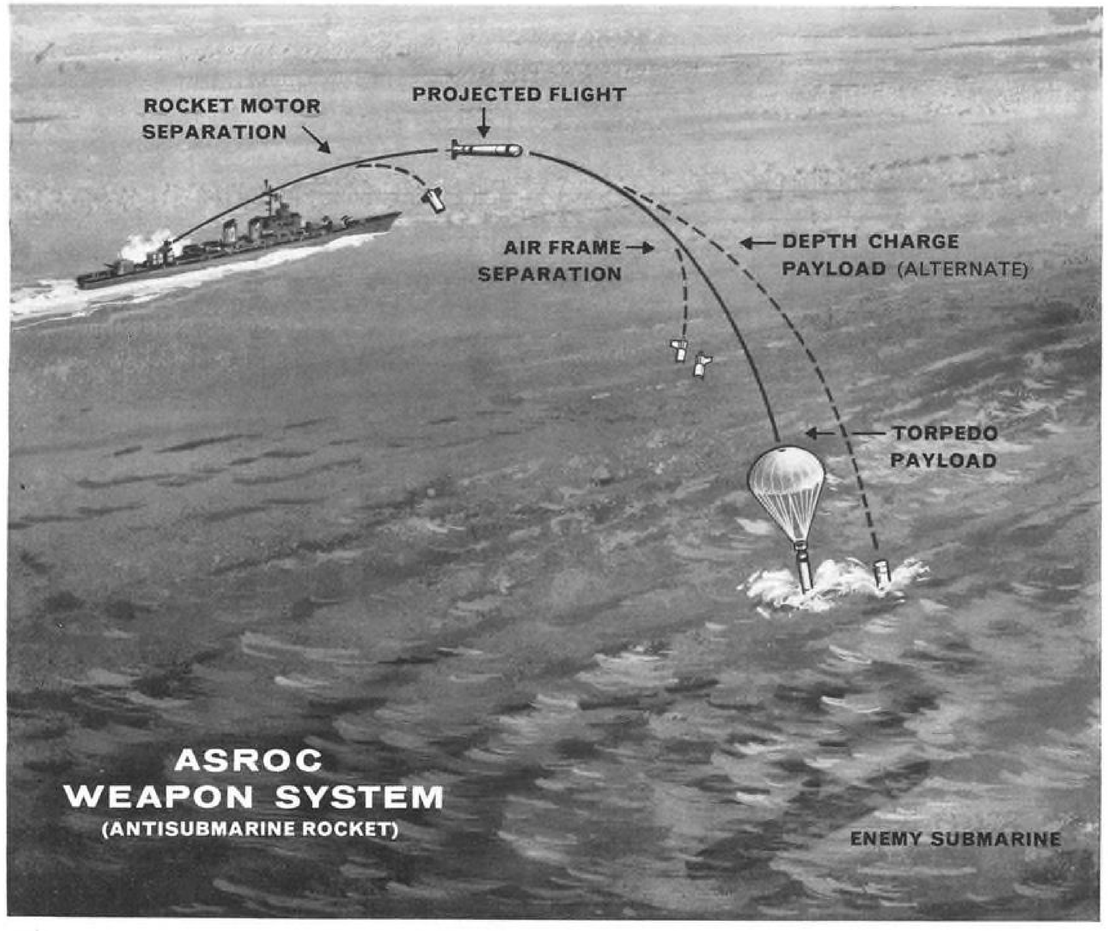


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Honeywell is conducting advanced research involving new methods and new metals (stainless steel, both low- and high-strength alloys; titanium; magnesium; nickel alloys; explosive hardening of beryllium; explosive compacting of copper) in the field of skin fabrication. Besides doing jobs that can't be handled by conventional processes, new refinements in technique are producing finer tolerances, greater flexibility, lower scrap rate.



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Honeywell-developed weapon gives craft long range anti-sub capability

As part of the Navy's modernization program, a formidable number of fleet vessels have been equipped with ASROC (antisubmarine rocket). Capable of blasting a sub with homing torpedoes or depth charges at a greatly extended range, ASROC was developed by the U.S. Naval Ordnance Test Station (NOTS), for the Bureau of Naval Weapons. As prime contractor, Honeywell is responsible for the entire ASROC weapon system, including computer, launcher, missiles and all aspects of control.

ASROC makes it possible for surface vessels to attack enemy submarines in a matter of seconds after detection. A combination of rocket, torpedo or depth charge, integrated with sonar and computer, ASROC detects and tracks submarines by bouncing short bursts of sound off the target. Returning echoes are magnified aboard ship to provide the course and speed of the target.

After the contact is identified and tracked, the ASROC payload (torpedo or depth charge) is aimed and launched with deadly accuracy by the shipboard digital fire-control system. During the entire search, detection, track and launch operation there is no need for the attacking vessel to maneuver or leave a convoy; ASROC can launch its weapons as the sonar identifies targets.

Sergeant missile battalions being activated

The Army's highly mobile Sergeant surface-to-surface missile will be the major striking force of battalions of nuclear artillery now being activated.

With a range of 75 miles, the 34½-foot, 10,000-pound Sergeant carries a Honeywell-developed warhead. Altogether, Honeywell has participated in more than two dozen missile programs in capacities ranging from prime contractor to supplier of precision inertial components.

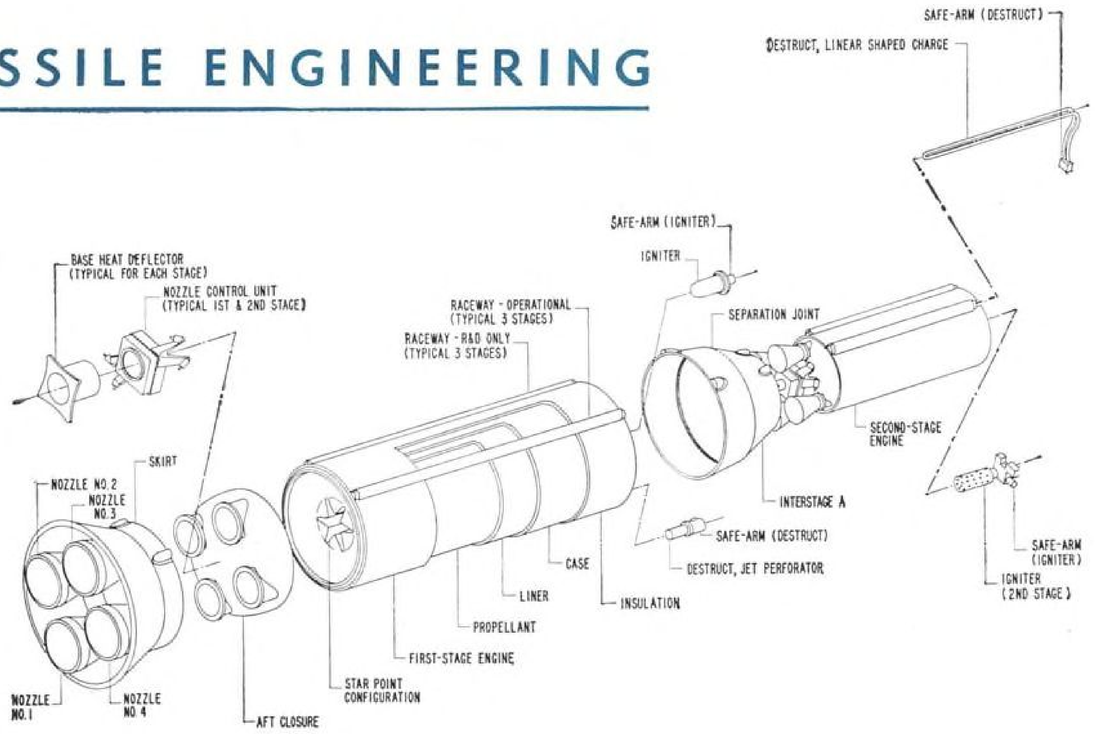


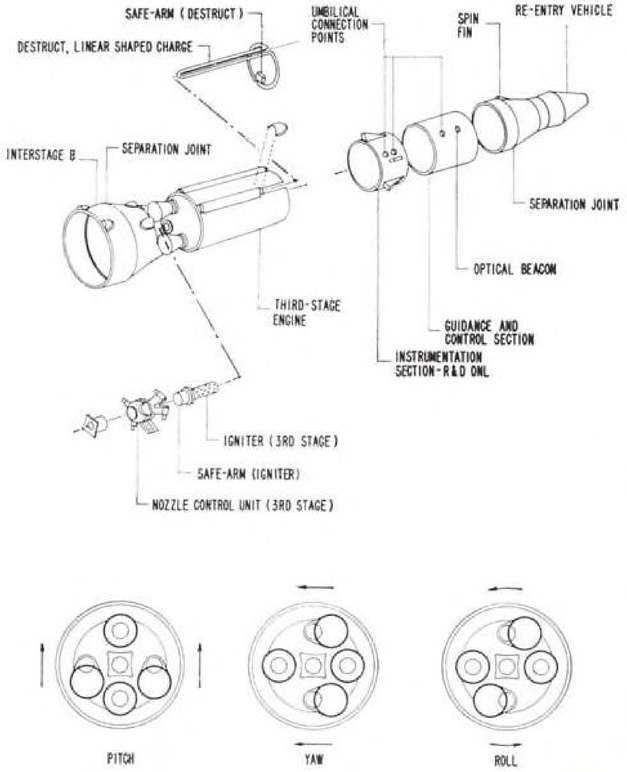
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Minuteman Propulsion—Part 1:

Minuteman ICBM Solid Motor Stages Enter Production Phase

By Irving Stone

Brigham City, Utah—Air Force Minuteman intercontinental ballistic missile wraps up in a single missile configuration three distinct approaches to the design and production of large solid-propellant rocket motors.

Engineering latitude allowed the contractors for the three rocket stages by the Air Force has been wide, and the results show the diversification possible in basic design of a stage, in production techniques, and in propellant grain formulation and configuration.

The three propulsion units have entered initial production in the missile's transition from an advanced research and development level, at these three facilities:

- **Air Force Plant 78,** here, operated by Thiokol Chemical Corp.'s Wasatch Division, for production of the missile's first stage.
- **Aerojet-General Corp.'s** Sacramento, Calif., plant, for the second stage.
- **Air Force Plant 81,** Magna, Utah, operated by Hercules Powder Co.'s Bacchus works, for third stage production.

Boeing Co., assembly and test contractor for Minuteman, connects the three stages and assembles other components at Air Force Plant 77, Hill AFB, Ogden, Utah, to produce the final missile. The weapon is undergoing advanced R&D testing and is being delivered also for training of Strategic Air Command crews in preparation for impending Wing 1 silo deployment at Malmstrom AFB, Great Falls, Mont.

To qualify the Thiokol plant here for production, Thiokol has run two inert full-scale motors through the processing cycle, to check out tooling and equipment and establish detail operating procedures. One of these motors has been completely assembled, and one processed to the extent of casting and cutting back the propellant to the finished level. Five live full-scale motors have been processed—three to check out the manufacturing cycle, and two for static test. First of the static-test motors was to be fired today and the second was scheduled to be fired soon after. Start of processing of three other live motors programed for static test will await results of the first firing.

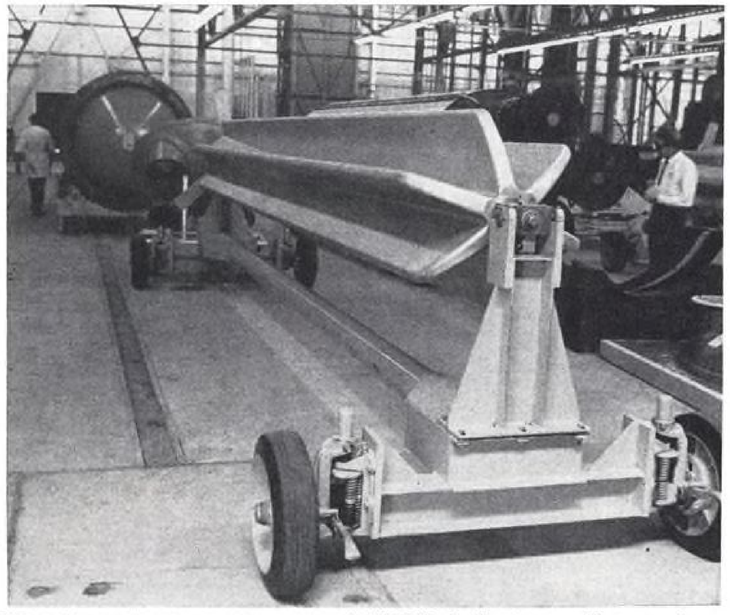
The Thiokol-designed stage 1 configuration for Minuteman is slightly over 24 ft. (290-in.) long from the forward dome to nozzle exit plane and has an outside diameter of approximately 5½ ft. (65 in.). Loaded weight is 23 tons.

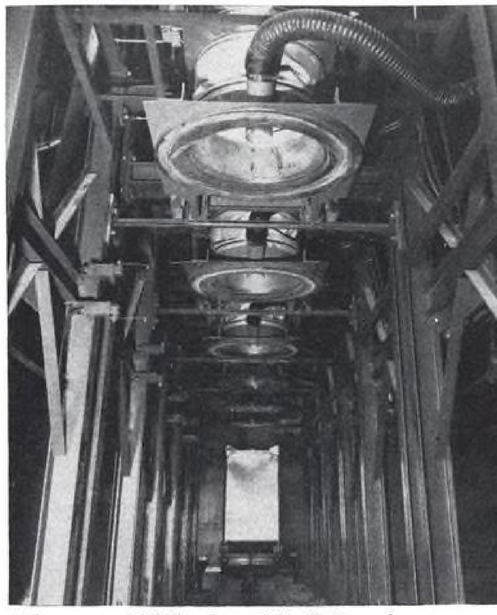
The four nozzles are the largest vectorable units for U.S. solid propulsion application. Nozzle throat diameter appears to be approximately 7¾ in. Nozzle exit plane diameter is approximately 22 in. Movable portion of the nozzle is about 25 in. long and expands in a 21-deg. half-angle, the included angle between the center line of the nozzle and the side of the exit cone.

Laterally opposed nozzles pivot up and down for pitch control, while the vertically disposed pair pivot to the side for yaw control. For roll control, the yaw nozzles are operated in opposition to obtain a couple.

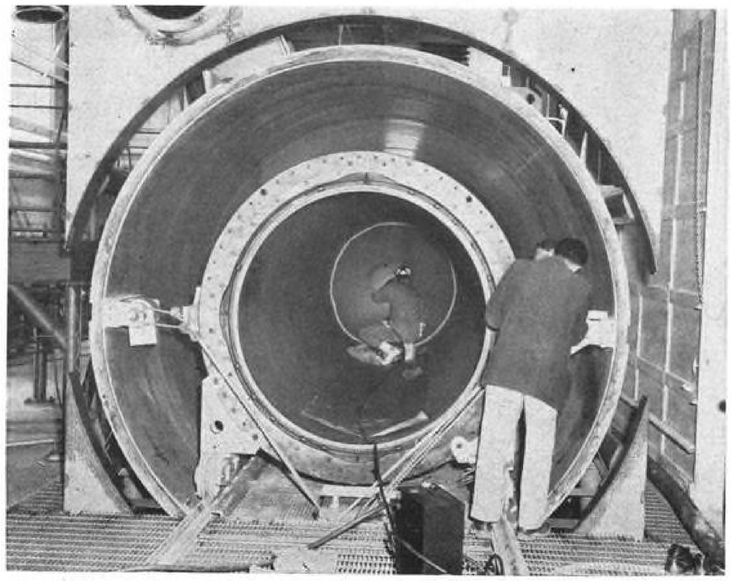
The nozzle control unit, a complete package furnished by North American Aviation's Autonetics Division as part of the missile's guidance and control system, is centered in the nozzle placement. It is a battery-powered hydraulic system with fluid pressure transmit-

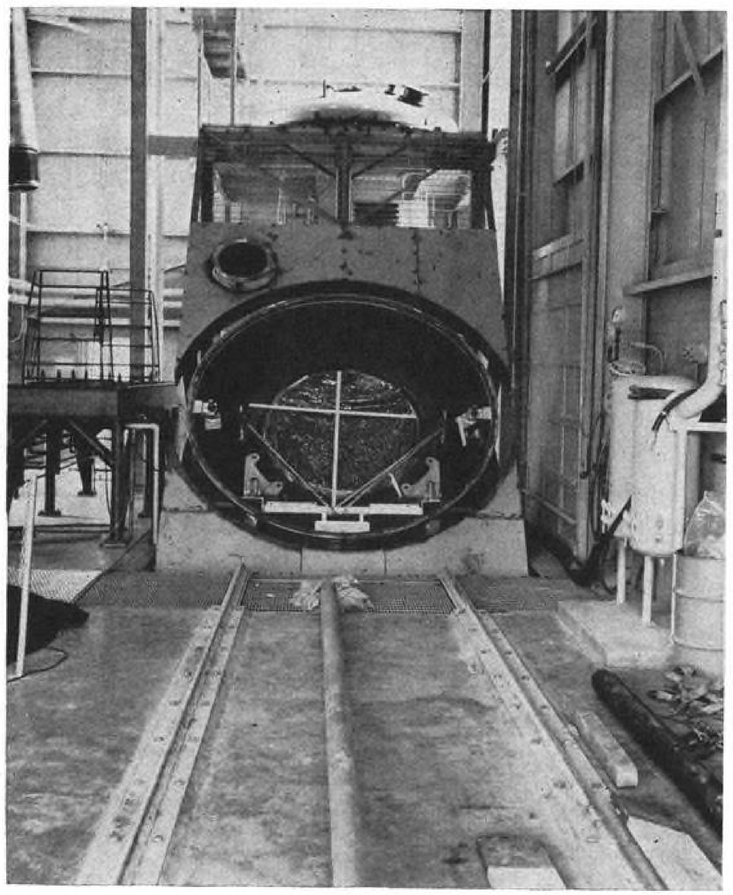
EXPLODED VIEW of USAF/Boeing Minuteman ICBM, left, shows major components. Note nozzle swivel details at lower right. Above, premix operation for two of the Thiokol first stage propellant constituents feeds aluminum powder from tilted can into hopper for conveying to container, right, into which acid is piped.





SIX-POINT, STAR-SHAPED ALUMINUM MANDREL for forming propellant core is supported on a special dolly, shown left. Battery of six hoppers, right, is used to feed various size-fractions of ammonium perchlorate oxidizer into tote bins for carrying material to the mix.





FIRST STAGE MOTOR CASE, above, is given final preparatory touches and secured in vacuum bell prior to propellant loading operation. Below, vacuum bell with first stage motor case secured in place is tilted into floor pit for propellant loading operation. Hot air duct, in floor deck, is used for propellant curing.

ted through arms to nozzle actuators.

Nozzle for the Minuteman Wing 2 configuration, an advanced version to be deployed first at Ellsworth AFB, Rapid City, S. D., will be modified to Prandtl-type internal contour to give a dished instead of a flat surface for more efficient gas flow. Improvement in specific impulse is expected to be about 5 sec. In this application the nozzle will be "moved into" the motor to shorten the fixed portion, smoothing the flow of gas before it enters the expanding portion of the nozzle.

Motor cases are supplied by Curtiss-Wright, General Electric and Allison Division of General Motors, and are furnished with the forward dome welded to the cylindrical section and the aft dome attached by a screw joint.

Case material is Ladish D6AC, a double vacuum-melted steel of great strength and purity. Cases are made up of six welded sections with a gage between tolerance limits of 0.144 and 0.149.

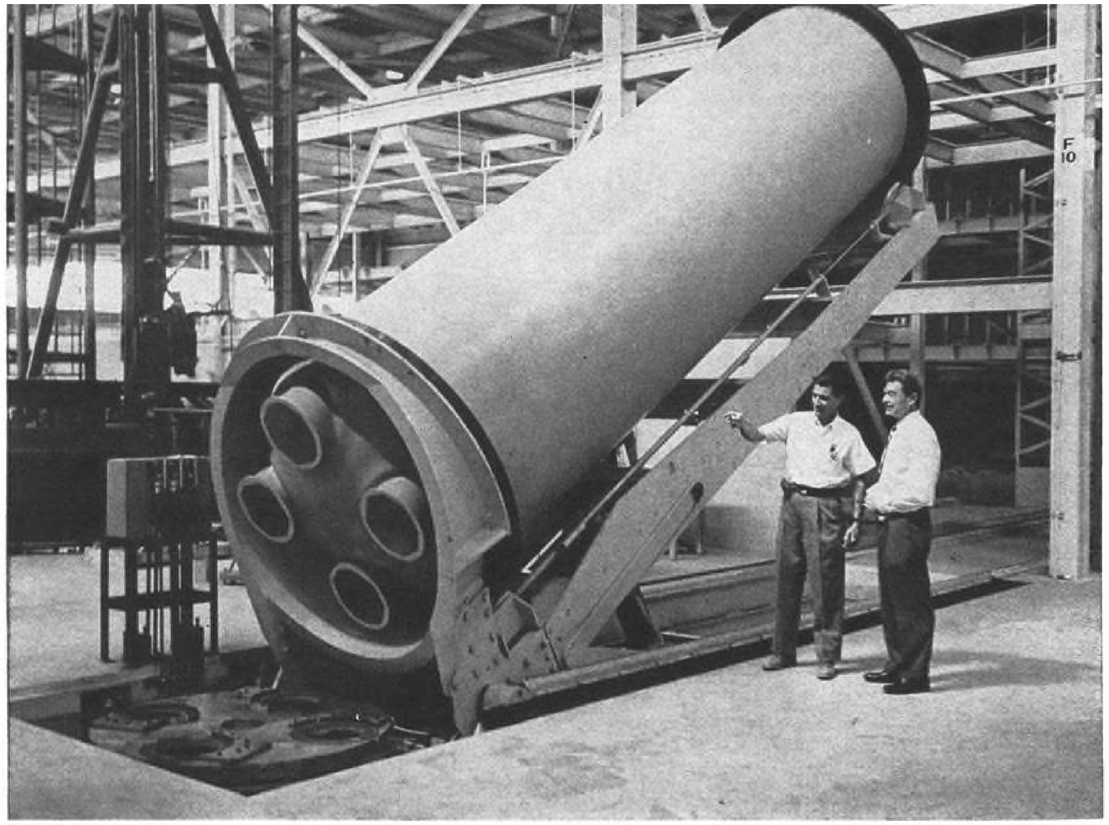
Incoming motor cases are stored in pigeonhole racks. For production processing, cases are fitted with a handling harness at each end-skirt and the harness reinforcing ring maintains case roundness and provides trunnion lift attachments. The harness also is designed to take demountable wheels for moving the case on tracks.

Cases are removed from storage prior to entering the production cycle for dimensional inspection, which is performed in a high, vertical fixture. Checks are made of the position of the case's blast tube ports, pyrogen (igniter) bore and—relative to the case centerline—the squareness of the pyrogen boss, blast tube flange, case forward and aft skirts, and case eccentricity and concentricity.

The fixture is operated from a floor console, which gives both visual and chart readouts. Checkout time is about 3 hr. from loading to unloading on the turntable bed. An X-ray source is used for checking welds, and Magnaflux for detection of cracks.

Cases after inspection are routed back to the storage area and, when withdrawn for processing, the aft closure is unscrewed and separated from the cylinder prior to the degreasing operation. In this process the case is suspended in a pit where steam coils heat liquid trichloroethylene and the vaporized solvent removes contaminants.

Premolded rubber liner about $\frac{3}{8}$-in. thick is bonded to the inside of the head. The aft case insulation, consisting of resin-impregnated glass fiber sheet, is applied next with mechanical force, in a jig. This insulation is thin at the tangent line and runs to about 2 in. thick at the curved end of the case, where the aft closure would be



THIOKOL FIRST STAGE is lifted by handling tool to vertical position above aft closure removal fixture below floor level at left. Removal fixture rotates 90 deg. to unscrew massive aft closure from which four blast tubes protrude.

attached. This thickness of glass fiber is necessary to prevent the 5,500F exhaust gases from burning through the aft end of the case.

A rubber flap, consisting of two layers, is applied to the glass fiber insulation so that the outer layer attaches to the case insulation, with the adjacent (inner) layer free to be bonded to the propellant when it is cast. This technique is used as a "controlled crack" to accommodate thermal expansion in the propellant due to temperature changes.

Six lightweight, inert, foamed-plastic triangular slivers about 8 in. at the base and about $1\frac{1}{2}$ in. high are installed longitudinally in the case. These slivers substitute for fractional amounts of propellant which would not contribute to the range of the missile because they would burn only during the tailoff period. This saves unnecessary propellant weight.

A rubber-type liner is sprayed in two coats over the entire interior of the case for a deposit of about 1/10 in. to provide thermal insulation, accommodate the different coefficients of expansion of the steel and propellant, and assist in bonding the propellant to the case. The coating is cured to a solid state by application of 140F air for about 18-24 hr. During the spraying and curing process the case is rotated on a dolly in order to ensure uniform effects.

The case, protected by a screen jacket to avoid external surface scratches, moves to the casting building—one of several—where it is rolled horizontally into a vacuum bell, which is tilted to the vertical position as it is lowered hydraulically into the casting pit.

The star-configuration aluminum mandrel, or core, is sprayed with an emulsion of Teflon (polytetrafluoroethylene), placed in a 750F oven where the Teflon fuses, providing a low-friction coating to prevent adhesion of the mandrel to the propellant and facilitating easy removal after casting and curing.

The mandrel is lowered into the case through a rubber casting sleeve which was installed prior to lining the case. A metal spider attached to the top of the mandrel centers the mandrel in the case. The forward end of the mandrel is supported by a stud extension which fits into a sleeve in the igniter hole. The mandrel allows approximately 20 in. of propellant web between the case and the point of the core star.

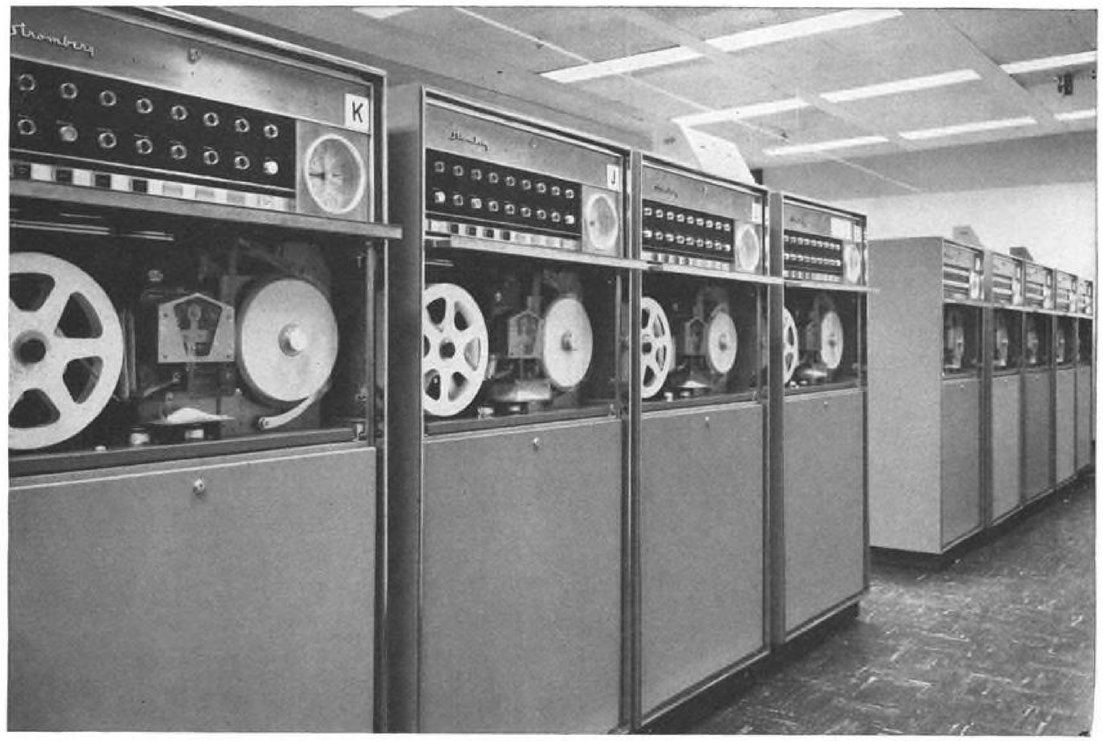
Vacuum bell lid is installed and bell is evacuated to about 4 in. Hg. absolute, to be readied for the casting of the propellant through a valve in the vacuum lid.

Meanwhile, the propellant line sequence is in operation to meet the motor case in the vacuum bell for casting.

First-stage propellant is a Class 2 formulation—it will burn but not detonate. Accelerated aging tests indicate propellant life will be at least five years and full-scale motors, already three years old, reveal no sign of deterioration. Environmental controls required for the guidance system, with the missile deployed in a silo, exceed that required for the propellant. After casting and curing the propellant, temperature limits required to be maintained during production are 60F-100F.

Propellant includes ammonium perchlorate as the oxidizer, supplied primarily by American Potash; aluminum powder, supplied by Reynolds Aluminum, as an additive to boost specific impulse and control burning rate; polybutadiene acrylic acid from American Synthetic Rubber Co. for the fuel and binder; and epoxy resin from Shell Chemical Co. for the curing agent.

The ammonium perchlorate is preprocessed prior to mixing of the propellant to control propellant viscosity within processing limits, obtain maximum density of the perchlorate in the propellant, and to control propellant burning rate. After preprocessing, perchlorate particle size varies from 10 to 1,000 microns, obtained by grinding some of the perchlorate to a fineness equivalent to that of talcum powder, mixing it

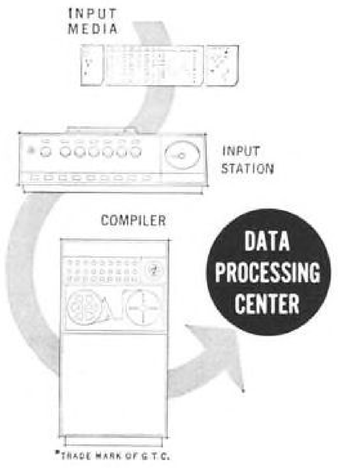


A partial view of the TRANSACTER System Compiler units at Boeing Transport Division.

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with four size-fractions of unground perchlorate and one fraction of a special coarse perchlorate, equivalent in fineness to powdered sugar.

There is a premixing operation for the aluminum powder and the polybutadiene acrylic acid fuel and binder. Constituent tolerance of the mixed batch is controlled to one-fifth pound, and the premix container is heat-jacketed to maintain proper consistency. Oxidizer and premix are conveyed on covered walkways to a 300-gal. mixer.

Propellant blending process is an automated batch mix, a joint development of Thiokol and Toledo Scale Corp. There are four mix buildings with one centrally located remote control building fitted with closed-circuit television. The mix cycle is controlled by an electronic preprogram board, with circuits representing a series of formulations.

Mix Cycle

The mix cycle starts as soon as the second ingredient is added. Normally, the first charge is perchlorate, the premix is then added, and finally the epoxy curing agent. Mix time may be about two hours and temperature of 140F, ± 3F, is controlled by circulating hot water in a jacket around each supply can. The mix cycle may be stopped at any time to take a sample.

In each mix building, there are three scales to weigh the oxidizer, the premix of aluminum powder plus polybutadiene acrylic acid, and the epoxy curing agent. Each scale is a load-cell type which measures the amount of material delivered into the mix bowl. This information is transmitted to the control building where it is typed on an IBM machine.

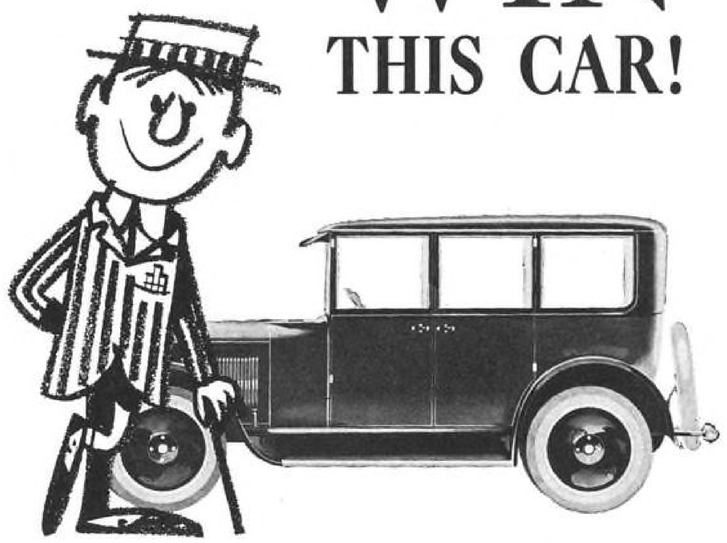
If the control panel indicates that the weight tolerances are acceptable—±2 lb. for 3,000 lb. of oxidizer, ±1 lb. for approximately 1,200 lb. of premix, and ±1/10 lb. for each 100 lb. of epoxy curing agent—the cycle is allowed to proceed for pouring of the next ingredient. If the weights are not acceptable, the cycle stops automatically. For it to resume, an "accept off-tolerance" key in the possession of the supervisor must be inserted and turned.

Air Removal

The mixed propellant is deaerated to remove trapped air to produce a denser batch and prevent uneven burning resulting from voids. After deaeration, the propellant is drawn into an empty casting can surrounded by a hot water jacket for transportation of the mix to the casting pit.

The propellant, now with a consistency of peanut butter, is fed through the lid of the vacuum bell, through a slit plate into the motor case. The reduced pressure in the vacuum bell

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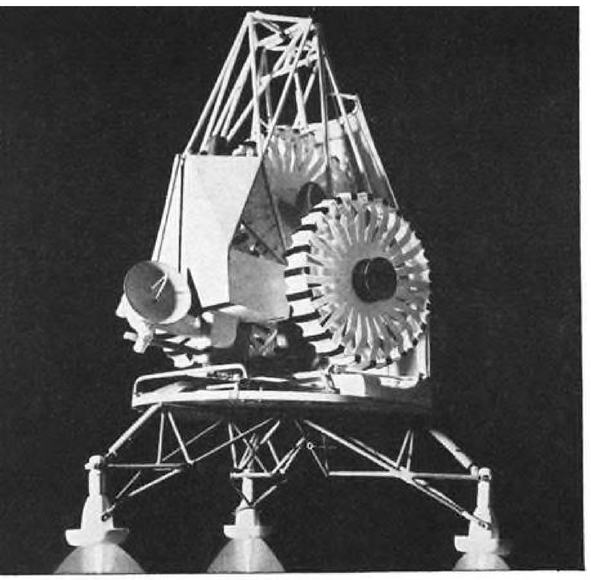
So 23 Skiddoo! Hop in! Write now for your entry form!

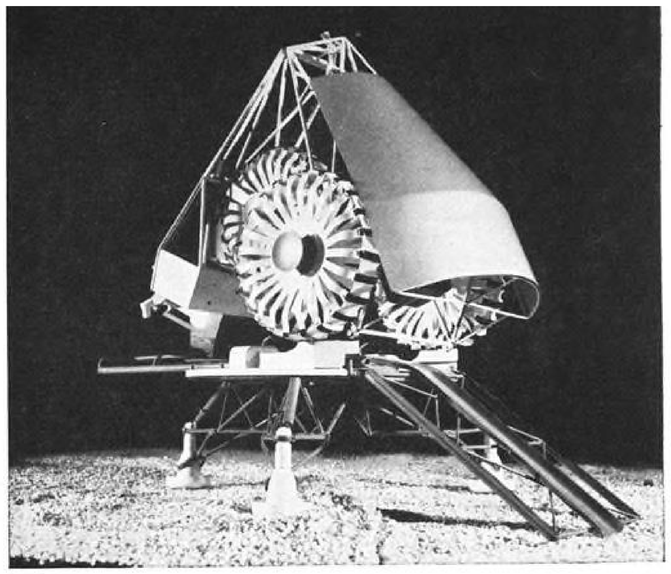
Note: Contrary to rumors, we *will* be open for business between now and the Utica I.R.E. Show, in spite of all the excitement over the big giveaway. Since members of our own staff are not eligible for the drawing, they will be prepared to discuss your requirements in their usual calm manner.

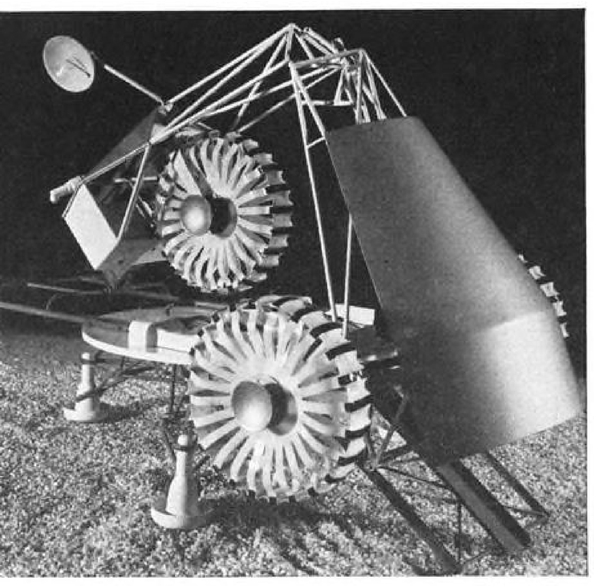
Note #2: In case you're curious, we're giving away this particular car because it incorporates the all-steel body pioneered, developed and produced by Budd 'way back in the flapper days. You may have seen the car at recent I.R.E. shows, where we displayed it fitted out as a space vehicle. The lucky winner will get it completely refitted for earth travel. Giving it away is our way of reminding you that Budd's tradition of leadership goes a long way back . . . and continues today.

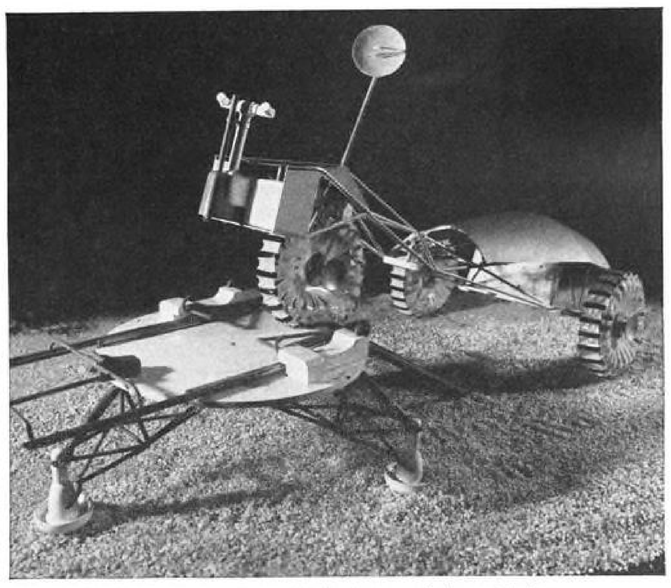
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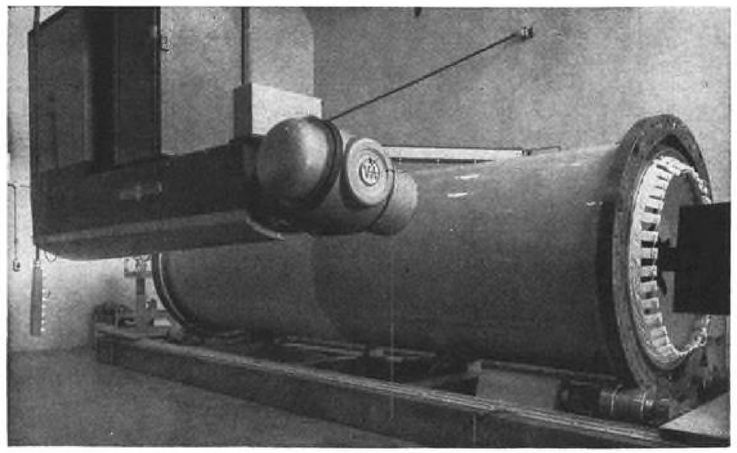
A model of a roving lunar vehicle is shown (upper left) in its folded position on the landing system during the final stages of descent to the lunar surface. (upper right) The landing shock triggers the release of an unloading ramp and initiates the debarking process. The vehicle, hinged in the middle and actuated by compressed gas, starts to unfold. (lower left) During the initial phase of debarkation the vehicle wheels, which were retracted during the flight from Earth, are extended outward and the communication antenna is erected to permit radio contact with Earth. (lower right) Near the end of the debarking process, the vehicle is fully extended and is locked into its operation position.

LUNAR RECONNAISSANCE is a Bendix program involving the design of roving vehicles systems, both manned and unmanned. It is one of several Bendix programs in the deep space sciences. If you are an engineer or scientist in the space technologies, and would like to join this team for greater personal recognition and opportunity, please contact our Personnel Director, Bendix Systems Division, Ann Arbor, Michigan—an equal opportunity employer.

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FIRST STAGE Minuteman filled motor case is subjected to radiographic inspection with Varian 13.5-mev. linear accelerator. Film (right) is supported on boom and fed incrementally through core slots to detect faults in the case.

facilitates drawing the propellant into the motor case. Thirteen batches, fed continuously, are required to fill the case.

The vacuum bell next is brought to ambient pressure and doubles as a curing oven. Air at about 150F is forced in at the bottom of the bell, circulates between it and the motor case, and is drawn out at the top of the bell. The curing period is approximately two days and is followed by a two-day cool-down to 80F, ±20F. The cooldown prevents differential shrinkage which could result in stress cracks.

The core mandrel is removed with a bridge crane by remote control and monitored by TV camera. The filled motor case, with casting sleeve attached and containing an excess of grain longitudinally is subjected to radiographic inspection to detect contaminants, voids, air bubbles, cracks, and separation of grain from case wall.

Casting Inspection

The inspection is conducted with a Varian 13.5 mev. linear accelerator with the motor case in a horizontal position. X-ray film supported on a boom is fed incrementally through the core and both points of one of the star-slots. This procedure is repeated in the other two star-slots, with the case rotated to the new position each time. Inspection process now takes about 16 hr., but probably will be reduced to 12 hr.

Casting sleeve is removed and excess grain at the aft end of the motor is trimmed with a cutter which removes very thin layers of material down to a prescribed depth. A catcher placed in the core prevents grain scraps from falling into the rocket motor, and after cut back the scraps are removed by a vacuum cleaner. The entire operation is controlled remotely and watched with a closed-circuit TV camera for safety.

A torque plate is attached to the motor aft closure, which is degreased, then insulated to withstand the exhaust gases at 5,500F and moving at 6,500 fps. which contain small particles of molten aluminum oxide, causing high erosion. Insulation consists of a layer of Abite (asbestos polymer) developed by Thiokol, topped by a layer of phenolic-impregnated glass fibers. The insulation is applied as four pre-molded segments and extends into the blast tubes (exhaust ports), which have an additional 1-in.-thick machined graphite insert bonded to the phenolic.

Wing 2 Missiles

For Wing 2 Minuteman missiles, the aft closure will contain an insert of propellant grain about 6 in. thick, covered with an inhibitor to slow the burning rate. In addition to serving as insulation against hot gas impingement, this layer of propellant grain will provide additional thrust.

The aft closure is screwed onto the case using a breech lock joint which requires only a 90-deg. turn. Developed by GM's Allison Division, the joint design was selected after evaluation of hundreds of others and is considered the lightest way to do the job. The locking operation is controlled remotely because it involves metal-to-metal contact.

Longitudinal clip on the side of the motor case serves to attach a raceway, or conduit, for electrical wiring from the guidance system to the motor powering the hydraulic system for nozzle actuation.

Nozzles, supplied by Arde/Portland, Portland, Me., and Kaiser Aircraft, Oakland, Calif., are bolted to the



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flanges of the blast tubes on the aft closure, and are aligned optically. Dual sources provide many components to prevent bottlenecks and to encourage competitive price competition.

Nozzle makeup consists of a fixed steel portion at the base, separated from the movable part of the nozzle by a Virton O-ring seal. The movable part of the nozzle has a steel shell to approximately the actuator attach point. The exit cone beyond this is H. I. Thompson phenolic-impregnated Refrasil backed by a plastic liner. Nozzle throat insert is tungsten with a carbon backup consisting of six graphite rings ranging in cross section from about ½ in. square at the forward end to about 1 in. square at the aft end.

A carbon liner also extends from the throat to the point on the nozzle exit cone where the expansion ratio is about 4 to 1.

Plastic Insulation

A plastic insulation—Avco's Avcote—is deposited automatically by a sprayhead which moves longitudinally as the motor is rotated in a horizontal position. This coating protects the motor from external heat and ablates during flight out of the solo and in the atmosphere. During the curing of the Avcote, which takes 16 hr., the case joints are leak tested by pressurizing with nitrogen on the inside and using a sniff tester on the outside.

Weight and center of gravity of the motor are determined with the unit in a horizontal position.

The handling harness is removed and a Boeing shipping harness is substituted.

Motors are stored in above-ground concrete and earth bunkers, two motors in each.

Flow time is about 35 days from the time case processing begins. This is expected to be reduced by about one-third as Plant 78 learning curves improve .

Plant History

Thiokol's Wasatch Division plant originally was established on 14,000 acres of company-held land (AW Apr. 25, 1960, p. 54). Approximately 1,555 acres were deeded to the U. S. government on which to erect Air Force Plant 78. Thiokol established the definitive criteria for Plant 78 for the Air Force and also was responsible for its design and construction. It encompasses 112 structures and has 470,000 sq. ft. of floor area.

Architect and engineering contractor was Ralph M. Parsons Co.

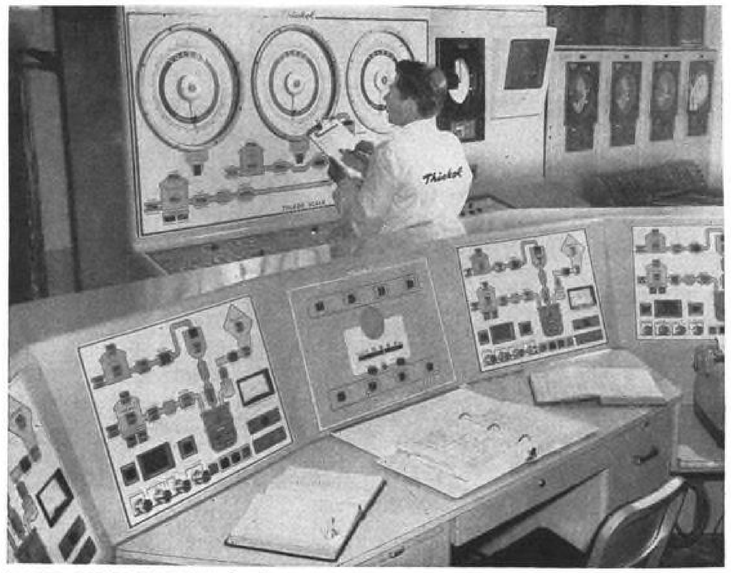
Thiokol's cost estimate for the plant was $29.2 million but final estimates indicate that the cost will be approximately $25 million.

The plant is expected to be completely operational by the last quarter of this year.

Thiokol's R&D facility adjacent to Plant 78 now is handling the development phase for the Minuteman Wing 2 first stage, as well as conducting fundamental research in rocket motor materials, including ceramics, metals, and plastics. Under a contract with the Air Force, Thiokol, through subcontractors including Lamtex Industries of New York, and Black, Sivalls and Bryson of Ardmore, Okla., has built four first-stage-size glass filament wound motor cases for hydrotest.

All of these motor cases exceeded requirements, but were heavier than originally contemplated.

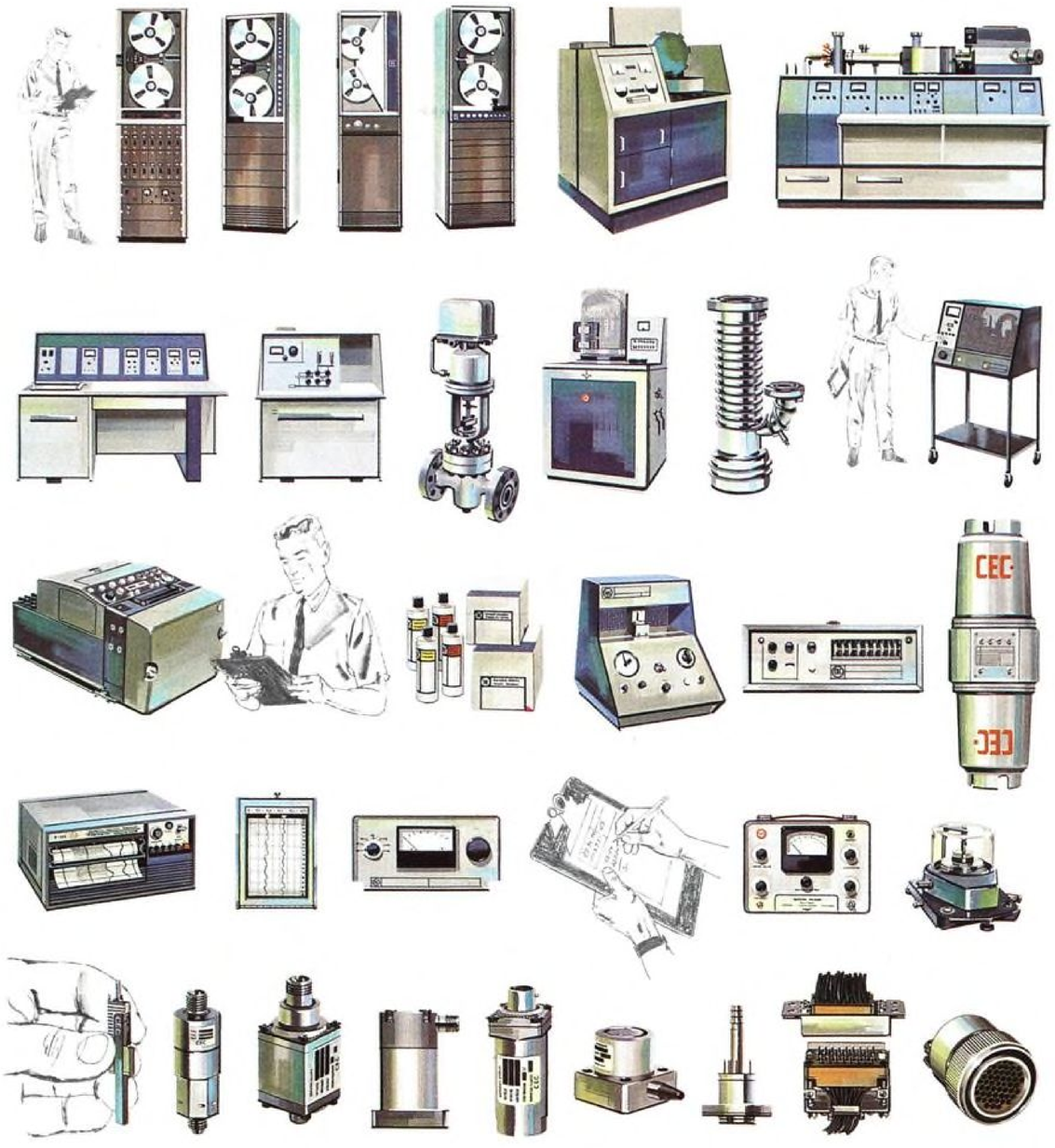
(This is the first of three articles on production of the three rocket motor stages of Air Force's Minuteman ICBM. The second article, on the Aerojet-General second stage, will appear in next week's issue.)



MASER CONTROL PANEL for four mix buildings shows consoles equipped with schematics of the mix cycle. Maser control closely monitors weight tolerances.



CUTTING TOOL is used to trim excess grain after propellant casting on Thiokol first stage. Three cutting edges successively trim thin layers of grain to a prescribed depth. Middle blade performs the initial cutting and then is followed by the blade at right. The left blade performs the final cut on the grain.



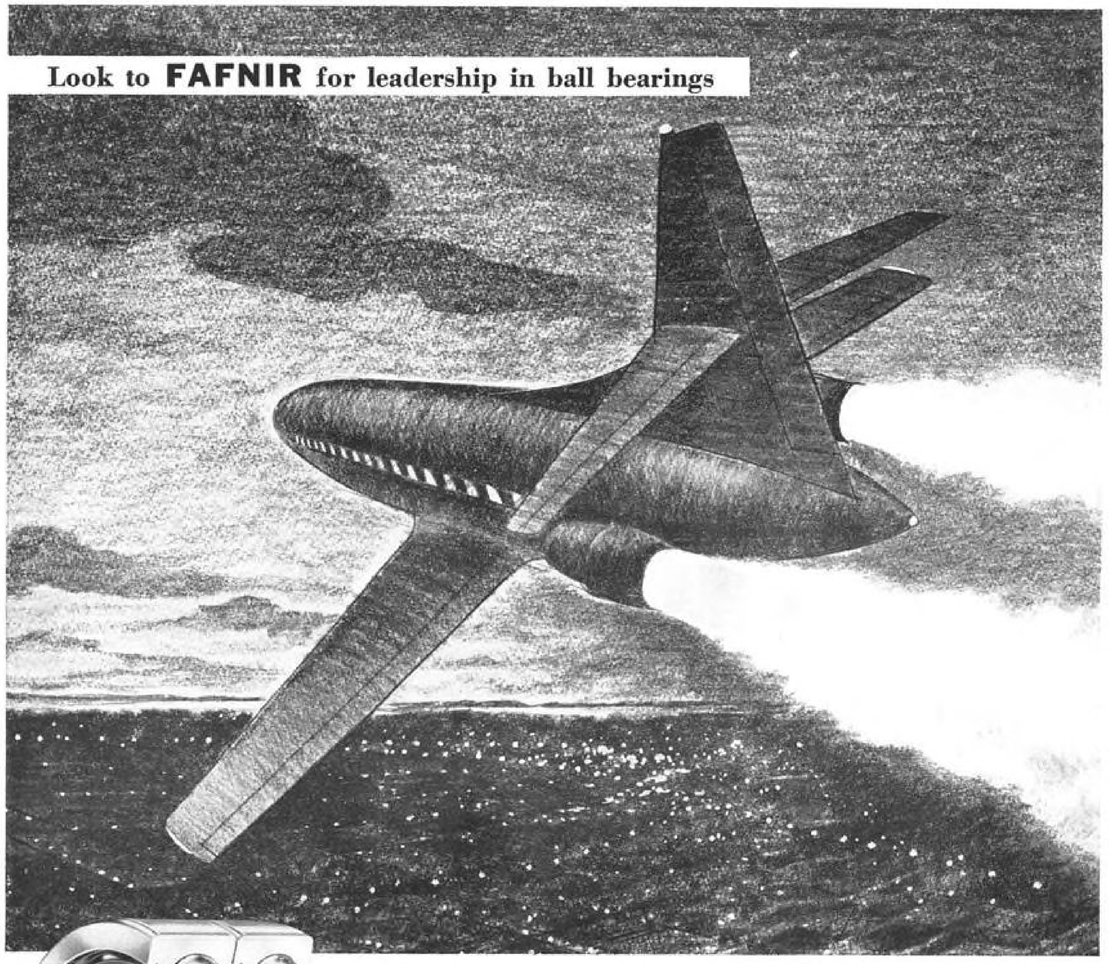
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Today's jet engines pack a powerful punch. Thrust runs to 20,000 pounds and more. Fafnir main rotor ball bearings carry the lion's share of the thrust load in many of these engines. And each bearing meets critical precision requirements. For *leadership* in ball bearings . . . look to Fafnir. The Fafnir Bearing Company, New Britain, Conn.

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POWERFUL NEW EYES FOR THE CANADIAN FOURTH BRIGADE

West Germany: CH-112 light helicopters operate in the vanguard of the 4th Canadian Infantry Brigade. As in combat missions, the CH-112's frequently maneuver below treetop level serving as the aerial eyes for the Canadian ground command along the East German frontier.

For this tough "nap-of-the-earth" flying, the Canadian Department of Defence selected the most powerful military helicopter in its class. Its commercial counterpart, the Hiller 12E, has become the first choice for government and commercial use in fourteen nations on six continents.

For the full story on the Hiller growth-planned family of helicopters — the H-23D, H-23D-1 and H-23F, write us: HILLER, 1350 Willow Road, Palo Alto, Calif.



Why so many?

We admit it.

Amphenol, more than any other connector manufacturer, accepts responsibility for confronting you with a seemingly endless selection of rack and panel connectors.

There's a good reason.

For some uses, a ten-contact connector the size of an Idaho potato will do just fine. In others, ten connections must be squeezed into a space no bigger than a jelly bean. Still other applications have unique requirements that relate to environment or mating force—even the technical skill of the operator.

WHY WE DO IT

We make a lot of different rack and panel connectors because it takes a lot to satisfy the wide range of applications.

For example: the Amphenol Blue Ribbon® rack and panel connector is widely used in "blind" mating applications. Part of Blue Ribbons' popularity is due to the fact that they mate with a smooth and gradual wedge-like force. Because they mate so smoothly, the "feeling" of correct alignment is unmistakable.

Another advantage of the Blue Ribbon design is the wiping action that occurs as connectors mate. Each time Blue Ribbons are mated, contact surfaces are wiped clean. Combine wiping action with high mated contact pressure, and the result is an extremely low-resistance connection.

THINKING SMALL?

As fine a connector as we know the Blue Ribbon is — it's just not right for the real tiny stuff. Thus, as miniaturized electronic equipment became popular, Amphenol engineers developed the Micro Ribbon®—a rack and panel connector utilizing the ribbon contact principle, but in as little as one-half the space. Further development produced a circular Blue Ribbon connector which crammed 50 contacts into a diameter just under 3 inches.

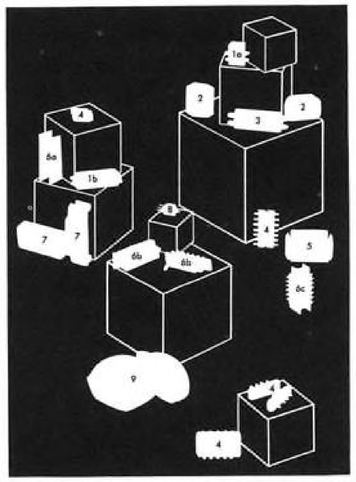
Also, there's the question of terminating rack and panel connectors. Often, confined quarters or complex wired harnesses can tax the dexterity of even the most skilled worker

To solve this problem, Amphenol engineers developed rack and panel connectors with Poke-Home® contacts. Poke-Home contacts make it possible to terminate conductors independent of the connector. Contacts are crimped, soldered, or even welded to conductors, then inserted into the connector. Besides simplifying assembly, Poke-Home contacts can be easily removed *after* assembly should circuit changes or repairs later become necessary. Needless to say, Amphenol rack and panel connectors with Poke-Home contacts (Min-Rac 17®, 93 and 94 Series, for example) are popular items with engineers who are forced to think small, spacewise.

BEATING THE ELEMENTS

There's a need for environmentally resistant rack and panel connectors, too. High performance aircraft, missiles and space craft led to the development of Amphenol 126 and 217 Series environmentally sealed rack and panel connectors. (The 217 offers the added feature of Poke-Home contacts.) Other Amphenol rack and panel connectors can accommodate coaxial connectors; many can be supplied with hermetically sealed contacts. There are rack-to-cable connectors available in every series. There are super-economy types and super-reliable types.

So, when you have a rack and panel connector problem, contact an Amphenol Sales Engineer (or an authorized Amphenol Industrial Distributor). With the broadest line of rack and panels in the industry—if he can't solve it, no one can. If you prefer, write directly to Dick Hall, Vice President, Marketing, Amphenol Connector Division, 1830 South 54th Avenue, Chicago 50, Illinois.



Amphenol connectors shown on the opposite page are: **1**—Min-Rac 17 with (a) crimp-type contacts and (b) solder-type contacts **2**—94 Series **3**—Micro-Ribbon **4**—126 Series Rectangular **5**—93 Series **6**—Blue Ribbon with (a) barrier polarization, (b) pin polarization and (c) keyed shell and barrier polarization **7**—126 Series "CNI" **8**—126 Series Hexagonal **9**—Circular Blue Ribbon



AMPHENOL ***Connector Division*** / Amphenol-Borg Electronics Corporation



JUNE 29, 1927 HAWAIIAN ISLANDS

Yesterday—Engines throttled to an easy drone, the big Fokker banked gently around the dawn pink island of Kauai. For the two tired, grinning men in the cockpit, no sight could surpass that surf and white coral sand.

Army Air Corps Lts. L. J. Maitland and A. F. Hegenberger went on to land at Wheeler Field, Honolulu. From Oakland, Calif., they'd flown 2,418 trans-pacific miles and hit the Hawaiian Islands smack on the nose. It took 25 hours, 49 minutes.

Theirs was another "first" that helped aviation grow up...another "first" flown with Standard Red Crown Aviation Gasoline.

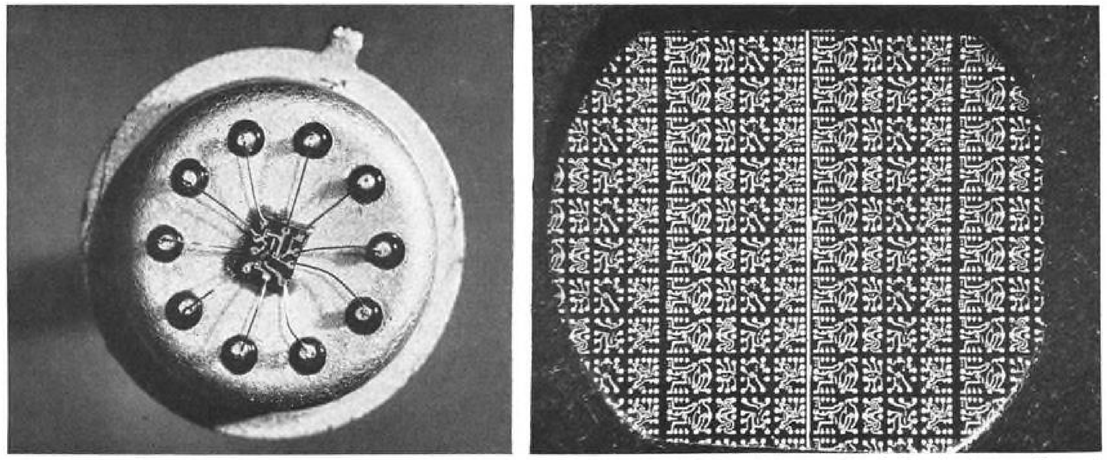
Today—More than 4,000 scheduled flights a year leap from the West coast to Honolulu. Most are jet. Wheels up...5 hours...wheels down. Miles measured in watch ticks.

But it's the same big ocean. And aircraft engines, whether jet or piston, still must deliver power every mile of the way. A major share of Hawaii Bound power comes from Chevron Aviation Fuels.

Chevron fuels have an outstanding record under severe flight conditions. Delivered clean, they flow freely at the coldest altitudes. They're blended for a smooth, complete burn. Fly better with "Chevron."

Chevron Airport Dealers take better care of your plane —at over 300 of the West's leading airports.

STANDARD OIL COMPANY OF CALIFORNIA



NEW SEMICONDUCTOR microcircuit process cuts time and cost of making custom-designed circuits. Hundreds of resistors and transistors fabricated in advance on silicon wafer are connected into variety of circuits in final step by depositing aluminum conductors (right).

Flexible-Design Microcircuits Developed

By Philip J. Klass

Versatile new technique for fabricating epitaxial semiconductor microcircuits, which is expected to slash the time and cost required to produce circuits tailored to an equipment designer's needs, has been developed by General Electric's Semiconductor Products Department, Syracuse, N. Y.

New GE process, which permits fabrication of a variety of different circuit functions on a single silicon wafer, also provides a novel means for checking the reliability and characteristics of components in the microcircuit.

The new GE technique should ease a major obstacle to widespread use of semiconductor microcircuits. Previously, equipment designers either had to adapt their designs to use a limited number of available standard circuits or pay for costly tooling and accept a delay of several months in delivery to obtain custom-designed microcircuits.

Seven different types of computer logic microcircuits fabricated by the new process are now available in sample quantities, the company says. Within several months, GE expects to be ready to fabricate microcircuits to special customer designs.

Where previous processes fabricate many identical and complete circuits on a single semiconductor wafer, GE initially produces a checkerboard array of unconnected components, 1,100 transistors and 4,200 resistors on a 1-in. dia. wafer.

Only in the concluding step of the process are the transistors and resistors to be used interconnected by the deposition of aluminum film conductors to form the desired circuit function.

Manufacturing cycle time for producing this array of components by epitaxial techniques may require as long as a month, but these can be mass produced and stocked in quantity in a few basic types. When a specific customer circuit requirement is received, it is only necessary to prepare an aluminum interconnection mask and to deposit these conductors on a basic component array. GE estimates that this will enable it to turn out custom-designed microcircuits in two weeks compared to 10 weeks or longer needed with more conventional techniques.

The transistors produced in the new microcircuitry process by an epitaxial technique have performance comparable to the general purpose Type 2N914, with an alpha cutoff frequency of about 250 mc.

The resistors, each 3,000 ohms in resistance, are tapped to provide the equivalent of a 1,000 ohm and a 2,000 ohm resistor in series. These basic resistors are fabricated in packs of two, four and six elements and located so that 30 or more can be conveniently interconnected in series, parallel, or series-parallel, to achieve desired resistance and power handling capability.

In the area of a semiconductor chip measuring 0.1 × 0.1 in., in size suitable for mounting in a standard TO-5 transistor can, a total of 18 transistors and 66 tapped 3,000-ohm resistors can be fabricated. Where a diode is required in the circuit, a portion of a transistor is used for this function.

For the present, the GE technique is limited to producing resistors and semiconductor active elements, but the company is working on diffused semiconductor capacitors and also considering the possibility of deposited thin-film type capacitors.

However, GE's Advanced Electronics Center, Ithaca, N. Y., has developed a new type of computer logic circuitry which needs only resistors and transistors and can therefore be produced using the presently available techniques. This new circuitry, called emitter-coupled logic operators (Eclo), employs a negative logic in which a voltage of 0.7 v. represents a "zero" and 0.1 v. represents a "one."

The new logic can be used in a d.c. mode or clocked from pulses or a sinewave. A clock rate of two megacycles has been achieved with a total dissipation of only six milliwatts per half-shift register using the new logic, GE says. The new logic circuitry, using emitter-follower gate inputs, eliminates current-hogging problems experienced with other types of microcircuit logic, the company says.

Seven logic functions now available in sample quantities include a half-shift register, a majority logic gate, a four inverter package, three double-pair gates, a three-input AND gate, a logic flip-flop and an AND-OR double gate circuit. These are housed in a stand-

Microcircuitry Meeting

Washington—Two-day conference on recent developments in microcircuitry will be held on Sept. 25-26 by Navy Department at the Interior Department Auditorium in Washington. Conference will include a report on Navy programs in microcircuitry and its in-house efforts.

ard 10-lead TO-5 package, but the company plans also to market its microcircuits in a flat package at a later date. Price of samples will be about $100.

Semi-monolithic construction of microcircuits fabricated by conventional processes makes it difficult to measure the operating parameters of individual components within the circuit, according to U. S. Davidsohn, of GE's Semiconductor Products Department.

In the new process, GE reserves small clusters of transistors and resistors at different locations around the large silicon wafer surface for test purposes and does not interconnect them into a circuit function. When the aluminum conductors are deposited, each of the hundred or more functional circuits and each cluster of test components is given an alpha-numeric identification which indicates its original location on the wafer.

When the wafer subsequently is cut into small chips, those with unconnected components can be subjected to rigorous tests. If these reveal substandard performance or reliability, functional microcircuits which came from the same area of the same wafer also are suspect, and these can be located by means of the chip identification codes and sorted out for rejection.

Semiconductor Products Department is preparing a handbook for equipment designers describing techniques for converting a conventional circuit design to the new microcircuit format. The company will provide large work-sheets, each a greatly enlarged copy of the basic arrays of components, which circuit designers can use to lay out the required component interconnections. These can then be used to prepare the masks for deposition of the aluminum conductors.



Eyeglass Display

Eyeglass display enables pilot or operator to view remote instrument readings superimposed on direct view of foreground. Developed by Bell Helicopter Co. and Optic-Electronic Co., Dallas, system uses 100,000 fibers to transmit remote readings and project them on curved lens.

FILTER CENTER

►**Army To Push Micro-Modules**—Army and Radio Corporation of America will attempt to win industry converts for their Micro-Module approach to miniaturization to counter growing interest in thin-film and semiconductor microcircuitry. Under Army sponsorship, P. R. Mallory & Co. is building an automated assembly line capable of turning out more than 200 Micro-Modules a day, which can be expanded to produce 1,000 per day. In effort to spur their use, Army and RCA will report impressive results of extensive reliability tests on the Micro-Modules. However, companies building avionics for Bureau of Naval Weapons and the Air Force find these services generally prefer thin-film and semiconductor microcircuitry.

►**Dual Laser Action Reported**—Simultaneous laser emission from two different materials, neodymium and ytterbium ions in silicate glass, has been reported by scientists at the Naval Research Laboratory. Operating at liquid nitrogen temperature, the laser emits both at 1.06 microns and 1.015 microns, the former due to neodymium and the latter due to ytterbium.

►**Thin-Film Active-Element Program**—Rome Air Development Center plans to sponsor a program to develop techniques for depositing active thin-film elements for use in microcircuitry. (For a report on Sylvania's thin-film active-element program, see AW Apr. 30, p. 70.)

►**Bionics Conference Scheduled**—Air Force's Aeronautical Systems Division and Aerospace Medical Division will jointly sponsor a bionics symposium in Dayton, Mar. 19-21, 1963. Theme of program will be Information Processing by Living Organisms and Machines. Persons wishing to deliver reports should submit 200-word abstracts by October 5. Address them to ASRNEB-3, Bionics Symposium, Wright-Patterson AFB, Ohio.

►**Single Sideband Laser Modulator**—Electro-optical modulator for lasers, which produces a suppressed-carrier single sideband, permitting rapid tuning of the impressed signal, has been developed by General Telephone & Electronics Laboratories, Bayside, L.I., N.Y. The technique has been demonstrated using audio frequencies but is expected to be adaptable to radio and microwave frequencies, according to Sylvania. Output from a helium-neon gas laser is first converted to left-circular polarized energy by passing it through a quarter-wave birefringent plate. The beam then passes through two crystals of potassium dihydrogen phosphate (KDP). A modulation voltage of about 2,000 v. peak amplitude is used to produce fields in the crystals which cause part of the left-circularly polarized beam energy to be converted to right-circularly polarized light at the modulation sideband frequencies. The relative amounts of upper and lower sideband light depend upon the relative phase of the modulation voltages on the crystals and the relative orientation of the crystals about their optic axes. Light at the lower sideband frequency is extinguished by making the phase of the voltage on the second crystal lag that on the first by 90 deg. and rotating the second crystal by 45 deg. relative to the first. The light emerging from the second crystal, consisting of left-polarized light at the laser carrier frequency and right-polarized light at the upper sideband frequency, is passed through a second quarter-wave birefringent plate and plane polarizer which block the left-polarized carrier and permit only the upper sideband light to pass through, company reports.

►**Changing Industry**—Micronetics, Inc. is new company formed to specialize in microwave instrumentation, with emphasis on using short pulse widths ranging from 0.4 to 50 nanoseconds. Micronetics, headed by Robert E. Horner, is located at 5221 University Ave., San Diego 5, Calif. Other recent industry changes include the following:

• **Strand Engineering Co.**, Ann Arbor, Mich., has been acquired by **Burroughs Corporation** and will become a Michigan unit of the Burroughs Laboratories.

• **Mark Systems, Inc.**, Los Altos, Calif., is newly formed company which will specialize in development of electro-photo-optical products for use in graphic data acquisition, reduction, analysis and display. New company, headed by Bernard P. Marcus, is a subsidiary of Allied Research Associates, Inc.

►**Flying Radio Station**—Mobile broadcast station, capable of being transported by helicopter, has been ordered by Army Signal Corps from Gates Radio Co. The station is designed to be transported anywhere and quickly put on the air to reach a civilian population or enemy forces. Station will have a 150 ft. high telescoping antenna and a 50 kw. standard AM transmitter as well as a 50 kw. short-wave transmitter. First system, being built under $1.2 million contract, is scheduled for delivery in 10 months.

Automatic Data Aids to Speed Air Traffic

Washington — Federal Aviation Agency's plan for improving the national airspace utilization system is based on the use of automatic data processing and display equipment which can be implemented on a gradual step-by-step basis, with full implementation expected by 1969.

Each of the FAA's air route traffic control centers is expected to have a full complement of automation equipment, as will 10 or 15 major terminal area control facilities. Smaller terminal areas will be given less automatic, less complex facilities.

A detailed blueprint of this and other aspects of the FAA program, prepared during a year-long study by a panel of agency experts, is contained in a 700-page report released recently (AW Aug. 20, p. 41). A briefer report, summarizing highlights of the plan, is being printed for widespread distribution to industry in September. The proposed plan is not "set in concrete" and will be subject to periodic review and possible revision, according to Robert J. Shank, Deputy Administrator for Development.

Here is the sequence of implementation recommended for automatic data processing and display under the new FAA program:

• **Digital computer** added to store and process flight plans, compute estimated time of arrival and update flight plans from data introduced by controller through keyboard.

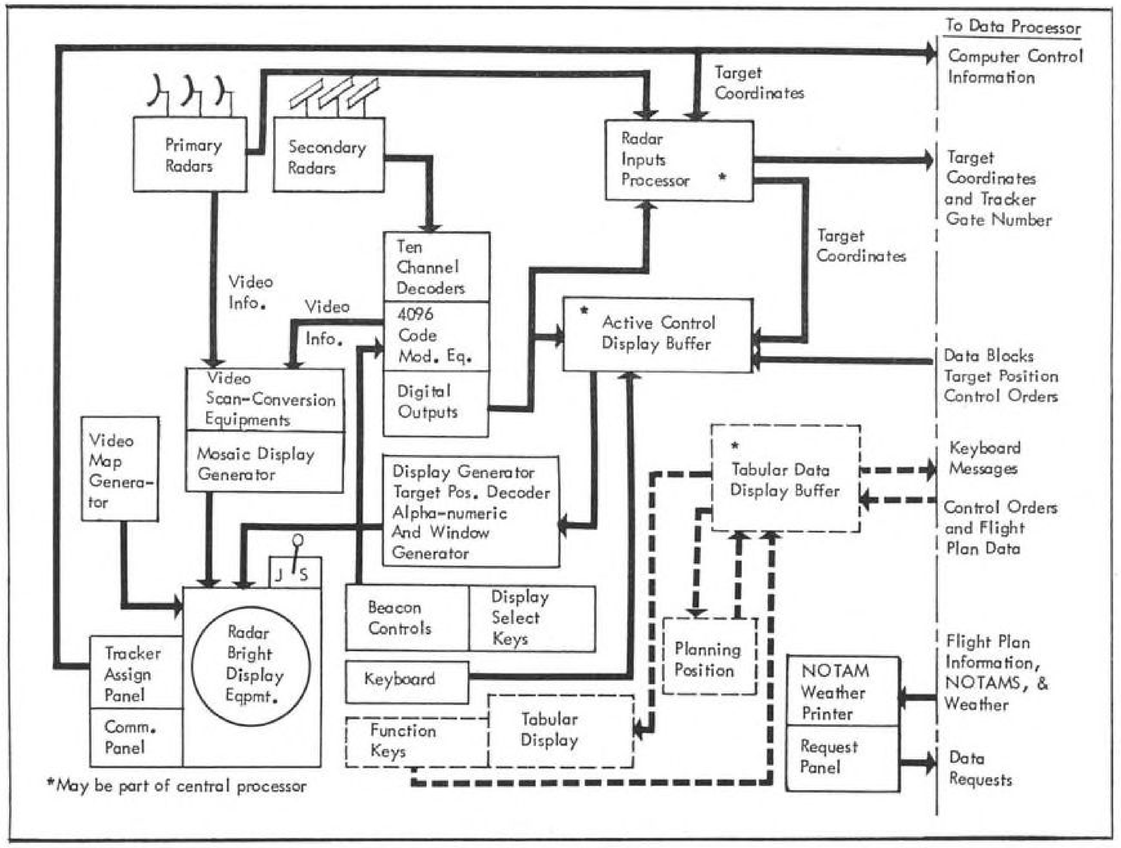
• **Composite bright display,** plan-view cathode ray tube type, showing both aircraft equipped with radar transponders and unequipped aircraft spotted by primary radar. Transponder-equipped aircraft display would be accompanied by alphanumeric tag which shows aircraft identity and altitude, obtained from transponder.

• **Computer-radar display** interconnected so that cathode ray tube can now display computer estimated position for all aircraft, based on their flight plans, in addition to their radar position. This can be used to help controller identify aircraft not equipped with transponders, and to periodically update the stored flight plan to make it correspond to actual aircraft position. To update stored flight plan, controller will operate a small joystick to maneuver computer predicted aircraft position into coincidence with the airplane's radar blip.

• **Automatic tracking** of both primary radar and transponder signals so that each is identified and continuously correlated with corresponding flight plan stored in the computer. This would permit continuous automatic updating of stored flight plan and provide the controller with positive identification of each aircraft on his display.

• **Automatic computer evaluation** of the situation will next be introduced, in which controller is automatically alerted to situations demanding his attention. For example, pending transfer of control, a potential conflict between two aircraft in the present or more distant future. This will be the first use of the computer as a "check" on the human operator.

• **Computer recommended solutions** for conflict situations which it detects. For example, computer may recommend new route and/or altitude to avoid up-



FAA Automatic Data Processing and Display System will be designed to permit step by step implementation to full configuration shown.

From 1200 miles...

to 1500 miles...



to 2500 miles...

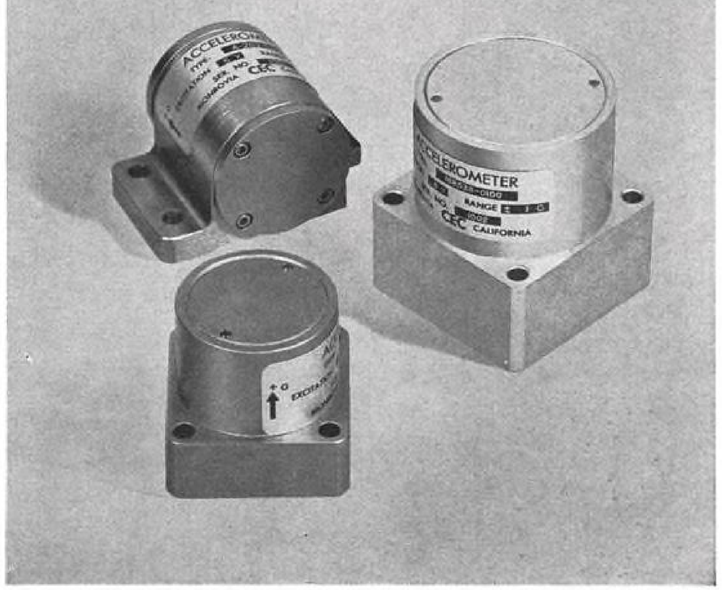
in just two years

That's how the Navy-Lockheed team has increased the range of the Polaris missile since it became operational in 1960. And they've done it without increasing the diameter of the missile or its launch tubes. This means that all Polaris submarines are basically capable of carrying all three generations of the missile. Now being flight tested, the A-3 will be operational in 1964. Like its predecessors, it is a year or more ahead of the Navy's original schedule. To meet the demands and deadlines of today's major weapon and space programs, Lockheed Missiles & Space Company has brought together more than 25,000 scientists, engineers and technicians . . . equipped them with research laboratories, test equipment, and production facilities to handle the most difficult assignments. The constant aim of LMSC management is to coordinate the talents and facilities of industry, the military, and government and academic groups for total development of successful major weapon systems — such as the Polaris missile.

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coming conflict, as well as devising climb/descent profiles for aircraft involved to prevent conflict with other aircraft.

• **Automatic flow control,** in which computer is used to analyze projected flights throughout the area under a traffic control center's jurisdiction to detect possible overloads which might saturate the system, and to recommend alternative routes which will prevent such overloads. Later, this would be expanded to encompass the entire nation.

Vortac System

The last two functions are sufficiently far in the future that they are subject to change, and to later appraisal as to the cost-effectiveness, the FAA report says.

The present Vortac system appears suitable for navigation needs through the 1975 period considered in the FAA report, although expansion and some modification may be required.

In the Northeast portion of the U. S., there are areas where VOR stations are 10 mi. or less apart, raising frequency allocation problems. This high density results from the use of VOR to provide parallel departure routes and as let-down aids at military bases. The use of a small, low-power VOR solely as a terminal area let-down aid (TVOR), is "wasteful", the FAA report says, because it compounds the frequency allocation problem and makes only limited use of the facility.

The report calls for the development of a low-cost distance measuring equipment (DME) for use with a TVOR to enable it to provide more complete en-route service as well as serving as an airport approach aid. A more ideal solution, the report suggests, would be the development of a low-cost ILS instrument approach facility for use at low-density airports instead of using a TVOR.

Doppler Aids

Self-contained Doppler navigation aids are expected to find increased use for domestic operations, as are pictorial displays and off-course computers. Route segments set into the Doppler course-distance computer can be selected to correlate with Vortac reporting points which can be used for periodic correction of accumulated errors in the Doppler system.

Inertial navigation equipment "is still too expensive and unproven to be considered economically practical for civil use," the study says.

"Furthermore, there is some question as to whether or not there are unacceptable operational burdens involved in the use of (inertial) equipment," the study concludes.

Use of the old low/medium frequency ranges must be phased out, including the compass locator used to locate the ILS localizer. The compass locator will be the last to go, and FAA must provide a substitute method of transition guidance, the report warns. The logical replacement would be a DME installed at the ILS facility.

Voice communications will remain the primary means by which the traffic controller exercises ATC control through 1975, the FAA study concludes.

The study acknowledges that pilots complain of difficulty in gaining access to a free voice channel. While admitting that more channels are needed than are presently available, the report points out that in some cases the delay is due to the controller's occupation with other duties.

Radio Time Cut

The situation should be improved when radar transponders equipped with automatic aircraft altitude reporting come into use. A study of high-activity sectors in the New York ARTC center indicates that eliminating aircraft position and altitude reports saves 38% of the total radio time. When unknown traffic advisories are also eliminated, as is being done in positive control airspace today, the reduction would increase to 47%.

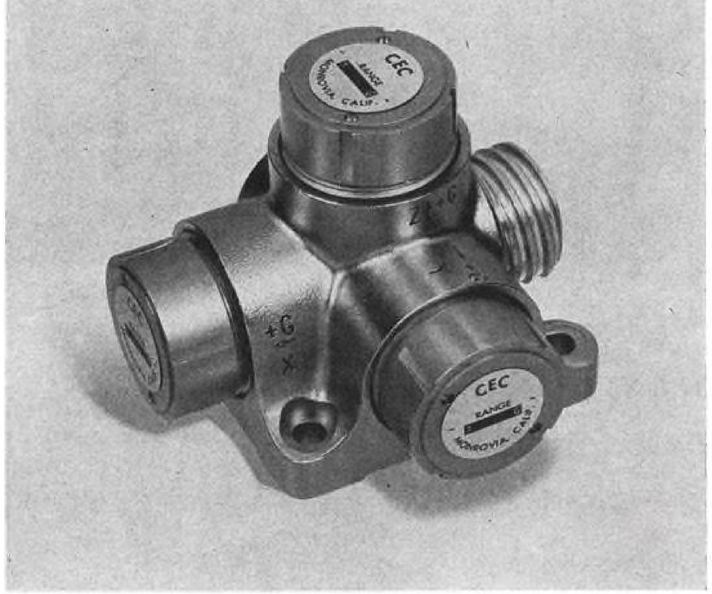
Where the bottleneck occurs is the unavailability of the controller rather than lack of radio channels. The addition of computers to compute estimated time of arrival, to update flight plans, should ease the controller workload and thereby increase his availability for communications with pilots, the FAA report concludes.

The FAA report suggests that additional channels could be provided if geographical separation between stations operating at the same frequency is reduced, perhaps using directional antennas to reduce possibility of interference. Other possibilities include reduced separation between stations whose frequencies differ by 50 kc. (adjacent channel) or by using frequencies separated by 100 kc. at the same site.

To provide coverage of areas larger than technically possible with a single VHF or UHF transmitter, particularly for high-speed aircraft, FAA proposes to study both the offset-carrier technique pioneered in Great Britain and now used by Aeronautical Radio Inc. for some airline communications, as well as the use of switching controls which would enable controller to select desired transmitter location.

The role and feasibility of data link in air traffic control are still uncertain, the FAA report says. However, several recent trends make its introduction for specific applications more favorable after 1970, it adds. The FAA will continue to investigate these applications and

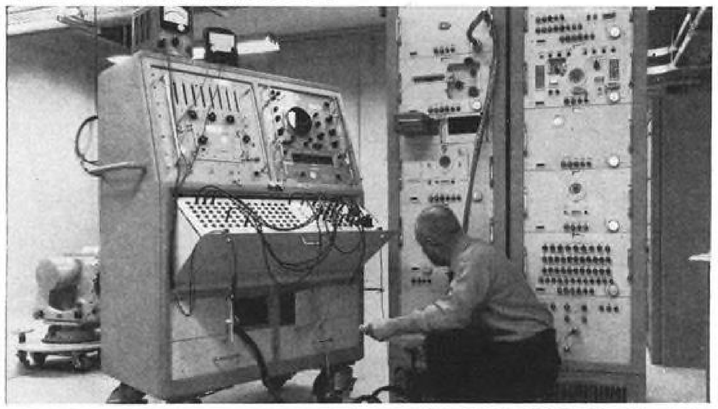
FIRST MINIATURE TRI-AXIS ACCELEROMETER



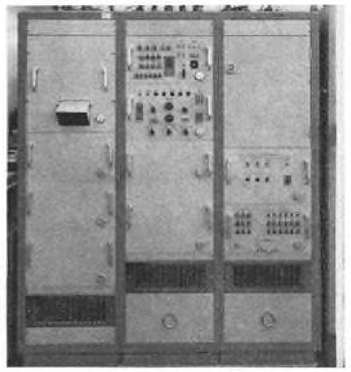
A new instrument, CEC's Type 4-204 Tri-Axis Strain Gage Accelerometer is the smallest and lightest of its type—measures three axes of acceleration on a single mounting surface. Range of each axis (±5g to ±500g) is factory selectable. Provision is made inside the transducer case for electrical temperature compensation. Performance characteristics are outstanding. Cross axis response: less than 0.01g/g. Linearity and hysteresis combined: not more than ±0.75%. Operable temperature range: −70°F to +300°F. For complete data, call your nearest CEC sales and service office or write for Bulletin CEC 4204-X2. *When you think of transducers, think of CEC.*

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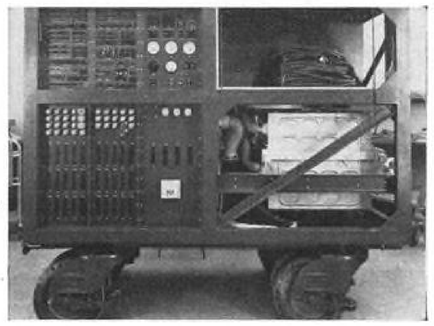
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ARMA DIVISION

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to support a limited development of feasible techniques and components.

After considering a variety of techniques, the FAA study team concludes that the radar beacon system (secondary radar) is the most attractive and available technique for obtaining information automatically on aircraft position and its barometric altitude.

The report even goes so far as to suggest that the cost of the ground facilities could be cut considerably if secondary radar (beacons) was used entirely and primary radar were eliminated. However, it acknowledges that this is predicated upon the successful development of a low-cost, lightweight transponder suitable for small private aircraft, and that there might be interference problems.

The present system design plan therefore is based on the use of both primary and secondary radar.

Altitude Radar

The FAA study team concurred with the original Project Beacon report conclusion that a height-finding radar is not sufficiently accurate at long range to serve as the basic source of aircraft altitude data. However, the recent study does suggest that a height finding radar may be a useful aid in a terminal area, particularly for use with aircraft which are not equipped with an altitude-reporting transponder. The FAA therefore plans to continue its evaluation of the Maxson passive-type height-finding radar, currently installed at the National Aviation Facilities Experimental Center in Atlantic City.

The report also says that a data link system should be considered as a means of obtaining aircraft altitude information automatically. However, the study team concluded that the radar transponder offers earlier implementation and should therefore be pushed for initial use.

Flight Level Use

Use of flight levels—barometric altitude based on a 29.92 setting—currently is in use above 24,000 ft. in domestic airspace, and FAA is considering lowering this to 14,500 ft. The system design team proposes eventual use of flight levels for all altitude assignments made by traffic controllers to provide vertical separation.

This will assure that all aircraft are using the same (29.92) reference and will eliminate the need for controller to transmit area altimeter settings to pilots. It will increase the workload at the control center since the traffic controller must not assign flight levels which will bring an aircraft too close to terrain and this will require blocking off certain lower flight levels as a function of the barometric conditions in the area at the time. However, this blocking off can be done by the computer. The report points out that flight levels are used throughout Switzerland, with its mountainous terrain, without imposing a significant burden on the traffic controller or on airspace utilization.

The FAA program to permit lower weather minimums for landing is organized into the three categories recently adopted by the International Civil Aviation Organization:

- **Category 1:** Facility which permits operations to minima of 200 ft., ½ mile.
- **Category 2:** Facility which permits operations to minima of 100 ft., ¼ mile.
- **Category 3:** Facility which permits touchdown under all-weather conditions.

Efforts are under way to improve existing ILS facilities to achieve the Category 1 requirement. By September, 1963, FAA hopes to be able to demonstrate the Category 2 capability at Nafec in Atlantic City, with subsequent implementation at 20 to 25 airports by 1968.

Current investigations and those planned during the coming year will, it is believed, enable FAA to narrow the choice of suitable techniques for Category 3 by 1963-65, according to the present timetable. During the 1964-66 period, FAA hopes to demonstrate this capability experimentally for jet transports. If successful, implementation would take place at perhaps 10 major airports during the 1968-73 period, the report says.

Acknowledging the importance of having the pilot remain a part of the control process during low-minimum and all-weather landings, the report calls for development and evaluation of windshield displays which will simplify the problem of transition from landing system to runway lights.

NASA, USAF Studying Techniques For Quasi-Passive Satellite Use

Washington—Several techniques for a "quasi-passive" communication satellite, which might offer some advantages over conventional active and passive types for certain applications, are under study by the National Aeronautics and Space Administration and by the Rome Air Development Center (RADC).

One new technique, proposed by International Business Machines Corp., could operate without electric power on board the satellite, extracting energy from the signal transmitted by one of the ground stations.

Another new technique, suggested by Joseph Ryerson of RADC, could provide a 100-fold (20 db.) increase in reflected signal strength compared with an Echo type passive satellite of the same size. Texas Instruments is investigating this concept, AVIATION WEEK has learned.

Other Proposals

Other companies that have submitted quasi-passive satellite proposals to NASA include General Electric and Space General. Sanders Associates is reported to be working on a quasi-passive satellite under a classified Defense Department contract.

NASA is studying the proposed quasi-passive satellite techniques and possible uses of such a satellite to determine the need for supporting efforts in this field. Possibly within several months, the space agency may invite industry to submit specific project proposals. However, the emphasis will be placed on investigating basic techniques, not on proposing a complete operational quasi-passive satellite program.

Air Force spokesman at RADC says there is "intense interest" in the military potentialities of quasi-passive satellites. Recently, RADC solicited companies with new ideas with the view to sponsoring feasibility studies if NASA decides not to initiate such a program (AW July 9, p. 15).

Satellite Description

Unlike an active communication satellite which uses an on-board receiver and transmitter to amplify the ground station signal before rebroadcasting it, or the familiar Echo-type passive satellite which only reflects the signal without amplification, the proposed quasi-passive satellite would provide modest amplification (gain) without use of a conventional receiver-transmitter.

Previously there have been studies on passive satellites with geometric configurations which would effectively focus reflected energy to provide modest gain. The quasi-passive satellite, however, obtains signal enhancement by electronic rather than geometric means. Whether the name of "quasi-active" is more descriptive than "quasi-passive" is a moot point of semantics.

Studies conducted by IBM indicate that its new technique, called Commarray, could provide a 10-mc. bandwidth at X-band with a satellite working area of only 10 sq. ft. at an altitude of 6,000 mi., using ground stations equipped with 40-kw. transmitters and 60-ft. antennas, E. L. Gruenberg reported here during the recent Military Electronics Convention.

Interesting feature of the IBM technique is that the receiving station receives none of the energy transmitted from the other station, only the intelligence contained in the latter's transmission. The receiving station transmits an unmodulated carrier to the quasi-passive satellite which is modulated by signals from the transmitting station and this modulated carrier then is reflected back to the receiving station.

This permits the two stations to operate at different frequencies, a feature which might be of value in military applications. But an attendant disadvantage is that each station requires two antennas and two transmitters for two-way (Duplex) communications.

Van Atta Array

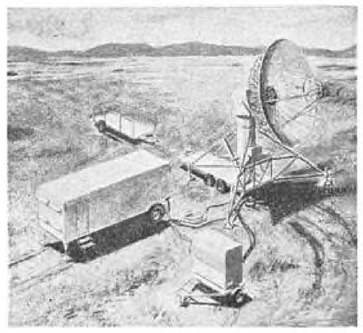
IBM technique is based on the use of a Van Atta type array on the satellite, modified to include varactor modulators. The concept of using a Van Atta array to achieve signal enhancement (gain) in a passive satellite is not in itself new, and has been suggested by others including Rome Air Development Center's Ryerson and R. C. Hansen of Aerospace Corp.

In operation, the Van Atta array resembles the familiar corner reflector. Radio frequency energy impinging on either is reflected back in the direction of the source. However, the Van Atta array can accept signals from a broader angle.

Where a ground station signal directed at an Echo-type satellite is reflected in all directions, the same signal aimed at a satellite outfitted with a passive Van Atta array would reflect the signal back in a narrow cone, thereby providing a stronger signal at the receiving station.

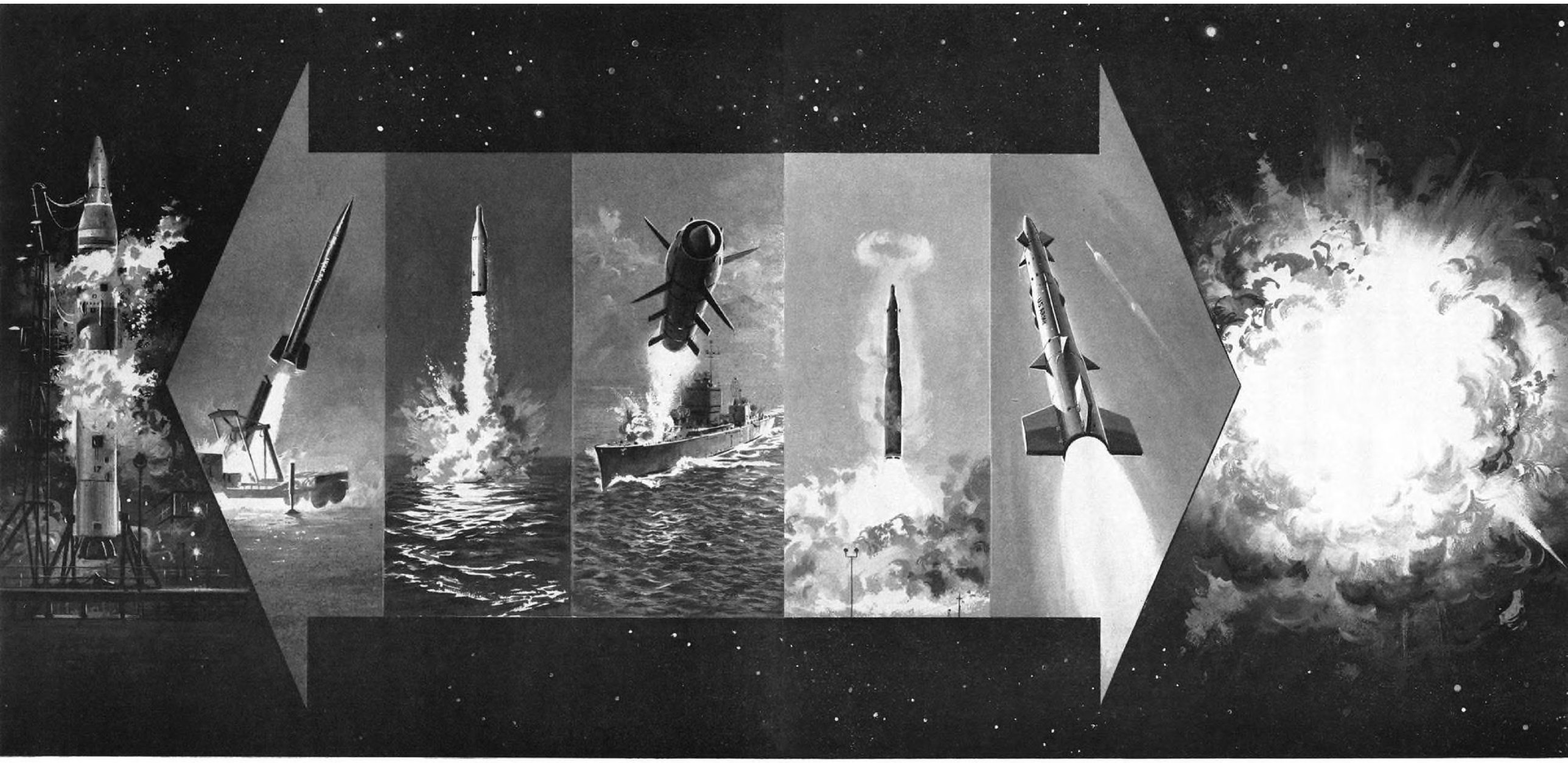
The gain that is obtained depends upon the number of elements that are used in the array.

When a passive array is used, the beam width must be sufficiently broad



Satellite Station

Transportable communication satellite ground station will be used initially in Brazil for tests with National Aeronautics and Space Administration's Project Relay satellite. Developed by ITT Federal Laboratories, the facility has a 30-ft. parabolic steerable antenna, a 10 kw. FM transmitter and associated equipment.



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Sperry knowledge and experience is helping to shape and sharpen America's missile capability—current and future.

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Latest Sperry subcontract is for stable platforms for Air Force's Minuteman, to provide exacting references against which the slightest change in the missile's course can be measured with high accuracy. And at the extreme end of the missile spectrum is Army's Nike Zeus – the nation's only anti-missile missile system in advanced development – for which Sperry provides the critical extended range target tracking and discrimination radar transmitters.

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to overlap both the transmitting and receiving ground stations, which limits the gain that can be achieved when the two terminals are several thousand miles apart.

Additionally, it requires some form of satellite attitude stabilization to keep both stations within the array viewing angle.

The IBM technique gets around this problem by using a broad-beam antenna on the satellite to receive the signal from the transmitting station, while the Van Atta array needs to illuminate only the receiving station.

This permits the array to be designed for high gain since the resulting narrow beam need not illuminate both stations.

This allows communications between two stations separated by an angle of up to 120 deg. according to Gruenberg, and does not require precise attitude stabilization of the satellite.

Passive Array

In a conventional (passive) Van Atta array, pairs of elements which are equidistant from the center of the array are connected using a low-loss transmission line.

The electrical length of this line is identical for all pairs of elements, regardless of their physical separation, so that the wave front of the reflected signal will match that of the incoming signal.

If suitable modulation devices with identical characteristics are inserted in each of the transmission lines, and controlled by the signal received from the transmitting station, then an unmodulated carrier beamed at the satellite array by the receiving station will be reflected back to the station with the desired signal superimposed upon it.

Varactors used either in series or shunt configuration in TEM transmission lines make excellent microwave modulators, Gruenberg says. To prove out feasibility, IBM constructed a varactor switching circuit (modulator) operating at S-band, but did not use the familiar circuit in which the diode operates between a forward bias (conduction) state and a negative bias (non-conduction) state.

Power Consumption

Instead, by incorporating a suitable resonant circuit with the varactor diode, sufficient impedance was obtained to achieve switching between two negative bias (non-conducting) states, which thereby greatly reduces power consumption.

The experimental varactor modulator of this type exhibited 1 db. of insertion loss in the "open" position and as much as 18 db. of isolation in the "closed" position. Over a range of 250 mc., IBM has obtained at least 10 db. of isolation in the path. Gruenberg reports. In either state, the diode current consumption is almost immeasurable, estimated to be one-thousandth to one-millionth of a micro-ampere (10^{-9} to 10^{-12} amperes).

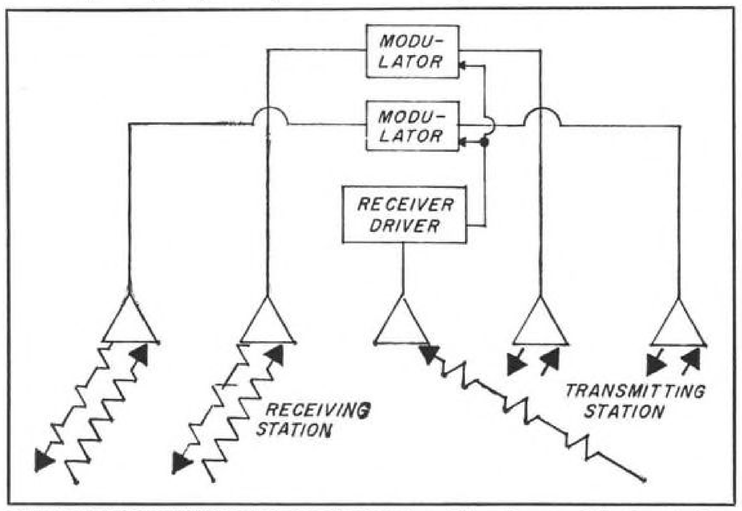
The only significant power drain comes from a transistor amplifier required to amplify the received signal and to drive the varactor modulators. An experimental driver, capable of operating several hundred modulators at a switching rate of 1.25 mc. consumes less than 50 nanowatts per array element.

The company is constructing a small scale demonstration model of an active Van Atta array, using 25 elements (5 x 5).

Quasi-passive satellite with an active Van Atta array that uses tunnel diodes instead of varactor diodes has been proposed previously by several companies, including Space Technology Laboratories. While the use of tunnel diodes provides signal amplification, permitting the use of a smaller number of elements in the array, it consumes considerably more power, Gruenberg says. This would require a power source on board the satellite, where the IBM concept permits extraction of power from the RF carrier of the receiving station.

One limitation of the proposed quasi-passive satellite technique is that the varactor diodes are digital rather than analog type modulators.

While this is satisfactory for data communications, for voice communications it would be necessary to convert to a digital format.



QUASI-PASSIVE COMMUNICATIONS SATELLITE would receive unmodulated carrier from ground station, then reflect back a modulated signal to receiving stations.

Negative Resistance

RADC's Ryerson proposes to make use of the negative resistance characteristics of tunnel diodes to effectively cancel out the radiation resistance of a light printed-circuit type dipole or spiral antenna to achieve signal enhancement from a quasi-passive satellite. The technique also appears applicable to conventional ground-based antennas to increase their gain.

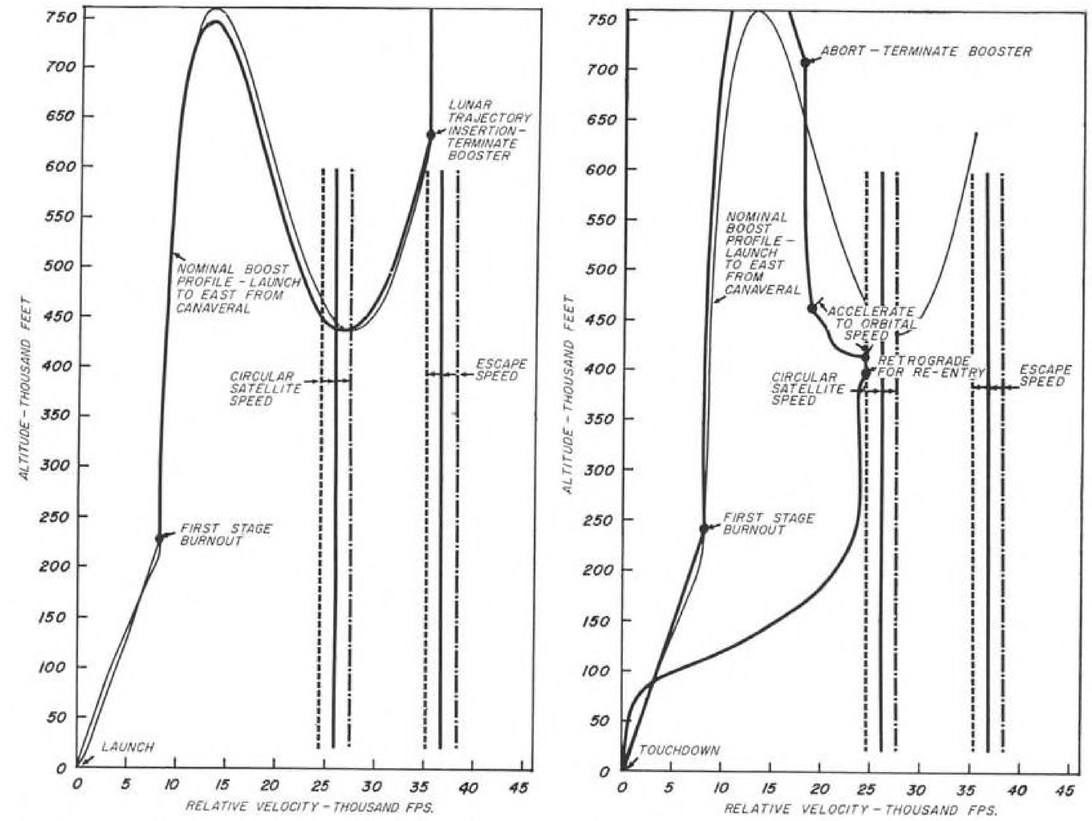
The low-level signal received from a ground station at satellite altitudes, normally would be partially dissipated in a series of dipole or spiral antennas on a passive satellite before being re-radiated to the receiving station. But if each antenna element is suitably coupled to a tunnel diode amplifier, which is biased from a well-regulated power source, the received signal can be amplified by a factor of 100, perhaps even as high as 1,000 for re-radiation to the receiving terminal, Ryerson says.

High Gains Possible

In-house investigations by RADC and Syracuse University show that gains of more than 30 db. (1,000:1 enhancement) can be obtained. But in practice 20 db. probably represents a more realizable figure, Ryerson says. Bandwidths of 100 mc. appear possible at a frequency of 10,000 mc., he adds.

To provide the tunnel diode biasing power required, Ryerson suggests the use of thin-film radio-isotopes in combination with solar cells which have been proposed by others. This would consist of a thin silicon wafer coated with a phosphor film with a top layer of a beta emitting isotope. Beta rays striking the phosphor would cause it to glow at a wavelength which matches the peak response sensitivity of the silicon cell.

In effect, this would amount to a solar cell operated by synthetic sunlight, generated by the phosphor and radio-isotope.



STUDIES BY VOUGHT ASTRONAUTICS DIVISION of Ling-Temco-Vought revealed typical altitude/trajectory plot of pilot-controlled boost phase of lunar mission exercise (left), and pilot-controlled abort procedure and re-entry, right. Both are typical of studies made in Vought's manned spacecraft simulator. Studies indicated that it is possible for a man inside the vehicle to control it from light-off to insertion into orbit. The studies at Vought Astronautics Division utilized a six-degree-of-freedom manned spacecraft simulator testing various modes from completely automatic to completely manual control by the crew members of the vehicle.

Vought Tests Man's Boost Phase Control

By Erwin J. Bulban

Dallas—Feasibility of man controlling the boost phase of space missions, from light-off on the pad to inserting the vehicle into the proper trajectory, is indicated by hundreds of simulator exercises carried out here by Ling-Temco-Vought's Astronautics Division.

Industry studies of man's role in managing the launch vehicle on lunar missions run the gamut from a completely automatic system to that in which the crew performs all of the functions manually.

Vought Astronautics technicians emphasize that they are evaluating the problem and are starting out with no fixed concept—rather are attempting to determine just what functions man can handle and what are best handled by automatic equipment, although they point out the value of having man incorporated in the system to take over in event of certain malfunctions and possibly save what might otherwise be an aborted mission. Considerably more experience and detailed experimentation is required before the possibilities are defined and adequate displays and controls are developed.

Initial studies, utilizing the company's six-degree-of-freedom manned spacecraft simulator (AW Jan. 15, p. 77), which provides acceleration, instability and noise cues to the pilot, has demonstrated its effectiveness in providing real-time environment to gain data in testing human capabilities.

Data obtained thus far indicate the following:

- **Launch can be controlled** by the pilot with satisfactory accuracy if he has adequate displays.
- **Feel for magnitude** of attitude corrections necessary for adequate control can be quickly developed by the pilot through simulator training.
- **Some degree of vehicle instability** can be tolerated, but a more detailed program is necessary to develop quantitative data on stability requirements.

In addition to studies of the pilot's ability to control the vehicle during boost phase of lunar missions from earth, the Vought simulator has also been used to investigate pilot's capability to monitor boost phase of orbital flights and manually execute abort procedures, to effect rendezvous in lunar orbit, and lunar landings and takeoffs.

A typical lunar mission simulation performed with a test pilot having 2,700



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hr., most of which was jet time, considered a rigid-body two-stage booster having five engines—two booster, a sustainer and two vernier—in the first stage, and two engines in the second stage, which also was assumed to have fixed-direction verniers for velocity control. Attitude was controlled by gimball nozzles on the booster, and reaction controls on the second stage and the spacecraft itself. Spacecraft was considered as a symmetrical blunt body with offset center of gravity to aerodynamically trim at a lift/drag ratio of 0.50.

The simulator was equipped with simulated booster staging and attitude control systems. Boost control provided automatic separation of the first stage with fuel exhaustion, followed by automatic ignition of the second stage. A timer could be manually preset as desired to function on first-stage separation to delay second-stage ignition. The four low-thrust vernier velocity engines and second-stage reaction controls would automatically begin operation.

Engine Control

Pilot had a fire-terminate switch for manually igniting and terminating the boost engines. Manual termination provided first-stage separation, if this had not already been accomplished automatically, and engagement of the second-stage reaction control system. The second-stage boost engines could be restarted so long as fuel supply permitted. Second-stage reaction control system was automatically in operation at anytime subsequent to first-stage, but prior to second-stage separation, provided the two boost engines were not firing. Second-stage termination was automatic with fuel exhaustion only or it could be terminated manually with the main boost switch. Included were switches for manually firing or terminating vernier velocity engines on the second stage, command module engine for second-stage separation and the command module reaction control system.

Attitude control system consisted of a three-axis side-stick controller and three-axis trim knobs for manually controlling attitude from the cockpit and a rate-damping stability augmentation system which was automatically engaged during first-stage boost but could be manually engaged or disengaged by the pilot at other times. Combined signals from the cockpit and stabilization system produced nozzle deflections or reaction control forces as necessary.

Cockpit display provided the pilot with attitude, heading, motion and vehicle position information. Dial-type indicators displayed horizontal inertial velocity and burnout command, vertical velocity and burnout command, altitude, boost corridor—altitude error and allowable error, plus and minus, for present velocity—angle of attack, normal acceleration and longitudinal acceleration.

An attitude director displayed pitch, roll, pitch error relative to nominal boost phase pitch time program, yaw error as a function of vehicle displacement from heading relative to the reference plane, and sideslip. Horizontal situation display included these geographic values—vehicle heading, present course, programed course.

References Eliminated

It was found early in the program that the pilot used the pitch and yaw error references in the attitude director only briefly and they were eliminated because it was felt that they were not required, although Vought technicians indicate that it is possible that they could be considered usable display functions.

Cockpit of the simulated spacecraft also provided a television display presenting differential heading of present course and program course and offset distance of vehicle from reference inertial plane. A cathode ray tube display showed attitude-velocity situation of the vehicle relative to a graphic presentation of the programed altitude vs. velocity trajectory.

Pilot flew a series of missions in the simulator during which he manually controlled the entire operations from the launch pad to final stage burnout, including igniting the first stage, termination and separation of each booster stage, and trajectory control and navigation.

Initially the pilot controlled pitch attitude according to the pitch command indicator, which was programed as a function of time. Later he flew a memorized pitch angle program to the first altitude peak after which he controlled pitch angle, and subsequently vertical velocity, as required to "round up" for the run to the injection point, controlling the roll attitude to zero and the yaw attitude as necessary to steer into the required inertial plane.

Simulated Flights

Simulated flights supposedly were made from Cape Canaveral with a heading of 100 deg. Altitude vs. velocity trajectory of the 826-sec. mission is plotted in chart. In addition to flying the trajectory, the pilot is simultaneously turning the flight path as required, to be co-planar with an inertial plane, prior to the time of the final stage burnout.

In first tries, the pilot followed pitch attitude commands displayed by the horizontal command bar of the attitude director as pitch angle errors from a pitch angle vs. time program. There were no inputs to correct burnout conditions as a function of observed trajectory errors. Although the pilot could follow the pitch command with a high degree of accuracy, the trajectory deviated from the nominal trajectory and required burnout conditions. In order to achieve accurate burnout conditions, Vought studied methods of providing the pilot with information to permit him to determine required attitude corrections rather than attempt to correct attitude commands for measured trajectory errors.

It was found that it was difficult for the pilot to attain a required set of burnout conditions when several of the display readings must change as burnout is approached. Most of the information used for control near burnout must be displayed in the form of error indications rather than absolute values, Vought notes. In initial simulator trials, the pilot controlled to zero error in his lateral display and attitude, but had to observe the total magnitude of his continually increasing vertical and horizontal velocity and terminate thrust at specified values of each. His task became much easier and control of burnout conditions was much more accurate when the specified nominal trajectory was adjusted to permit a constant vertical velocity of 3,000 fps. as burnout was approached.

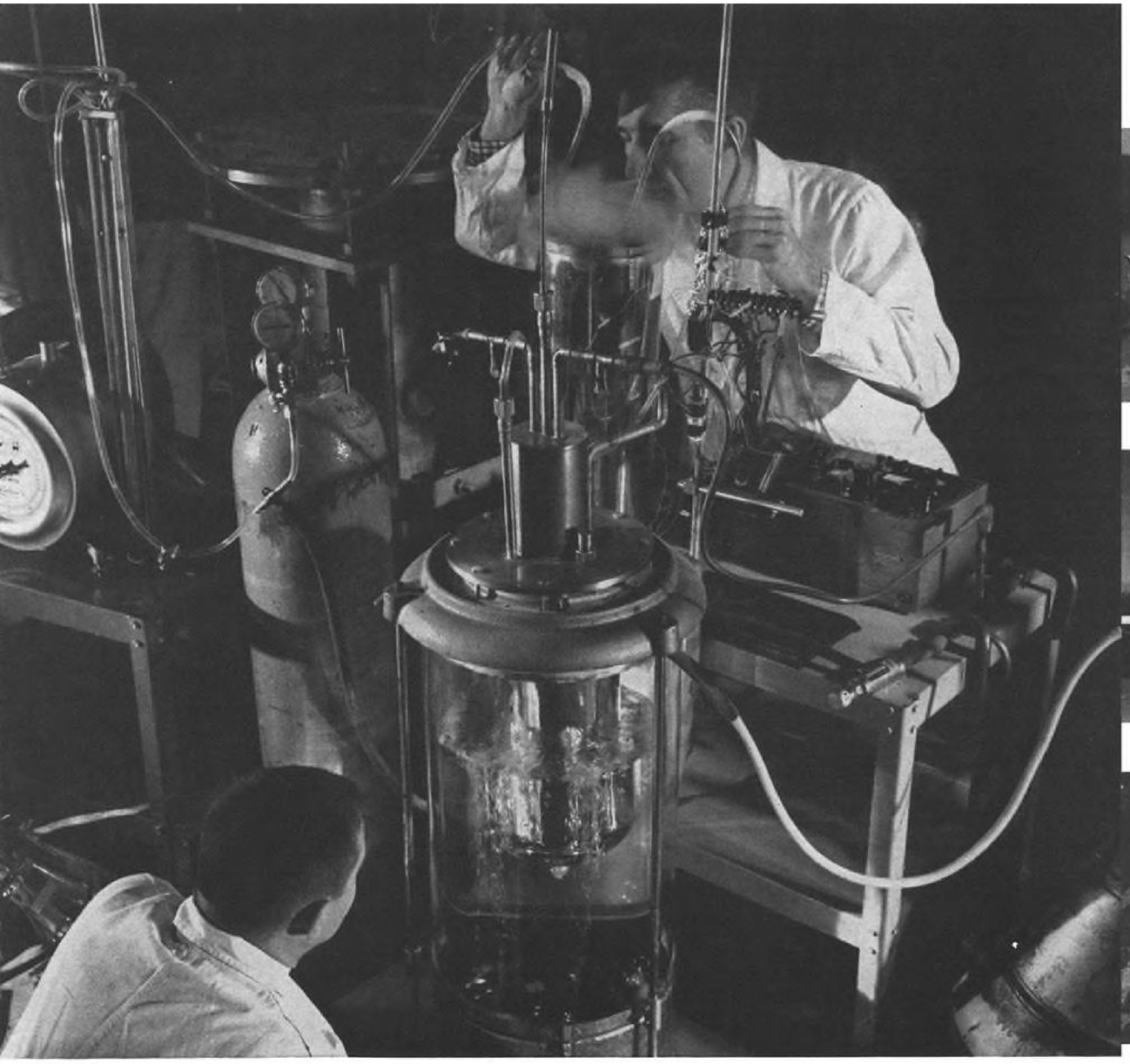
This enabled the pilot to hold all other display readings constant as horizontal velocity increased to the proper burnout value and avoided a need for controlling two rapidly changing parameters to bring each to a precise value simultaneously with the other.

Trajectory Control

It became evident that the pilot learns to control trajectory very efficiently after practice, only small sideslip corrections and variations from the intended angle-of-attack program being evident to demonstrate that he has ability to control the trajectory without maneuvers that waste booster fuel.

Although the data compiled showed that both booster stages were aerodynamically unstable, with a requirement that the first stage usually acquire peak dynamic pressures of 600-800 psf., it was noted that the pilot after practice was consistently flying the unstable first stage through the high dynamic force region and maintaining complete control. There were times that aerodynamic factors caused the vehicle to become unstable to the extent that it is possible that a requirement for positive stability will be necessary to ensure a high probability of success. A detailed investigation with accurate simulation of numerous factors, including booster size, magnitude of dynamic pressure, control system characteristics and aeroelasticity would be required to specify stability requirements for a particular booster and mission.

Study of the pilot's capabilities in the



Beech helps space vehicles get better mileage by turning "hot" fuel into icy slush

Slush hydrogen experiment shows vital facet of Beech's comprehensive systems management capability

At the heart of this experiment at Beech's Boulder, Colorado, space center are three double-walled vacuum jars, each inside the other. Inside the inner jar is liquid hydrogen, while the center jar contains liquid helium. The outer jar is filled with liquid nitrogen. The idea is to further reduce hydrogen temperature until it turns to icy slush.

The purpose of this experiment is to explore the feasibility of reducing hydrogen volume in order to increase space vehicle fuel loads without increasing tankage size or weight.

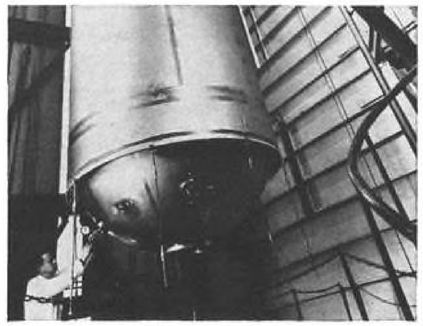
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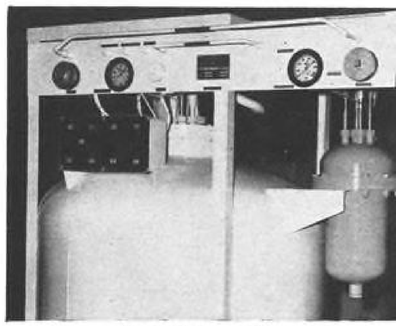
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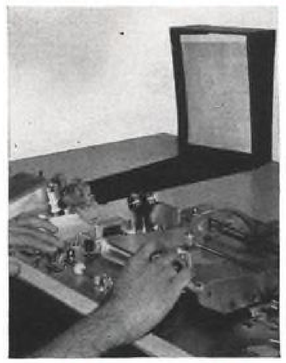
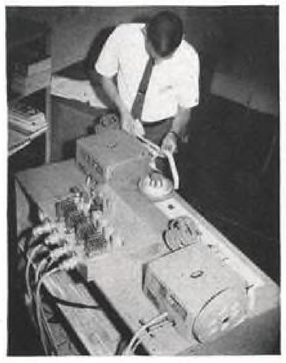
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abort situation were carried out considering a lunar mission. Random abort procedures were accomplished, depending on varied situations. One example provided (see chart) was an exercise conducted after the flight had progressed along the programed trajectory beyond the first altitude peak and when downward vertical velocity had built up to some 1,000 fps. At this point, the pilot was commanded to abort the mission.

Abort Maneuver

He terminated thrust of the second-stage booster and allowed the vehicle to descend to approximately 500,000 ft., where he oriented it to a pitch angle of +75 deg. and then relighted the booster, checking descent and accelerating the vehicle toward circular satellite speed. He maneuvered to attain zero vertical velocity upon reaching 400,000 ft. Holding altitude constant, he continued thrust until he reached circular satellite speed, then terminated thrust and coasted in a near-circular orbit until commanded to de-orbit. With the vehicle rotated 180 deg. in yaw, he relighted the second-stage booster until velocity was reduced by 500 fps. As the vehicle descended toward the denser atmosphere, the pilot separated the spacecraft from the booster and set up a lift/drag maximum glide attitude.

Since no drag or landing chute was deployed in this simulated flight, the module descended to impact the earth at 200 fps. Simulator could be programed to take into account even more sophisticated recovery systems such as the sail-wing concept, Vought technicians note.

Successful experience with the simulator in boost control phase studies has suggested additional techniques that look interesting to technicians here:

• **Range control** whereby adjustment for range error could be made by establishing a nominal trajectory that includes a short coast phase, or parking orbit, during which range might be adjusted by varying the coast time. Coasting technique could also be valuable by providing the crew with an opportunity to make a final checkout and decide whether to abort or proceed with the mission.

• **Altitude correction** might be accomplished during coast phase should large altitude errors develop which are difficult to correct efficiently prior to burnout because of the continuous increase in speed while thrust is being applied. If a favorable flight path is established and thrust is then terminated, the vehicle could coast to proper height and the booster re-lit to continue along the desired trajectory. The maneuver should be used in conjunction with range control method just mentioned in order to prevent large range errors from occurring.

Vought Astronautics plans to increase the simulator's attendant computer equipment utilization by putting in new equipment having what they term twice the capacity of the current PB-250. This will permit them to program a problem or task while the other computer is feeding data to the simulator. This would permit the simulator to be quickly used to follow up on a successive problem upon the completion of a prior task.

Mathematical model and manned cockpit mockup simulator studies by Martin Marietta Corp. scientists and engineers of pilot participation during boost phases of a space vehicle also tend to justify a basic conclusion of other experimenters that there is a high probability that a pilot can perform adequately in either the control or guidance loops. Staging functions, fuel mixture and ullage are other possibilities where the pilot may exert monitoring and control functions.

Highlights of experiments by the company indicate:

• **Optimum place** to insert the pilot in the control guidance loop is at a point where he can control the gyro reference system-in-essence, applying trim signals to the automatic control system and it carrying out the job of damping vehicle perturbations. The pilot is thus free to guide the trajectory and carry out other duties, if necessary.

• **Pilot can successfully** control and stabilize the vehicle with his signals inserted directly into the automatic control system (downstream of the attitude gyros). This mode, however, requires that other cockpit duties be minimized since it appears that three-axis control requires the pilot's full attention.

• **Pilot control downstream** of attitude gyros without assistance of rate dampers for stability augmentation is very difficult, particularly for the unstable vehicle configuration. With intensive preflight simulator training, it appears that the pilot could develop sufficient skill to handle this mode on an emergency basis.

Martin Marietta simulator studies have involved over 1,100 "flights" by four company test pilots and four military research test pilots. The fixed-base analog simulation facility and cockpit mockup represented a five-degree of freedom capability of investigating short-period stability in varied modes of pilot utilization. Pilot display information included rate of climb, sideslip angle, angle of attack, three-axis ball flight attitude indication, a cathode ray tube for attitude vs. altitude rate overlay display, displacement gyro error information by means of pitch, yaw and roll meters. Malfunction display monitors covered thrust chamber pressure, fuel tank pressure and oxidizer tank pressure and permitted measuring pilot reaction time to malfunction detection system signals.

Vehicle was configured to include a two-stage booster having a gross weight of 329,000 lb. at liftoff, aerodynamically stable in the first stage and unstable in the second. Auto-stabilization loops included rigid body dynamics, fuel slosh modes, elastic bending modes of the air-to-vehicle structure and roll-yaw dynamic damping.

Investigation included these pilot functions in the various modes:

• **Total autopilot replacement,** with the pilot performing vehicle attitude stabilization functions in place of autopilot displacement and rate damping loops and the pilot also handling guidance steering control.

• **Attitude gyro replacement,** with the pilot performing the same functions as in the above mode, except that the autopilot rate damping loop was operating.

• **Steering backup,** with the autopilot vehicle attitude stabilization loop remaining in operation and the pilot providing steering by applying a signal to torquers which precess the attitude gyros, with steering signal display being based on either open-loop or closed-loop guidance information.

Indications were that with rate loop inactive, the pilot could not maintain stable control throughout flight and in a number of cases studied, total instability was evidenced with no possible means for achieving stability through the use of practical compensation schemes. For the majority of the remaining cases, stability could be assured only with excessive and impractical gain indications.

Added Tasks

In regard to adding tasks to the pilot's guidance and control functions, such as monitoring cabin environment and maintaining communication with ground stations in addition to watching the malfunction detection system and being prepared to take appropriate action if malfunction occurs, Martin Marietta technicians added two requirements to measure their possible degradation on pilot performance. For malfunction detection system task one, the pilot had to sense and extinguish a light appearing at random intervals; for task two, the pilot extinguished the light and reported by voice communications specific quantitative readings to a technician outside the mockup.

Addition of task one did not appear to reduce pilot control efficiency for pitch and roll as measured by maximum rates generated, although pilot performance in regard to maximum yaw rates went very close to or over the malfunction detection system limit, Martin Marietta technicians note.



USS ENTERPRISE prepares to launch a mixed force of North American A3J-1 bombers and Chance Vought F8U-2 and F8U-1P fighter aircraft. A3Js are the largest carrier-based aircraft in current Navy inventory. Note large total wing area on A3J aircraft.

A3J-3 to Feed Photo, Other Data to Ground

By Larry Booda

Columbus, Ohio—Navy's A3J-3 reconnaissance version of the North American A3J-1 Vigilante supersonic bomber will be the first U.S. military aircraft to integrate photographic and electronic sensors in the vehicle itself and feed the data they obtain to a surface-based tactical data system.

The A3J-3 will have the same basic airframe as the A3J-2, which is now undergoing prototype testing and will be operational next spring. The A3J-2 in turn is a growth version of the already operational A3J-1, which can carry conventional or nuclear bomb payloads on low or high altitude missions.

All three versions of the aircraft carry a two-man crew.

The A3J-3 will carry a pod under the fuselage for electronic sensors and cameras (AW Aug. 6, p. 62). The central package of electronic equipment will be carried in a fuselage tunnel where weapons are stored in the bomber configuration.

Power for all three versions of the A3J is furnished by two General Electric J79-8 engines, equipped with afterburners, developing a total of 34,000 lb. of thrust. This is the same package that powers the McDonnell F4H-1 Navy fighter and the Air Force version of the same aircraft, the F-110 (AW July 30, p. 38). But there the resemblance ends. The A3J is designed to carry heavier loads and reach higher altitudes. It was designed primarily to perform as a bombing system, while the F4H and F-110 emphasize air superiority performance as a fighter.

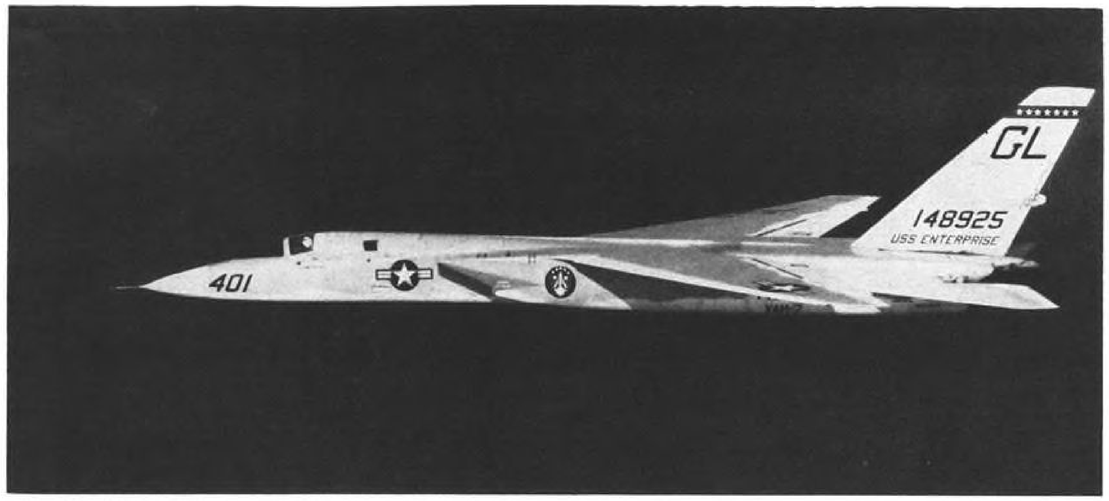
Nevertheless, the A3J is a Mach 2.1 aircraft when carrying a combat load.

The Vigilante is being considered for a third type of mission. The Air Force Air Defense Command has looked into the possibility of using it as a fighter armed with long-range missiles. ADC first investigated this possibility two years ago and recently initiated another study.

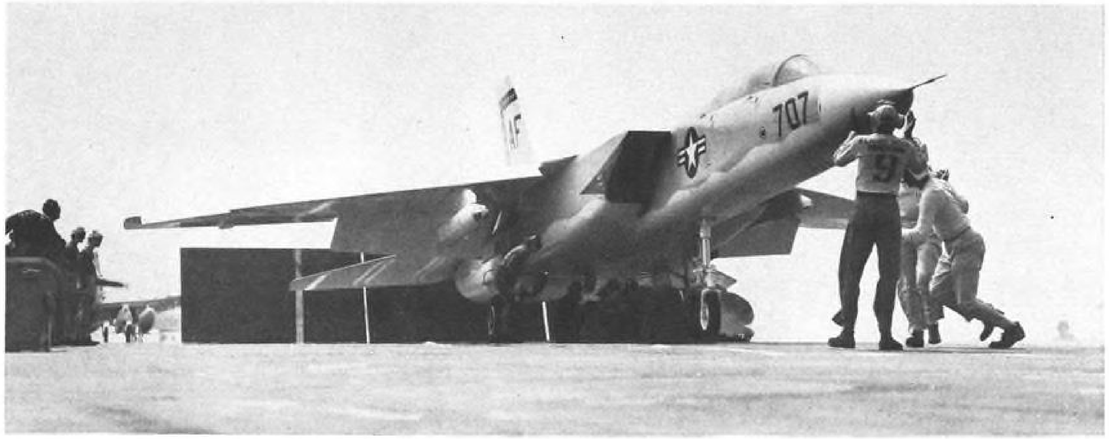
As a reconnaissance aircraft, the A3J-3 will be able to fly higher than 70,000 ft. It will have sufficient speed to thwart most air intercept attempts and will be able to act as a fighter for self protection. It also will be able to jam enemy air and ground anti-aircraft radar.

The camera inventory will include installations for shooting obliquely downward on each side, shooting vertically, splitting images between oblique and vertical, scanning from horizon-to-horizon, and conducting open-shutter, synchronous film transport photography for low level missions. The non-optical systems will include side-looking radar, multiple sensors in the radio and infrared regions to perform electromagnetic intelligence and electromagnetic countermeasures functions, and low light-level television capable of operation at night. Flares will enhance the night mission capabilities.

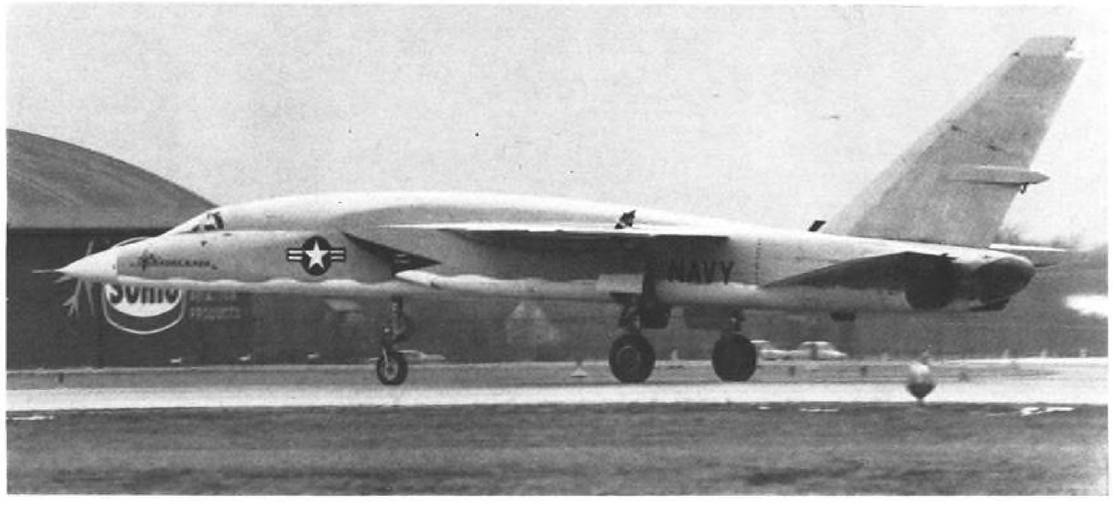
In the aircraft itself, data obtained will be partially integrated and processed before transmission to a ship or ground station for more complete processing and immediate preliminary evaluation. Since all data is recorded on magnetic tape, transmission can be delayed if desired and the complete record retained. On return to the ship or air-

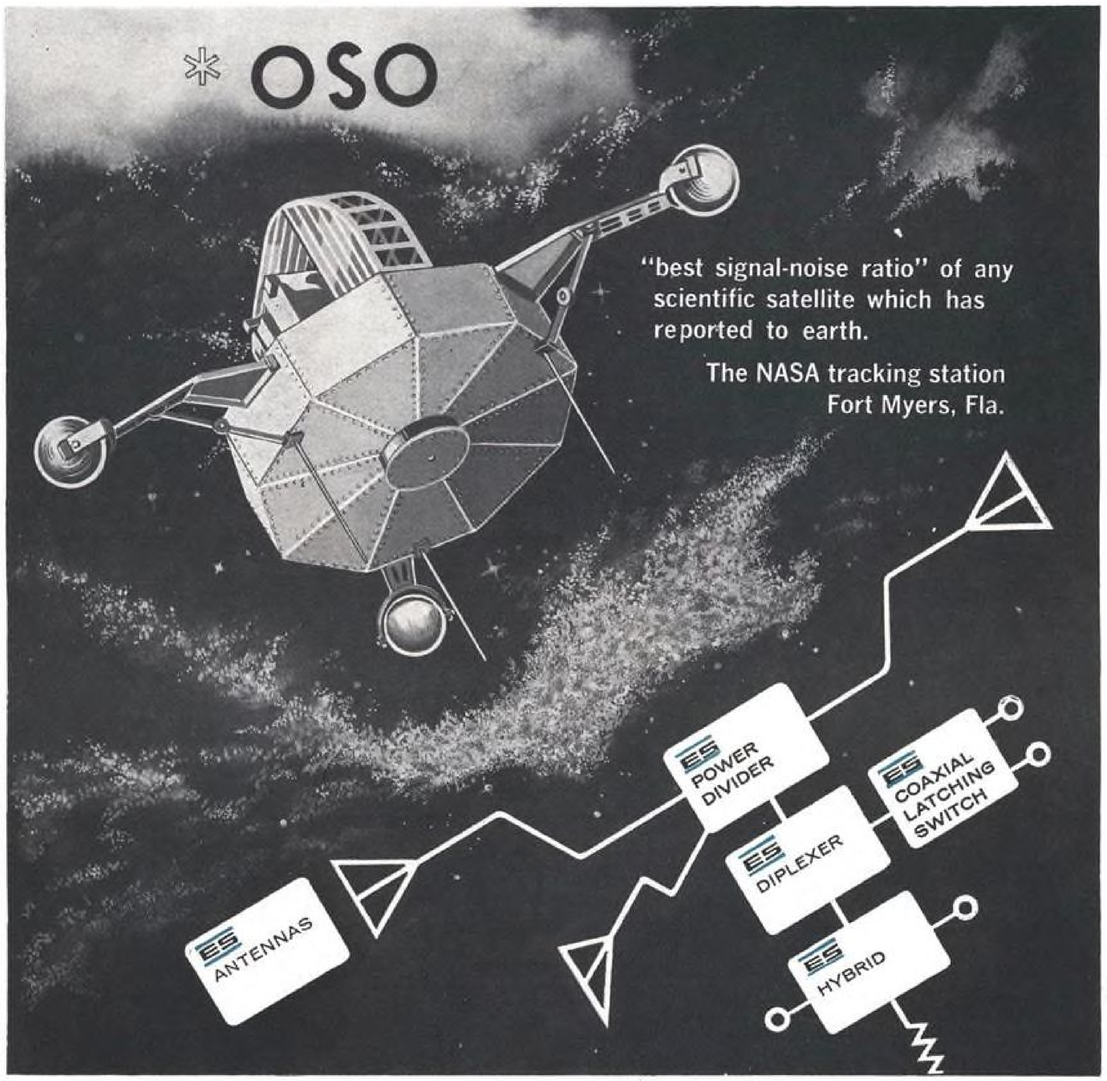


A3J-1 VIGILANTE of Heavy Attack Squadron 7 (Hatron 7), based on the USS Enterprise, is capable of speeds of Mach 2.1. Weapon stores are carried both internally, in ejection tube which runs from nose to tail of aircraft, and externally, in underwing pods. Crew of two is seated in tandem cockpits on the same level. In A3J-2, bottom, rear cockpit is elevated.



A3J-1 ON CATAPULT of the Enterprise has a practice bomb slung beneath starboard wing. Note leading edge slats and large flaps. Below, prototype A3J-2 is shown on the runway ashore. Changes from -1 model, top, are evident, including hump back for additional fuel.







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Min. Energy Gain ... —6 db
Polarization ... Arbitrary
Frequency ... 127 - 137 Mc
Impedance ... 50 Nominal
Efficiency ... 90%
Structure ... Existing Arms plus Parasitic Whips
Life ... 100 Arm Extensions plus 6 months



Diplexer Specifications
Isolation ... > 40 db (Rx from Tx) > 20 db (Tx from Rx)
Insertion Loss ... < .75 db (Tx) < 1.0 db (Rx)
Frequency ... 120/135 Mc Typ.
Impedance ... 50 Nominal
Size ... 5½ x 2²⁵/₃₂ x 1²⁵/₃₂
Weight ... 8 oz.



Hybrid Specifications
Power Split ... within .5 db
Isolation ... > 40 db (Rx freq.) > 20 db (±10% freq.)
Insertion Loss. < 1.0 db (Rx freq.)
Frequency ... 130 Mc Range
Impedance ... 50 Nominal
Size ... 2¹⁹/₃₂" DIA x 2⅞"
Weight ... 4 oz.



Coaxial Latching Switch Specifications
VSWR ... < 1.10
Insertion Loss ... < 0.2 db
Crosstalk ... 40 db
Operating Time ... 20 Ms
Frequency ... 120 - 137 Mc
Actuating Voltage 18 ±1.8 volts
Min. Actuating Current .. 300 MA
Size ... 2⅛ x ⅝ x 2¾
Weight ... 5½ oz.



Environmental Specifications
Temp. 4 hrs / −20°c to +55°c
Humidity ... 2 hrs / 95% / 50°c
Vibration ... 0.12" DA / 5-10 cps
0.06" DA / 10-75 cps
20 g's / 75-2000 cps
Accel. 18 g's / 7½ min / one axis
3 g's / 7½ min / two axis
Altitude ... 300 mi

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field, all stored data will be fed into a computer. Photographic film will be processed and the photographs interpreted for intelligence information, which is then coded for feeding into the computer with all other data. This computer will be able to recall previously stored data regarding the area covered on a mission, compare it with the new data and feed the results to intelligence storage facilities.

Force Control

The computer in turn will be part of the Navy Tactical Data System (NTDS) which has been designed to help commanders make rapid decisions in controlling combat forces. NTDS will feed intelligence and command data to a wide variety of surface and air units engaged in a military action.

Preparations for the full A3J-3 system test this fall are being made at the Naval Ordnance Test Station, China Lake, Calif. The test airframe itself is a modified A3J-1. Production versions would use the A3J-2 airframe.

Whether this reconnaissance aircraft system will go into production will depend to some extent on the outcome of studies conducted by the tri-service Darrow tactical reconnaissance board, which considered all military systems of this nature with the idea of eliminating overlap and integrating analysis and control systems (AW Aug. 6, p. 34).

It has not been decided yet whether the reconnaissance version will be included in Fiscal 1964 budget requests as a production item. Navy proponents want enough money to start a program that would provide more than 25 aircraft.

Present funding assures delivery of more than 50 A3J-1 and A3J-2 aircraft. Proposed programing would keep North American's Columbus Division busy producing the A3J series for at least another three years. If the Air Force should buy versions of the aircraft, as it is in the case of the F4H, there would be a substantial increase in the production rate.

Operational Deployment

First operational deployment overseas of the A3J-1 began early in August when a squadron sailed aboard the nuclear-powered aircraft carrier Enterprise for exercises in the Eastern Atlantic and Mediterranean. Although all of the Navy's carriers of the Midway, Forrestal and Enterprise classes are capable of launching the A3J, only the Enterprise can now provide the logistic and maintenance support required by the sophisticated A3J-3 electronics systems.

Since the A3J-1 and -2 were designed primarily as bombers with a wide variety of ways for delivering nuclear weapons, there was considerable debate within the Navy when Fiscal 1958 and 1959 budgets were being drawn over whether to buy the A3J in quantity. One faction, led by Garrison Norton, then assistant secretary for air, argued that strategic bombing was not the Navy's mission. He maintained it would be a basic mistake to invade the mission area of the Air Force.

Another faction within the Navy argued that the A3J also was capable of performing low altitude missions and carrying conventional weapons.

The latter group won and the Navy included a request for production funds for the A3J in its Fiscal 1960 budget request. This decision subsequently was approved by the Defense Department and the money was appropriated by Congress. At that time, development of the airframe was almost complete and the weapon system was about half completed.

Navy funding for the A3J-1 in Fiscal 1962 was $177.9 million. Because much of the development cost was included in this figure, the unit price ran about $9 million per aircraft. Funding for Fiscal 1963 is over $200 million. This includes money to begin production of the A3J-2.

Accelerated production rates and the tapering off of the bombing system development program will reduce the unit cost to slightly less than $5 million.

Bombing System

The A3J-1 at present is strictly a Navy bombing system capable of operations ashore or afloat. Plans for use by the Marine Corps have not jelled. The aircraft could be operated from Short Airfields for Tactical Support (SATS) by use of portable catapults and arresting gear. SATS units are already deployed with the Marines in the Western Pacific.

Heavy load-carrying ability was built into the A3J-1 in two ways. One was the provision of 700 sq. ft. of wing area. This is relatively large for a Mach 2-plus aircraft. By comparison, the F4H has 530 sq. ft. The second way is boundary layer control. In the A3J-1, air is bled from the compressor sections of the engines and piped along the forward edge of the flaps. When the flaps are down the air is blown over the upper surfaces of the flaps, assuring smooth air flow at high angles of attack. In the A3J-2, the blowing also is applied behind the drooping leading edges of the wings. The flaps also are extended further outboard to the wing fold.

A distinguishing feature of the Vigilante is its system for ejecting bombs rearward from its bomb bay, which is essentially a tunnel running lengthwise in the aft section of the fuselage. This tunnel, equipped with rails and a catapult, stores a nuclear or conventional bomb at the forward end. The bomb is



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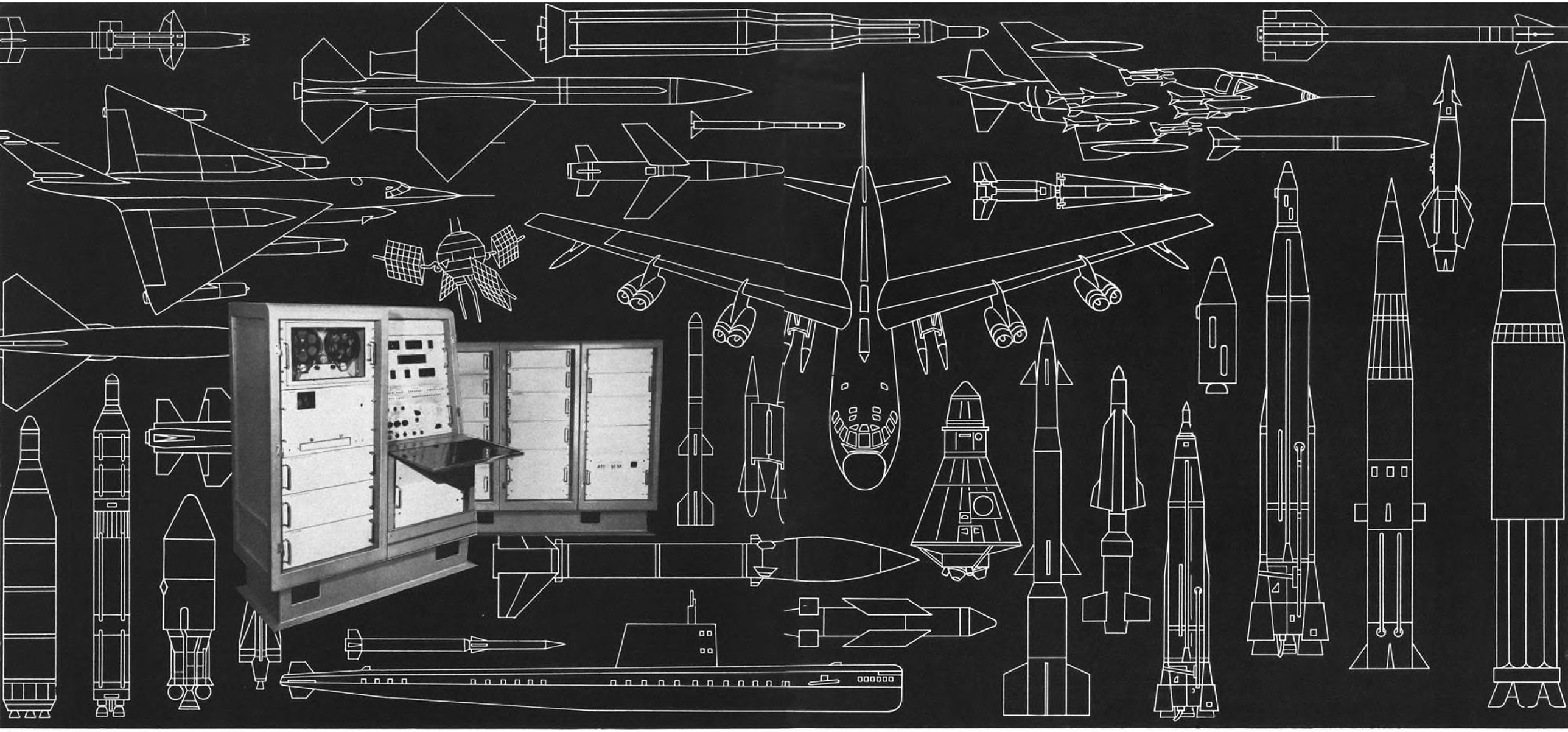
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There's more to light than meets the eye

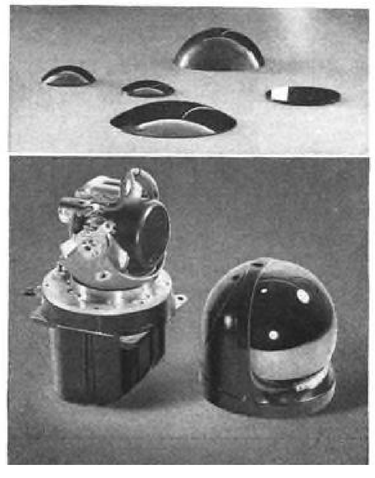
This candle is producing two kinds of light. One is the visible light you see. The other is "invisible" light—or infrared energy. This energy is produced not only by the flame, but by the candle itself. Because in the strange world of infrared, *all* objects which are "warm"—above absolute zero—radiate. In fact, Hughes infrared detection equipment could measure the infrared energy produced by an ice cube 5 miles away! Hughes scientists and engineers have been applying the science of "invisible light" to problems of national defense for well over a decade. Their work has produced striking results—such as the capability to sense distant temperature variations as small as 1000th of a degree.

Hughes infrared search, detection and track systems, being manufactured for our front line interceptor aircraft, can locate potential attackers by the infrared they generate. This allows the interceptor to attack its quarry without revealing its own presence. The Falcon infrared air-to-air missiles (a backbone of our air defense program with over 10,000 having been delivered by Hughes) have repeatedly demonstrated extremely high striking accuracy at competitive weapons meets.

Infrared techniques are exceptionally useful in space applications. A Hughes stellar tracker utilizing visible light will help navigate the Surveyor lunar landing vehicle on its 240,000-mile trip to the moon. This tracker, seeking a navigational "fix," will identify the star Canopus simply by the amount of energy it generates.

Other Hughes work in infrared covers the entire range of both systems and component research, development and manufacture. Now in progress are systems for anti-ballistic missile defense, anti-submarine warfare, bomber defense, and tactical weapons control. Simultaneously, Hughes is supporting the rapidly expanding infrared technology with the development and quantity production of highly advanced detectors, optical components and cryogenic systems.

In total, these activities represent one of the most important reservoirs of infrared capability in our nation—wholly devoted to helping man productively use the light he cannot "see."



Infrared windows—since glass is not transparent to infrared, "windows" and lenses of other materials, such as silicon or germanium, must be used. Hughes manufactures many types of such optical components.

Hughes infrared search-track sensor head designed for interceptor aircraft enables pilots to detect "bogies" by the infrared they generate. The infrared system works effectively even against very low altitude targets.

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FOLDING WING TIPS ease stowage problem aboard the Enterprise somewhat. Vigilantes parked on the carrier's elevators have auxiliary fuel tanks slung beneath their wings. Nose and vertical fins also fold to reduce over-all length and height.

attached to two cylindrical, pressurized 275-gal. fuel tanks. After takeoff and climb, the fuel in these tanks is the first to be used.

In the ejection sequence, the tail cone is jettisoned first. Then the catapult is fired, forcing the bomb and the fuel tanks out of the tail opening. The tanks remain attached to the bomb, acting as aerodynamic stabilizers for the fall to the target. The sequence can be initiated in any flight attitude.

The ejection system permits a wide selection of delivery maneuvers. Loft bombing, long employed by the Air Force and the Navy, can be used with the A3J. When this method is used, the aircraft climbs almost vertically to lob the bomb on a ballistic trajectory, then performs an Immelman turn to fly away in the opposite direction.

High or medium level approaches also can be made, with ejection taking place in level, climbing or descending turns in either direction, applying lateral motion to the bomb. Low altitude delivery, designed mostly for dropping conventional weapons, is aided by the use of a radar terrain clearance indicator. The bomb bay can be reloaded in a relatively short 30 min.

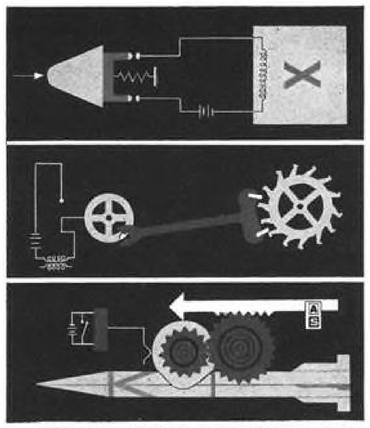
There are a number of stations for carrying non-nuclear armament under the fuselage and wings. Various general purpose and special purpose high explosive bombs, fire bombs, missile dispensers, Napalm tanks and Martin Bullpup missile launchers can be carried. Bullpup is a sight-guided, air-to-surface missile (AW May 7, p. 86).

Most of the bombing control equipment is carried in the nose to the aircraft. The complete system is called the ASB-12 bombing control system and it is assembled by North American's Autonetics Division. The radar portion of the package was designed and is manufactured by the Electronics Division of General Dynamics Corp.

An inertial navigation system, designed by North American, is located in the nose and is integrated with the ASB-12 bombing system. It consists of a network of accelerometers, integrators, potentiometers and indicators which produce true ground speed, direction and distance data for continuous map tracking.

The system can be used to identify a target for automatic bombing runs by comparing what is being observed with radar signatures and photographs stored in the computer. The computer solves the problem, and the system makes the bombing run to time of release, makes the release and controls the escape run.

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The A3J airframe development program progressed normally after wind tunnel tests in company and government facilities had proved the basic configuration. But the navigation-control-delivery integration problem is yet to be completely solved.

Until recently, the company and the Navy were troubled with trying to find out why the bomb bay stores did not fall properly. Fixes have involved the use of different aerodynamic designs for the tanks and the bomb, varying the coupling designs and shifting weight distribution.

The complex electronic gear demanded many engineering man-hours, mainly in trying to make the individual units work together as a complete system. North American designed the individual units to permit maintenance by semi-skilled military men. Readily replaceable modules are employed throughout. Faulty circuits can be spotted with a small portable analyzer and modules replaced in a short time.

But it is analyzing the system as a whole and making it work properly that has presented the greatest problem. Doing this at a test activity is not comparable with doing it at an operational installation aboard ship. It will take at least until next spring, according to Navy officers, to establish a smooth working relationship between the system, its checkout and repair and the personnel maintaining the system.

The A3J is a high wing monoplane with a 14.47 to 1 fineness ratio fuselage, which is its most distinguishing feature. Over-all length from nose to the furthest aft portion of the vertical stabilizer is 73.2 ft. To fit the elevators and hangar decks aboard carriers, the nose folds back and the vertical stabilizer folds down. Over-all length folded is 65.4 ft.

Width from wing tip to wing tip is 53 ft. With the outer panels folded, the width is 42 ft. The wings are swept back 37.5 deg. Lateral control is obtained through the use of spoilers on the upper surfaces of the wings and deflectors on the lower surfaces. There are no ailerons. Moving the control stick toward one wing causes the spoiler on that wing to rise and the deflector under the other wing to lower, resulting in a rolling motion in the direction in which the stick was moved.

Both the horizontal and vertical control surfaces are mounted on single axles, or spindles, to make them fully movable. They are swept back 45 deg. Horizontal span of empennage is 30.6 ft.; vertical surface rises to 19.4 ft.

In the A3J-1, the two tandem cockpits are on the same level, with the canopy tops forming a horizontal line. In the higher-lift, higher-load -2 and -3 models, the fuselage height has been raised so that the rear cockpit sits higher than the forward one. This raised portion of the fuselage behind the second cockpit provides more fuel storage space and its humped shape also provides more aerodynamic lift, similar to the action of the upper surface of a wing.

Both cockpits are equipped with HS-1 rocket ejection seats developed by North American. They permit safe ejection in level attitudes while on the runway with no forward speed.

Flight controls are installed only in the front cockpit. The system is electro-hydraulic, the hydraulic portion of which is dualized to provide a margin of safety. Automatic yaw damping is effective at all speeds, while pitch damping cuts in at speeds above Mach 0.5. When the automatic pilot is engaged, heading can be changed by use of the control stick without disconnecting the automatic pilot. It holds preset altitude, speed and heading. It is an integal part of the bombing system. In case of malfunction and erratic flight, it can be overriden manually.

A liquid oxygen system provides an eight hour supply for the two crewmen.

The two engines are mounted horizontally on each side of the extreme aft portion of the fuselage, with the bomb bay tunnel between. Full length doors give access to any part of the engines and their accessories, even while the engines are running. Variable position ramps which lower from the top of each engine inlet assure subsonic air flow in the ducts during supersonic flight.

Many parts of the aircraft are readily accessible in addition to the engines. When the nose is folded, the inside of the entire forward fuselage area can be reached. Hydraulic systems for the landing gear and speed brakes are mounted openly for ready access in the landing gear and speed brake wells. The empty bomb bay permits the plumbing and wiring runs to be reached.

The A3J can be catapulted under most combat loading conditions without the use of afterburners. When an extreme-range mission is to be flown at maximum takeoff gross weight, afterburners can be used to gain safe climbing speed more rapidly. A normal combat loading would produce a gross weight of 54,000 lb. to 56,000 lb.

Firm, Long-Range Program in Nuclear Power Plant Development Expands Need at Allison for More Top Level Scientists and Engineers



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(Mechanical)—Mechanical or Chemical Engineers with background in nuclear powerplant layout, nuclear powerplant mechanical integrity and high temperature component design.

(Electric Power)—Electrical Engineers (Power Systems) with background in steady state system performance and power system stability.

REACTOR PHYSICISTS—(Analytical)—Physicists with substantial experience in reactor physics field to analyze nuclear behavior of projected reactors; generate new concepts in design or control of nuclear reactors.

(Experimental)—Physicists, preferably nuclear, with experience in experimental nuclear physics, to analyze and evaluate experiments on compact reactor core configurations.

(Shielding)—Physicists with capabilities in nuclear reactor shielding, including experience in experimental shielding investigations and associated minimum weight shield configurations.

NUCLEAR REACTOR DESIGNERS—Mechanical Engineers with nuclear experience or training. Extensive experience in layout and detail design of structures and mechanisms operating under conditions of high temperature, thermal stress, irradiation and corrosion, and with close dimensional tolerances.

HEAT TRANSFER SPECIALISTS—Experience with liquid metal heat transfer preferred. To plan, analyze and conduct research programs involving liquid metal boiling and condensing heat transfer, convective heat transfer, and radiant heat transfer.

ELECTRICAL ENGINEERS—(Power Systems)—Power system engineers for study of MCR applications. Experience in design of central station or standby powerplants, with knowledge of load analysis, synchronous machines, switchgear control and specifications.

(Instrumentation Systems)—Nuclear or Electrical Engineers with instrumentation or control experience for design of MCR console, instrumentation, and data transmission link.

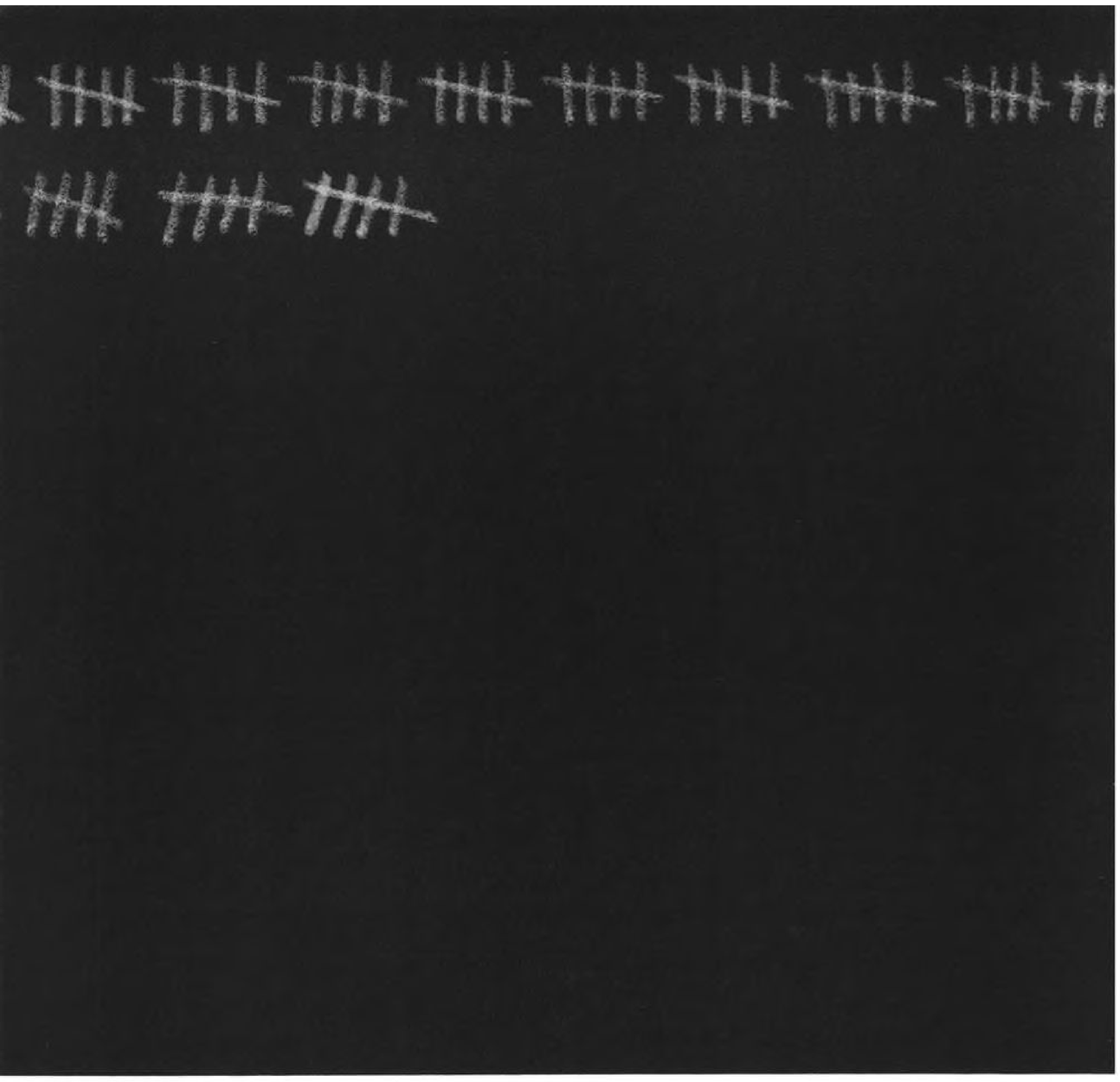
(Design)—Electrical Engineers to design controls and switch gear. Also, EE's to conduct studies on electrical power systems, including load analysis and stability requirements.

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Bendix Radio Division

THE Bendix CORPORATION

Weapon System Program Conduct Studied

By William H. Gregory

Conclusions drawn in a weapon system acquisition study by a Harvard Business School team reflect a skeptical view of the proposition that weapon systems developments should generally be conducted in the minimum possible time.

In the light of the conflicting approaches indicated by Defense Research and Engineering and the Air Force Systems Command before a House Government Operations Subcommittee, (AW Aug. 13, p. 32), the study takes on added significance since one of the authors, Merton J. Peck, an associate professor at the school, later joined the Department of Defense comptroller's staff.

Over-all Research Project

The study, sponsored by a Ford Foundation grant and co-authored by Peck and Frederic M. Scherer, research associate, is titled "The Weapons Acquisition Process: An Economic Analysis." It has been published by the Harvard Business School and is part of an over-all research project, involving case studies of 12 advanced weapon systems, under direction of Prof. Paul W. Cherington.

"As we read the record," the authors contend, "the conduct of U. S. weapons programs has on the average been fairly good on the technical performance dimension and somewhat less favorable on the development time and reliability dimensions. But the most notable deficiency has been the failure to hold development and production costs to reasonable levels."

Weapons program costs have been high, the study says, because of inadequate attention to the efficient utilization of technical, production and administrative manpower and because of the development of qualitative features and increments of technical performance not worth their cost. More fundamental reasons, the study continues, are:

- **Time and quality** considerations have been emphasized by the services rather than cost reductions.
- **Technical competence** has been lacking in the services to evaluate contractor costs in detail.
- **Meeting schedules** and delivering high quality products has been recognized by contractors as more important than efficiency in obtaining new contracts.
- **Cost-plus** contracting for development has meant profits have been roughly proportional to total costs, reducing incentives for cost reductions.

"Given the state of the art at any moment," the study says, "weapon system quality appears to increase with the expenditure of development time and resources, but only at a decreasing rate."

Not all programs lacked economic rationality, the study indicates, referring to technical compromises made in the Convair Atlas missile to provide early availability. In a low-priority fighter project—probably a reference to the Republic F-105—production was held back for a considerable time while improvements were fed into the design, peaking production with the most advanced design.

Nevertheless, in all 12 programs studied, excursions in pursuit of technical perfection were reported which cost far more than they were worth. In one program, for example, the design philosophy was to use standard components only when customer-developed units offered no operating advantages.

Defining Efficiency

Absence of profit is often wrongly equated with efficiency in the weapons acquisition process, the Harvard Business School research study found, an assumption stemming from a false analogy with traditional concepts of competition as a regulator.

"Once the purely and perfectly competitive marketplace is forsaken, there is no assurance that minimum profits are synonymous with economic efficiency," according to the study.

"Government personnel recognize that if any item in the weapons bill can be attacked and perhaps reduced, it is the profit item. However, this Machiavellian realism ignores the 90% or more of the bill in which a much greater potential for efficiency improvements typically exists."

The study defined efficiency as accomplishing a desired result with the minimum possible expenditure of resources. It rated the general efficiency of the defense industry favorably with industry as a whole, considering the environment. Procurement and utilization of manpower were considered the weakest areas in the defense industry, though improvements were noted in recent months.

In addition to this type of gold-plating, the study found in two programs that the use of multiple backup approaches had been carried well beyond the point where it promised any significant marginal return. In some areas, astutely conceived backups can enhance program success probability, the study notes, especially in the components area, where uncertainties often are greatest and costs of developments are relatively low.

Changes in service attitudes in some of these areas—in stressing cost as equal to schedule and performance results and in the training of military cost analysts—were indicated at the Air Force Systems Command management conference at Monterey, Calif., earlier this year (AW May 14, p. 26).

The study also takes up the position of the defense contractor, whose lot, the authors of the study agree, is not an easy one.

"To be sure," the study says," he has a customer who agrees to pay his costs during the development period, whatever the outcome may be.

"Yet he deals with a bureaucratic maze for a customer. Some of the occupants of this maze may be less than fully qualified for their demanding jobs. Second, the non-market character of weapons acquisition brings the customer into his internal operations in a way that restricts his freedom to manage his own business.

Changing Requirements

"But a more fundamental problem of the weapons contractor is the insecurity of his market position . . . the rapidly changing requirements of military technology [that] force firms to shift their product lines rapidly . . . the relatively easy entry of new firms into the weapons industry . . . "

What has ensued, the authors conclude, has been a preoccupation with development which enhances capabilities for new projects at the expense of performance on current programs. Capability developed by companies to remain technologically competitive has been to some extent redundant.

Excess capacity in technical groups leads to gold-plating and overcomplexity, the study says, and encourages unrealistic bids for new development contracts to keep staffs busy.

Still another consequence the authors cite is the difficulty in reducing overhead by companies faced with a decline in sales. Overhead in general is a prob-

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lem in the weapons business, and the authors report that the services, as reflected in their case studies, felt overhead—especially of airframe manufacturers—is excessive.

Overhead is a difficult area to measure, the authors report, because a great deal of engineering is charged to it and because a sort of accounting shell game is played by many contractors conscious of the weight placed by the services in overhead ratio. Overhead finds a natural climate for growth in the defense industry, the authors say.

The complex structure of government management agencies requires great integration effort, they report, and cost-plus contracting requires more paperwork than comparable commercial enterprises.

'Empire Building'

"The groups which perform these functions," the study says, "provide an unusually broad base for the empire building that is common to most large staff organizations."

Some method of meeting these transition problems is recommended, of encouraging the entry of new companies for their value in providing innovations, of moderating the preoccupation of older companies with the next program at the expense of the existing one. "Just as a mechanism is needed to bring in newcomers," the study says, "so a mechanism is needed to displace the older firms which have lost their vitality."

Incentives for good performance might serve these objectives, the study notes. On the basis of a comparison survey made among DOD, military and contracting officials, the study concludes that program performance can be evaluated, despite marked differences in some cases along service lines.

Programs Surveyed

Eight of the 12 programs studied by the team were included in the survey: the Air Force Atlas intercontinental ballistic missile, Bomarc A air defense missile, B-58 supersonic bomber and F-105 fighter-bomber; the Army Nike Ajax and Nike Hercules anti-aircraft missiles and Jupiter intermediate-range missiles, and the Navy Polaris submarine-launched ballistic missile.

Contractor performance evaluation of Army programs by Air Force panel members tended to be lower than the panel average. Army panel members did not downgrade Air Force program contractors, but tended to evaluate Army program contractor performance higher than the panel as a whole. Air force members also followed the latter pattern in evaluating their own programs.

Nevertheless, the survey indicates that sufficiently knowledgeable persons could distinguish consistently between good and bad contractor performance and that this might provide a basis for award of future business. What the study is unable to conclude, however, is whether or not good past performance is an indicator of good future performance.

Some contractors turned in good performances on successive programs, others did not. Poor performance could well stimulate contractors to make vigorous changes in their organizations to improve results, the study indicates, and, in the opposing situation, a successful job can lead to complacency or unwillingness to adopt new and better concepts.

In this connection, the study notes the use of the "hungry contractor" criterion in various ways in contract awards. If a company is short of business, it is apt to devote its best efforts and allocate its best talent to prospective new business. Thus in one program studied, the prime contractor's lack of commitment to any other high-priority program was a decisive factor in the award.

Other points made in the study include the following:

• **Contractor ideas,** often the best sources of weapons development possibilities, frequently are not fully evaluated by the services because of lack of time or other reasons. Despite President Eisenhower's warning against the "munitions lobby," the weapons acquisition process may need some advocates for initiation of new programs to offset the many levels of no-sayers.

• **More component,** materials and subsystem development could profitably be undertaken by the U. S. Component development has little attraction for private capital. Feasibility studies that require only "cigarette money" are more attractive to contractors because of their

AIA Study

Aerospace Industries Assn. is taking an initial step to define an industry position on defense business issues through a contract for a study by the Stanford Research Institute of private and public institutions in the defense effort.

Problem areas in the government-business relationship are relatively easy to identify, AIA said, but causes and cures are less obvious. The study is to provide a basis for formulating public and private policy.

Various industry sources have been calling for a stronger or unified industry stand on such issues, and a resolution adopted at the AIA governor's meeting in Williamsburg, Va., last spring urged a strong industry effort to defend its profit system.



GIANNINI CONTROLS CORPORATION

LOOKING FORWARD

by Julian Hartt

GLENDORA, CALIFORNIA: The movie cameras have been responding to the order to "Roll 'em" for thirty years or so in Culver City, California, where M-G-M has shot enough film to gird the globe many times over.

So it is fitting that the first film ever to bring down to earth actual moving pictures of the moon will also have been master-minded in Culver City.

These pictures of the moon's surface will be transmitted to earth from four closed-circuit TV cameras stowed snugly in Surveyor, the lunar soft-landing vehicle being developed by Hughes Aircraft Company for NASA's Jet Propulsion Laboratory.

The use of television in space experiments is of very recent vintage, the most dramatic results having been achieved this year aboard Centaur and Project Echo on which there were Lear-Siegler video systems.

To look more closely into this increasing acceptance of closed-circuit TV by space scientists, I talked to Grayson Jones, Chief Engineer of the Giannini Controls Conrac Division here in Glendora. For ten years Conrac has been producing monitors and receivers for a wide variety of applications including TV broadcasting, education, industrial automation and transportation. Perhaps as a result of this specialized capability, the company has been called upon to provide most of the video monitors used by the aerospace industry.

"The basic advantage of video signals is simply that TV is real time. You're actually seeing events as they happen," Jones stated. "Our capability to design highly specialized video monitors for these space efforts stems from our past experience with custom designed equipment. But it is to companies like Lear-Siegler, Hughes and RCA who have pioneered new camera designs that the credit really belongs.

"These cameras, using a slow-scan technique, permit film exposure at a rate of ½ frame per second. Sixty times slower than conventional TV cameras, 'slow-scan' has licked the problem of excessive demands on the telemetry system's power and bandwidth.

"Simultaneously with this development, we worked with Lear-Siegler's Electronic Instrumentation Division to come up with terminal video equipment capable of receiving this type of signal. The result is our 2-Mode, Slow-Scan Monitor which has two video outputs, one at a rate of ½ frame per second, the other at 1 frame every 20 seconds. From either output it is possible to take remarkably clear photographs right off the monitor screen."

This slow-scan technique achieved excellent results recently when the giant Centaur booster was launched to study the behavior of the new liquid hydrogen fuel under zero-g conditions. The pictures received prior to aborting the mission proved of vital importance to the study of flow characteristics, clotting, sloshing and adherence of the fuel to the tank walls.

Closed-circuit TV was proved just as effective in Project Echo, the balloon from which radio signals are bounced to the far reaches of the earth. Last July, a remarkable 27 minute flight record of the Echo 3 test was received. Razor sharp images of the balloon's successful ejection from the capsule and correct inflation provided invaluable data to our space scientists.

Important as they are, these achievements will be no more than "B" features compared to the big show on the moon scheduled for 1963.

Video signals will unveil secrets of the moon's surface after Surveyor's 66-hour flight from Earth.

After the spacecraft's three legs have touched down, Conrac monitors on Earth will reveal to scientists the operation of various subsystems on the spacecraft. Other Hughes cameras aboard Surveyor will shoot in a complete circle and from 15° above to 45° below the horizontal line of the spacecraft.

The first Surveyor will explore the lunar surface for at least one month, according to JPL, and will be followed by six more between 1964-1965.

The engineers here at Conrac eye Surveyor and subsequent space programs as opportunities to prepare for their role in the most awe-inspiring technical achievement of the century: Man on the Moon. Conrac's decision to seek opportunities out of its TV broadcasting habitat was made by people at Giannini Controls Conrac Division like Grayson Jones who are . . . . . .Looking Forward.

Giannini Controls Corporation
1600 South Mountain Avenue, Duarte, California

Instrumentation & Controls for Aerospace & Industry.

potential in winning future system business. A well-stocked components cupboard appears to offer a little advantage to a company when it is engaged in a competition.

• **More contractor risk-bearing,** especially in the components areas, appears desirable. However, it would probably require encouragement of higher profits or making binding informal government commitments.

• **Salaries and wages** paid in the defense industry are not out of line with industry as a whole. Executive compensation for chief executives is on a par with the rest of industry and that of second tier executives below.

Three more volumes in the study are planned, including a detailed case study of the 12 systems. Besides the eight previously listed, they are the McDonnell F4H fighter, the Bendix Talos surface-to-air missile, the Raytheon Sparrow 3 missile and Army Nike Zeus.

New Offerings

Ling-Temco-Vought, Inc., Dallas, Tex., engaged in the design, development and production of military aircraft and missiles, electronic products and electro-mechanical and acoustical equipment, etc. Offering is 79,611 outstanding common shares by James J. Ling, vice chairman of the board (see AW July 16, p. 76).

Shin Mitsubishi Jukogyo Kabushiki Kaisha, Tokyo, Japan, engaged in diverse manufacturing operations in Japan including the production of aircraft. Offering is $10,000,000 of convertible debentures, due 1977, and 100,000 American Depositary Receipts (each representing 100 common shares) into which the debentures are convertible. Proceeds will be added to general funds and applied to the financing of capital expenditures, (estimated at $46,200,000 for 1963, and $19,800,000 for 1964).

R. E. D. M. Corp., Town of Little Falls, N. J., engaged in the manufacture, engineering studies and research and development under prime and subcontracts for the Department of Defense for fuzing, arming and warhead systems, timing devices, barometric sensing devices and related electronic and electromechanical devices. Offering is 125,000 common shares; 50,000 shares by the company, and 75,000 outstanding shares by the holders. Of the company's proceeds, $150,000 will be used to acquire production machinery.

Coast Guard UF-2G Sets Two Speed Marks

New York—Two new world speed records for amphibians of unlimited weight were claimed here recently for a Coast Guard Grumman UF-2G Albatross.

Both records were set in a single attempt carrying a 2,000 kilogram (4,409 lb.) payload. The average speed of 201.45 kt. bettered two old records for both 1,000 and 2,000 kg. payloads set by the USSR in 1940 by over 50 and 70 kt. respectively. The pilot, Cdr. W. C. Dahlgren, and copilot, Cdr. W. Gene Fenlon, flew the 1,003.06 km. course (approximately 540 naut. mi.) from Floyd Bennett Field, Long Island, to a point near Elizabeth City, N. C. in 2 hr. 40 min. 42.08 sec.

Cdr. Dahlgren, who is stationed at the Third Coast Guard District, New York, will attempt to set another world record in the same airplane for longest straight line distance without landing for amphibious aircraft. The trip will originate at Kodiak, Alaska, and terminate somewhere in Florida.

The record-setting flight was the first of six expected attempts by the Coast Guard, Air Force and Navy to establish a total of nine new world records for the Albatross.

NASA Contracts

National Aeronautics and Space Administration recently awarded the following contracts:

WALLOPS STATION, WALLOPS ISLAND, VA.:

Doyle & Russell, Norfolk, Va.—$490,000 for repair of storm damage to launch area.

International Business Machines Corp., Norfolk, Va.—$57,000 for rental of electronic accounting machines and devices.

MANNED SPACECRAFT CENTER, LANGLEY FIELD, VA.:

North American Aviation, Inc., Downey, Calif.—$1 million for paraglider development program.

Space Technology Laboratories, Inc., Los Angeles, Calif.—$100,000 for Project Gemini analytical study of orbital rendezvous missions.

Secretary of Navy, Washington, D. C.—$100,000 as reimbursement for services performed by BWR, St. Louis, Mo., and other offices of Navy materiel inspection services in administration of contract NAS 5-59.

U. S. Air Force, Hickam AFB, Hawaii—$175,000 for contingency recovery services in support of Project Mercury.

MARSHALL SPACE FLIGHT CENTER, HUNTSVILLE, ALA.:

Boeing Co., Seattle, Wash.—$1 million for preparatory effort leading to project for engineering, fabrication, assembly, checkout, static testing, transportation and launch of Saturn S-1C stages.

Space Technology Laboratories, Inc., Los Angeles, Calif.—$125,000 for study of launch vehicle size and cost analysis.

Radio Corporation of America, Van Nuys, Calif.—$1,750,000 for development and fabrication of Saturn ground computer systems.

Bomac Laboratories, Inc., Beverly, Mass.—$130,000 to construct and deliver hydrogen masers and carry out research and development effort to simplify and improve method for removing expended hydrogen from the masers.

Dynatronics, Inc., Orlando, Fla.—$59,000 for fabrication and delivery of analog-to-digital converters in support of Saturn project.

Westinghouse Electric Corp., Huntsville, Ala.—$72,000 for design and development of pulse interferometer radar-transponder system.

Tenney Engineering, Inc., Union, N. J.—$201,000 for hyper-environmental space simulation test chamber for Saturn project.

Republic Aviation Corp., Farmingdale, N. Y.—$961,000 for fabrication of various items of space vehicle components for Saturn.

Ortronix, Inc., Orlando, Fla.—$121,000 for single sideband-FM modulation airborne telemetry systems for Saturn project.

Martin Marietta Corp., Denver, Colo.—$56,000 for test program for determination of low-temperature fatigue properties of aluminum and titanium alloys.

White Electromagnetics, Inc., Bethesda, Md.—$79,000 for research and development of electromagnetics interference control program.

Texas Instruments, Inc., Dallas, Tex.—$66,000 for gate turn-off silicon controlled rectifier.

General Dynamics Corp., San Diego, Calif.—$62,000 for services and materials for preparation of facility criteria for Centaur Complex 36B. (This contract awarded initially through Air Force.)

Rust Engineering Co., Birmingham, Ala.—$82,000 for architect-engineering services for design of addition to Building 4707 for structural assembly.

Bechtel Corp., Vernon, Calif.—$98,000 to develop criteria for components test facility for Saturn project.

Sverdrup & Parcel & Associates, Inc., St. Louis, Mo.—$1,343,000 for conceptual and feasibility site development plans and basic design criteria.

Chrysler Corp., Detroit, Mich.—$101,000 for fuel vent valve assembly.

Texas Instruments, Inc., Houston, Tex.—$59,000 for transistor and component tester with assemblies, parameter and attachments.

Bendix Corp., N. Hollywood, Calif.—$284,000 for telemetry playback station.

Wiancko Engineering Co., Inc., Pasadena, Calif.—$51,000 for pressure pickups.

General Electric Co., Philadelphia, Pa.—$211,000 for design criteria of zero-leakage connectors for launch vehicles.

North American Aviation, Inc., Canoga Park, Calif.—$203,000 for feasibility evaluation of toroidal hoop combustion chamber.

Telemetrics, Inc., Gardena, Calif.—$79,000 for synchronizer, digital-to-analog converter unit and digital power supply.

D. B. Milliken Co., Arcadia, Calif.—$99,000 for photographic instrumentation lens plate camera for Saturn project.

Air Force Systems Command, Washington, D. C.—$2,400,000 for Atlas boosters and launch services in support of Project Fire.

Air Force Systems Command, Patrick AFB, Fla.—$84,000 for Azusa Model C transponder for Saturn.

SPACE NUCLEAR PROPULSION OFFICE, WASHINGTON, D. C.:

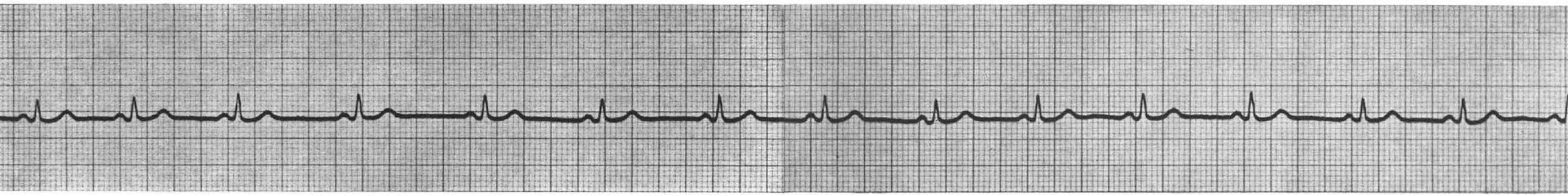
Aerojet-General Corp., Covina, Calif.—$106,000 to perform engineering studies and analysis to establish final facility design criteria for Engine Test Stand 2 at Nuclear Rocket Development Station, Jackass Flats, Nev.

LAUNCH OPERATIONS CENTER, COCOA BEACH, FLA.:

Amco Engineering Co., Chicago, Ill.—$117,000 for electronic equipment enclosure racks for Saturn.

Air Force Systems Command, Patrick AFB, Fla.—$73,000 to procure and install telemetry transmission systems to support Ranger, Mariner R and Surveyor projects.

Army Engineers, Jacksonville, Fla.—$545,000 to provide advanced facility planning, design and estimate of cost for spacecraft operations and checkout facility at Atlantic Missile Range.



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Today, many people with weak and faltering hearts are leading healthy, active lives.

The reason? A tiny electronic device called the *cardiac pacemaker,* which is implanted by surgery inside the patient's body. Through wires connected directly to the heart, it transmits electrical impulses — impulses which trigger the heart into a sure, steady beat.

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Dassault-Sud Mystere 20 twin-turbojet executive aircraft mockup, located at Dassault's Bordeaux factory, shows aircraft's aft-engine, low-wing configuration. Integral forward door swings down to form entrance stairway. Maximum cabin headroom is 67 in. Aircraft will be powered by two Pratt & Whitney JT12A-8 turbojets of 3,300 lb. thrust each.

Mystere 20, Spirale 3 Configurations Detailed



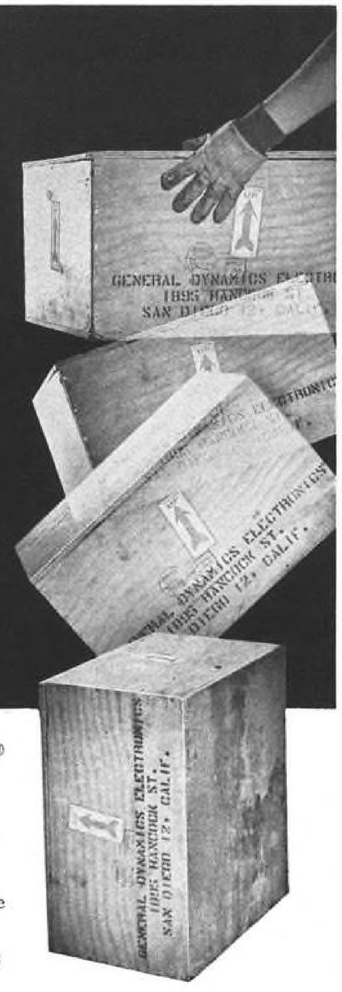
Spirale 3, winner of the French air force competition for an STOL light support transport, also is under construction at Dassault's Bordeaux plant. Sud will produce the aircraft's boundary-layer wing and the tail section. Mockup, above, shows fuselage configuration.

Range of the Mystere 20 will be 1,550 mi. with auxiliary wing tanks or slightly under 1,000 mi. with standard tanks and a gross weight of 17,600 lb. Maximum gross weight is 21,800 lb. Span of the unswept wing is 44 ft., 2 in. and the fuselage length is 51 ft., 5 in. Cockpit mockup, right, shows dual instrument layout plus weather radar and autopilot. Cylindrical, high-stress fuselage for the first Mystere 20 prototype, below, is under construction by Dassault. Cruising speed will be 513 mph. at 40,000 ft.





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GENERAL DYNAMICS | ELECTRONICS
SAN DIEGO

PRODUCTION BRIEFING

Rocket Research Corp., Seattle, Wash., has received a contract from National Aeronautics and Space Administration's Goddard Space Flight Center to develop and manufacture a microthrust balance for measuring, in a simulated space environment, the performance of microrockets which will be used to control the speed and attitude of satellite vehicles.

U.S. Science Corp., Los Angeles, a subsidiary of United Industrial Corp., will produce pre-flight testers for checkout of Mohawk AO-1 aircraft instruments and control systems. Work is sponsored by a $469,000 contract from Air Force's Aeronautical Systems Division.

General Precision Corp.'s Aerospace Division will build and install a celestial-inertial test complex at Holloman AFB, N.M., which will be capable of checking star trackers separately or as integral parts of stellar-inertial platforms. Work will be financed by a contract exceeding $1 million from Air Force's Missile Development Center at Holloman.

Borg-Warner Corp.'s Pesco Division, Cleveland, Ohio, has been selected by Lockheed Aircraft Corp. to build thrust reverser actuating systems for the USAF C-141 StarLifter transport.

Melpar, Inc., Falls Church, Va., will design and build a prototype tandem-rotor helicopter flight trainer, simulating the HRB-1 helicopter, under a contract from the Naval Training Device Center, Port Washington, N.Y. Trainer is for Marine Corps use.

Cessna Aircraft Co., Wichita, Kan., has received a $1.75-million Air Force contract for additional T-37 jet trainer aircraft. The contract will extend the four-unit-a-month production of the twin-engine jet from July 1963, when the present contract expires, through December, 1963.

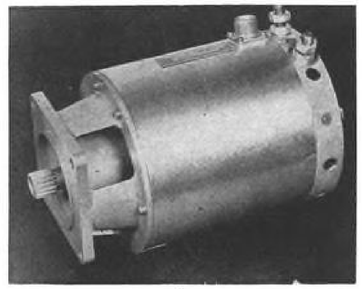
Atlantic Research Corp., Alexandria, Va., is working on a $17-million Air Force project at White Sands Missile Range, N.M., using special solid-propellant test vehicles to gather information which will improve ballistic missile effectiveness.

Lockheed JetStar jet transport has Federal Aviation Agency approval for 12-place seating configuration. The extra seats will be added by re-arranging the interior and will be available in all JetStars. Aircraft's performance will remain unchanged.

NEW AEROSPACE PRODUCTS

Aircraft Generator

Type D-10 brushless d.c. generator, designed specifically for small aircraft, delivers 100 amp. at 30 v.



The manufacturer says the 29¼-lb. generator is lighter than conventional brush-type generators of the same rating. The generator uses rotating silicon diodes to perform the functions of commutator, slip rings and brushes in a conventional generator. Stationary diodes in the generator frame rectify the output voltage. Overhaul consists of bearing replacement at 1,500 hr. intervals, the manufacturer says.

Aerospace Electrical Division, Westinghouse Electric Corp., Wapakoneta Rd., Lima, Ohio.

Holding Pattern Computer

Computer shows pilot the correct entry procedures to use with standard and non-standard holding patterns in accordance with new Federal Aviation Agency requirements.



Made of laminated vinyl plastic, the computer is 3½ in. in dia. and fits into a shirt pocket. Dark sectors in the accompanying photo are brown (left) and blue (top) selected for maximum visibility under red night lighting.

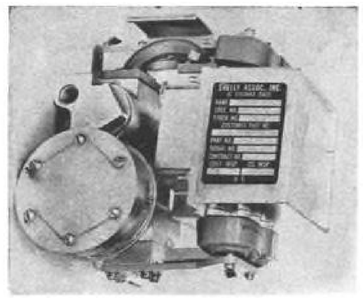
The device is operated by:

- **Setting index** at in-bound holding pattern course, using the inside azimuth scale.
- **Without moving** index card again, read aircraft heading on arrival over holding fix on the outside scale to determine color approach direction sector.
- **At arrival over fix,** follow the matching colored line for correct entry into the holding pattern.

The Whitehead Computer Co., 2900 N. Keystone, Burbank, Calif.

Feel System Loader

Artificial feel system loader for jet aircraft—to give pilots proper stick "feel"—incorporates a 50% reduction in size and weight over the 16-lb. model now used in F-102 and F-106 aircraft.



The pneumatic instrument consists of a computer section which computes Mach number from static and ram air pressures and a valve section which releases controlled air pressure as a function of the Mach number. The instrument compensates for any change in speed, altitude or both.

The instrument is designed with "fail safe" features, whether the malfunction originates in the piping or the instrument itself, the manufacturer says.

Shelly Associates, Inc., 111 Eucalyptus Dr., El Segundo, Calif.

Fire-Fighting Unit

Mobile, trailer-mounted fire-fighting unit can be used at small airports.

The unit consists of a 200-gal., corrosion-resistant water tank, a gasoline-driven pump, 50 ft. of 1-in. booster hose, and 2½-in. suction and 1½-in. discharge water fittings. Called the Model ST-200 Mobile Pumper, the unit is 48 in. wide, 48 in. high and 8½ ft. long.

The manufacturer says the pumper can project a 65-ft. stream at 100 lb. pressure for 10 min. from its own tank. Using suction procedure, more than 100 gpm. can be pumped from an auxiliary water supply and projected at 70- to 100-lb. pressure for continuous fire fighting.

Fire Equipment, Inc., 10 Indel Ave., Rancocas, N.J.

DEPENDABLE fuel flow



with ROPER four gear fuel pumps

This is the most advanced gear pump in the industry. Its 4-balanced-gear principle eliminates bearing loads; and in combination with its absolute balanced sealed plates, permits high pressure operation at high or low temperatures. The unit illustrated is the "heart" of the B-70 Bomber. It has an extremely high power-to-weight ratio.

GENERAL SPECIFICATIONS

Pumps all jet fuels, water, hydraulic oils, cryogenics, etc.
Pressures to 4,000 psi
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Meets MIL-5009-B for jet engine main fuel pumps

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Aerospace Firms File Management Salaries

Following is a list of aerospace industry officers and directors with 1961 salaries above $30,000:

Beech Aircraft Corp.—O. A. Beech, president and director, $116,446 salary, 237,024 shares of common stock; **F. E. Hedrick,** executive vice president and director, $84,018 salary, 38,610 shares of common stock, 5,040 shares of common stock beneficially owned by members of Mr. Hedrick's family; **J. A. Elliott,** secretary-treasurer, and director, $44,343 salary, 7,863 shares of common stock; **L. L. Greever,** vice president-domestic sales and director, $36,319 salary, 9,123 shares of common stock; **W. L. Henry,** vice president-marketing and director, $51,567 salary, 1,764 shares of common stock; **J. N. Lew,** vice president-engineering and director, $59,491 salary, 6,144 shares of common stock; **A. R. Bell,** director, 1,000 shares of common stock; **D. S. Wallace,** director, 17,103 shares of common stock. (Salaries were paid for services during the fiscal year ended Sept. 30, 1961; all stocks beneficially owned as of Nov. 2, 1961.)

Bendix Corp.—M. P. Ferguson, president and director, $160,699 salary, 6,101 shares of common stock; **A. P. Fontaine,** executive vice president and director, $79,349 salary, 1,183 shares of common stock; **E. K. Foster,** vice president and director, $85,499 salary, 3,538 shares of common stock; **W. H. Houghton,** vice president, treasurer, and director, $87,225 salary, 7,523 shares of common stock; **R. P. Lansing,** vice president and director, $91,175 salary, 6,776 shares of common stock; **C. Marcus,** director, (until Feb. 23, 1961), $42,700 salary; **L. F. Polk,** vice president and director, $36,750 salary, 4,230 shares of common stock, (Mr. Polk also had as of Dec. 31, 1961, a reversionary interest in 10,335 shares of common stock, with a right to receive such shares upon termination of certain trusts on or subsequent to Feb. 2, 1964); **G. E. Stoll,** executive vice president and director, $110,200 salary, 6,348 shares of common stock; **C. C. Tillinghast, Jr.,** vice president and director, (until Apr. 15, 1961), $47,350 salary; **H. B. Baker,** director, 2,360 shares of common stock; **J. D. Diggers,** director, 210 shares of common stock; **L. I. Doan,** 200 shares of common stock; **E. Kanzler,** director, 1,180 shares of common stock; **C. S. H. Mott,** director, (as of Dec. 31, 1961, the Charles Stewart Mott Foundation held 23,594 shares of common stock in Bendix and members of the Mott family owned 33,921 shares of Bendix); **E. R. Palmer,** director (retired), 942 shares of common stock.

(Salaries were paid for the fiscal year ending Sept. 30, 1961; all stockholdings were as of Dec. 31, 1961.)

Cessna Aircraft Co.—D. L. Wallace, president and director, $96,000 salary, 143,807 shares of common stock (members of Mr. Wallace's immediate family own an additional 69,508 shares of common stock); **F. A. Boettger,** vice president, treasurer and director, $70,200 salary, 19,841 shares of common stock; **D. L. Roskam,** vice president-aircraft divisions and director, $68,640 salary, 25,813 shares of common stock; **S. Coleman,** director, 3,120 shares of common stock; **R. E. Dillon,** 400 shares of common stock; **H. P. Quinn,** director, 150 shares of common stock; **R. C. Russell,** director, 3,384 shares of common stock; (Salaries are for the fiscal year ended Sept. 30, 1961; all stockholdings were as of Nov. 6, 1961).

International Telephone and Telegraph Corp.—H. S. Geneen, president and director, $138,378 salary, $100,000 bonus, 2,999 shares of common stock, 40 shares of series "B" preferred stock; **C. D. Hilles, Jr.,** executive vice president and director, $51,030 salary, 11,821 shares of common stock, $2,500 debentures; **W. T. Marx,** senior vice president, $77,300 salary $35,000 bonus; **L. T. Rader,** vice president and director (until Mar. 26, 1962), $86,400 salary, $35,000 bonus; **E. W. Stone,** vice president and director, $70,810 salary, $27,000 bonus, 322 shares of common stock, four shares of series "B" preferred stock; **G. R. Brown,** director, 23,242 shares of common stock, $44,400 debentures (stock and debentures are owned in part by the partnership of Herman Brown & George R. Brown and in part by corporations wholly owned by the partnership. George R. Brown is one of two equal partners. The partnership also owns 12 shares of series "B" preferred stock); **A. M. Hill,** director, 13,500 shares of common stock, $25,000 debentures; **A. P. Kirby, director, 39,383 shares** of common stock (of which 600 shares are owned by a corporation of which Mr. Kirby is a stockholder); **H. Knowlton,** director, 2,000 shares of common stock, (of which 1,000 shares are held in a trust of which Mr. Knowlton is trustee and beneficiary); **J. P. Lannan,** 10,000 shares of common stock; **R. S. Perkins,** director, 1,000 shares of common stock; **W. L. Pierson,** director, 200 shares of common stock, $400 debentures; **L. D. Welch, vice president and director** (will replace L. T. Radar after Mar. 26, 1962), 100 shares of common stock (all stockholdings are beneficially owned as of Feb. 1, 1962).

Piper Aircraft Corp.—W. T. Piper, chairman of the board and president, $40,652 salary, 109,921 shares of common stock, 124,350 shares of common stock held as trustee under a voting trust; **N. J. Greene,** director, 500 shares of common stock; **R. K. Griffin,** director, 606 shares of common stock; **E. N. Hunting,** director, 502 shares of common stock held in joint ownership with wife; **W. C. Jamouneau,** secretary, chief engineer and director 220 shares of common stock; **H. Piper,** vice president-research and development and director, 24,199 shares of common stock held in joint ownership with wife; **T. F. Piper,** vice president and director, 22,306 shares of common stock held in joint ownership with wife; **W. T. Piper, Jr.,** executive vice president and director, 22,913 shares of common stock; **C. W. Pool,** treasurer and director, 200 shares of common stock held in joint ownership with wife. (Salary paid for fiscal year ended Sept. 30, 1961; all stockholdings beneficially owned as of Nov. 24, 1961.)

The Ryan Aeronautical Co.—T. C. Ryan, president and chairman of the board, $77,500 salary, 111,727 shares of common stock; **R. C. Jackson,** executive vice president and director, $67,500 salary, 525 shares of common stock; **C. A. Stillwagen,** vice president, $49,000 salary; **C. A. Smith,** director, 3,780 shares of common stock; **A. J. Hair,** director, 253 shares of common stock; **G. Witter,** director (since 1961), 900 shares of common stock.

(Salaries paid for fiscal year ended Oct. 31, 1961; all stockholdings were beneficially owned as of Jan. 8, 1962.)

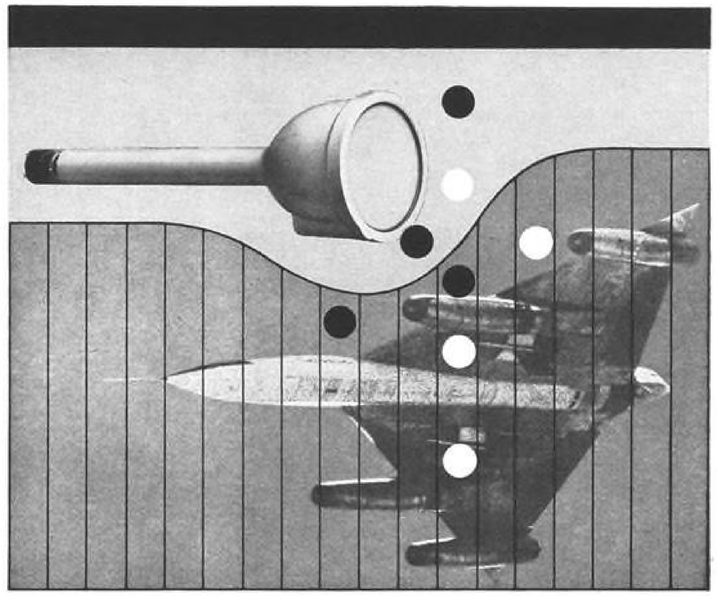
Thompson Ramo Wooldridge, Inc.—J. D. Wright, chairman of the board and chief executive officer, $149,125 salary, 13,400 shares of common stock; **D. E. Wooldridge,** president and director, $89,750 salary, 40,143 shares of common stock; **S. Ramo,** executive vice president and director, $89,000 salary, 47,245 shares of common stock of which 1,090 are jointly owned with wife; **H. A. Shepard,** vice president and director, $89,500 salary, 8,800 shares of common stock; **B. W. Chidlaw,** vice president and director, $57,000 salary; **A. T. Colwell,** consultant and director, $39,715 salary (includes $12,250 deferred compensation paid for services as vice president during 1960), 10,000 shares of common stock; **J. H. Coolidge,** vice president and director (died July 14, 1961), $32,000 salary; **F. C. Crawford,** consultant and director, $68,000 salary, 31,874 shares of common stock; **J. H. Doolittle,** chairman of the board of Space Technology Laboratories, Inc. (a subsidiary), $62,250 salary, 20,000 shares of common stock; **R. P. Johnson,** vice president and director, $61,750 salary.

(All stockholdings beneficially owned as of Feb. 9, 1962.)

Republic Aviation Corp.—M. I. Peale, president and director, $139,766 salary, 15,878 shares of common stock; **H. S. Jones,** executive vice president and director, $142,600 salary, 4,000 shares of common stock; **A. Kartveli,** vice president and director, $67,650 salary, 11,856 shares of common

MICROPIX® multi-purpose cathode ray tubes, used in high-resolution applications, are part of the extensive line of Litton display devices and microwave tubes. San Carlos, California. In Europe, Box 110, Zurich 50, Switzerland.

LITTON INDUSTRIES
ELECTRON TUBE DIVISION



PROBLEMATICAL RECREATIONS 133



Johann Jungfrau, the famous mountain climber, was traveling through the Trondheim timber country one day. Quite by accident he dropped his trusty Alpenstock, an unusually straight stick, near the buzz saws where, in two shakes of a yak's tail, it was neatly cut into three pieces. What is the probability that these three pieces can be placed together to form a triangle? *Contributed*

Problem solvers who have used our Monroe Division's IQ-213 desk calculator astound their friends with speedy answers. "It even recalls constant divisors from memory," they happily exclaim, "thereby eliminating the need for reciprocals in most problems." As with all Monroe machines, the IQ-213 will delight you by doing more while you do less. For a whopper of a catalog offering a wide choice of models, write: Monroe, 555 Mitchell Street, Orange, New Jersey.

ANSWER TO LAST WEEK'S PROBLEM: Very easily. He takes the center square and then counters each of his opponent's moves by taking the diametrically opposite square.

LITTON INDUSTRIES, INC.
Beverly Hills, California

stock; **W. H. Moore,** director, 1,210 shares of common stock; **R. L. Clarkson,** director, 292 shares of common stock; **F. G. Coburn,** director, 600 shares of common stock; **L. Platt,** director, 584 shares of common stock; **H. N. Taylor,** 400 shares of common stock; **W. V. Platt,** director, 200 shares of common stock; **R. C. Taylor,** director, 1,022 shares of common stock; **J. J. Tuohy,** director, 200 shares of common stock. (All stockholdings were beneficially owned as of Feb. 1, 1962.)

North American Aviation, Inc.—J. L. Atwood, president and director, $157,833 salary, 18,000 shares of common stock; **C. J. Gallant,** executive vice president and director, $90,000 salary, 2,000 shares of common stock; **J. H. Kindelberger,** chairman of the board, $162,000 salary, 19,917 shares of common stock; **R. A. Lambeth,** senior vice president, treasurer and director, $79,200 salary, 1,450 shares of common stock; **J. S. Smithson,** senior vice president and director, $79,200 salary, 3,200 shares of common stock; **A. V. Call,** director, 1,000 shares of common stock; **H. B. du Pont,** director, 3,466 shares of common stock; **H. G. Fales,** director, 2,500 shares of common stock; **R. A. Lovett,** director, 1,200 shares of common stock; **H. T. Mudd,** director, (since Dec. 1, 1961), 200 shares of common stock; **W. C. Mullendore,** director, 234 shares of common stock; **C. A. Rude,** director, 350 shares of common stock.

(Salaries were paid for the fiscal year that ended September 30, 1961; all stockholdings were beneficially owned as of Dec. 1, 1961.)

Motorola, Inc.—R. W. Galvin, president, $85,000 salary, 359,856 shares of common stock (Mr. Galvin has a contingent beneficial interest in 311,160 shares held in a trust); **D. E. Noble,** executive vice president, $80,000 salary (Mr. Noble receives an estimated $19,706 annual benefit under a supplementary retirement plan), 11,732 shares of common stock; **F. J. O'Brien,** vice president, $65,000 salary (Mr. O'Brien receives an estimated $23,896 annual benefit under a supplementary retirement plan), 11,434 shares of common stock (Mr. O'Brien is acting as executor of the estate of Joan O'Brien, deceased, which estate owns 12,222 shares of common stock); **A. L. Reese,** vice president, 60,000 salary (Mr. Reese receives an estimated $24,817 annual benefit under a supplementary retirement plan), 800 shares of common stock; **W. B. Scott,** vice president, $55,000 salary (Mr. Scott receives an estimated $26,686 annual benefit under a supplementary retirement plan), 4,400 shares of common stock; **E. R. Taylor,** executive vice president, $80,000 salary (Mr. Taylor receives an estimated $26,409 annual benefit under a supplementary retirement plan), 8,000 shares of common stock; **E. P. Vanderwicken,** vice president, $70,000 salary (Mr. Vanderwicken receives an estimated $21,965 annual benefit under a supplementary retirement plan), 1,200 shares of common stock; **E. H. Wavering,** executive vice president, $80,000 salary (Mr. Wavering receives an estimated $31,181 annual benefit under a supplementary retirement plan), 41,600 shares of common stock; **M. J. Hickey, Jr.,** director, $30,000 salary (Mr. Hickey receives this remuneration for serving as a consultant), 11,000 shares of common stock; all stocks beneficially owned as of Feb. 1, 1962.

Northrop Corp.—W. C. McDuffie, chairman of the board, $47,500 salary, 1,000 shares of common stock; **R. W. Millar,** director, 100 shares of common stock; **R. R. Miller,** senior vice president, $80,000 salary, 10,600 shares of common stock; **J. O'Melveny,** director, 342 shares of common stock; **A. E. Pointing,** director, 500 shares of common stock; **A. C. Rubel,** director, 100 shares of common stock; **T. V. Jones,** president, $122,499 salary, 4,450 shares of common stock; **R. E. Horner,** senior vice president, $80,000 salary; **J. Allen,** vice president, $48,000 salary, 200 shares of common stock; **L. L. Austin,** director; **W. F. Ballhaus,** executive vice president, 7,035 shares of common stock; **E. W. Carter,** director, 500 shares of common stock; **E. M. Jorgensen,** director, 500 shares of common stock; All stocks beneficially owned as of Oct. 6, 1961.

American Machine & Foundry Co.—C. L. Burgess, president and director, $102,450 salary, 7,200 shares of common stock, $20,500 debentures; **F. P. Downey,** vice president and director, $88,075 salary, 27,800 shares of common stock, $69,600 debentures; **R. C. Gott,** executive vice president and director, $95,800 salary, 19,904 shares of common stock, $63,600 debentures; **G. S. Hastings,** vice president and director, $46,800 salary, 5,041 shares of common stock, $4,200 debentures; **G. S. Hills,** general counsel and director, $26,428 salary (this amount does not include $274,072 paid to the law firm of Rogers, Hoge & Hills, of which Mr. Hills is a member, for legal services rendered), 10,308 shares of common stock, $25,800 debentures; **D. S. Melklejohn,** vice president, treasurer and director, $72,835 salary, 10,161 shares of common stock; **M. Patterson,** chairman of the board, $171,050 salary, 145,457 shares of common stock, (Mr. Patterson is a trustee and residuary beneficiary of a trust which held as of Feb. 1, 1962, 61,116 shares of common stock and $16,000 of 4¼% convertible subordinated debentures; a trustee but not a beneficiary of two trusts which held 69,872 shares of the common stock and $4,000 of 4¼% convertible subordinated debentures; a life beneficiary, but not a trustee of a trust which held 40,000 shares of the common stock); **M. D. Sprague,** vice president and director, $59,700 salary, 3,790 shares of common stock, and $7,000 debentures; **S. deJ. Osborne,** director, 834 shares of common stock, $2,100 debentures; **H. P. Patterson,** director, 3,889 shares of common stock, $10,000 debentures (Mr. Patterson is a residuary beneficiary of a trust which held 40,000 shares and he had registered in his name as guardian for his daughter, 2,119 shares of common stock as of Feb. 1, 1962); **F. Seitz,** director, 120 shares of common stock, $100 debentures; **R. P. Soule,** director, 2,800 shares of common stock. All stock holdings beneficially owned as of Feb. 1, 1962.

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Positions are available at Aerospace Corporation in Southern California which will provide highly qualified professional engineers with the opportunity to associate with the country's most knowledgeable experts in the field of rocketry. Those selected will have an opportunity to influence the course of development of a new technology.

Successful applicants will be required to perform analysis, preliminary design, design review, and project engineering in programs permitting professional growth into space vehicle system aspects of solid rocket applications.

Candidates for these positions should have acquired broad design and analysis experience in solid rocketry with particular specialization in one or more of the following:

- Case, nozzle and insulation design and materials
- Propellant properties, processing and performance
- Grain design and interior ballistics
- Test operations, instrumentation and data reduction
- Nozzle design, gas dynamics and heat transfer
- Quality assurance, process inspection and non-destructive testing
- Handling and ground support equipment
- Combustion instability and detonation behavior
- Vehicle system integration

Openings exist for engineers, preferably with advanced degrees, whose minimum of ten years of professional engineering experience includes at least five years of successful employment in the solid rocket industry.

Qualified applicants are invited to contact Aerospace Corporation, an equal opportunity employer. Write to Mr. Charles Lodwick, Room 301, P.O. Box 95081, Los Angeles, California.

AEROSPACE CORPORATION

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CESSNA 205, single-engine, six-place aircraft, provides high carrying capacity at single-engine cost.

Aviation Week Pilot Report:

Cessna 205 Slanted to Charter Market

By David A. Brown

Wichita, Kan.—Cessna 205, a single-engine, six-place version of the retractable-gear, high-wing Model 210, has been introduced by Cessna Aircraft Co. to provide charter operators with a low-cost, high-density aircraft as well as a station wagon-type vehicle for private or business fliers.

A fixed-gear aircraft powered by a 260-hp. six-cylinder, fuel injection Continental IO-470-S engine, the 205 will carry six adults without crowding or five persons and considerable baggage.

Delivery of the aircraft to dealers began last week. Price of the standard airplane is $22,295, delivered at Wichita.

The 205 has a gross weight of 3,300 lb. and a maximum useful load of 1,550 lb. With full fuel and optional navigation and radio equipment, the aircraft can carry six persons, plus 52 lb. of baggage.

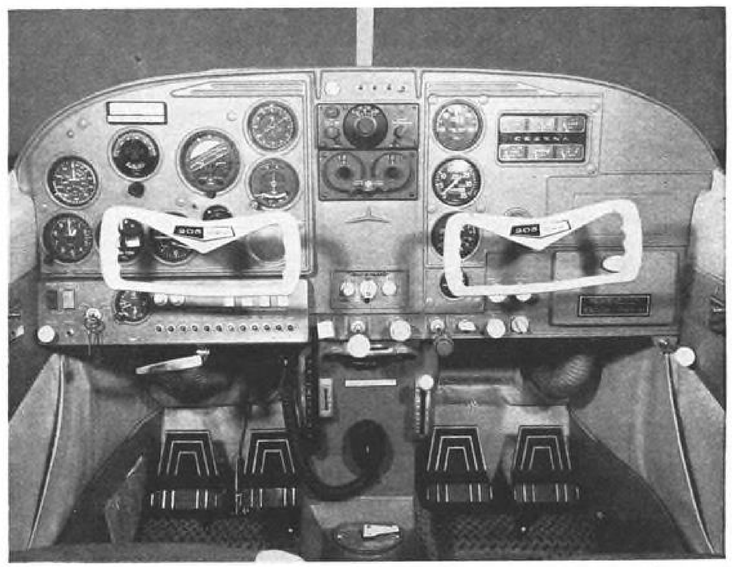
Any or all seats may be removed to provide space for additional baggage or bulky objects.

Other features include a third door on the left side to provide entrance and exit for the rearmost seats, optional oversize fuel tanks, electrically operated wing flaps and a relocated radio compartment.

Third door has been increased in size from the baggage-size door on the 210 by extending it downward to the main structural longeron.

Standard fuel tanks in the wings carry 32.5 gal. each or a total of 65 gal. Additional wing tanks available as optional equipment carry 42 gal. each for a total of 84 gal., 1.6 gal. of which is not usable. With the oversize tanks, the 205 has a range of 1,275 mi.

Wing flaps are similar to those on



COCKPIT LAYOUT features grid lines on horizon indicator (on panel above left control wheel). Autopilot is located between control wheels above engine controls.

A LOOK OVER THE TRANSOM AT GENERAL ELECTRIC

SEPT. 1962

FUEL CELLS

■ **ABOUT THIS SERIES.** Things are happening with G-E fuel cells. Looking back on our years of developing these power sources that generate electricity directly from a chemical reaction, the progress is enormous. We could write books—(in fact there are two of a progress report flavor already available; yours for the asking*)—but fuel cells are such a new and promising technology that this is hardly the stage at which to tell all. That's why, for now, we'd rather limit the world to monitored (but regular) glances through our laboratory transom.

■ A LITTLE CURVE THAT'S CREEPING UPWARD

Bucking the downslope of so many business trendlines this year has been a modest little curve that's particularly close to our hearts—the power density growth rate for G-E ion-exchange membrane fuel cells.

Last year we foresaw little likelihood that our solid electrolyte cells would soon be reaching the 100 watt/ft² mark (200 amps at 0.5 volt). Yet today they are producing such output time after time.

Effective surface dimension for these cells is 2¾ inches square, so that each *actually* produces about 5 watts. Hence the inevitable question: will a scale-up really live up to these projected outputs?

Preliminarily we find the answer is yes. Already a veteran of our test rack is a 1½-square-foot cell of the same make-up that is not only producing the prescribed quota of 150 watts (300 amps at 0.5 volt), but has on occasion doled out as much as 175 watts. There's still plenty to be learned about the intricacies of making cell size and power density grow, but the ceiling appears to be a lofty one. The practical result will be even smaller, lighter, more powerful fuel batteries than those we are now producing for the Gemini spacecraft.

■ ENVIRONMENTAL TESTS AND A STUBBORN CELL

How severe must environmental extremes be to kill an ion-exchange membrane fuel cell? Our original projected estimates, put to trial early this summer at the mercy of a certain stubborn fuel cell, soon appeared somewhat on the conservative side.

The question to which we subjected this 54-sq.-in. test fuel cell went well beyond the range of our everyday environmental tests. It was a three-barbed one querying what limits of vibration, temperature, and internal disorder must exist to administer the operational *coup-de-grace*.

In its first test phase, the cell underwent vibration exceeding twice that expected in service from standpoints of both time and intensity. The result: no effect at all on performance.

The temperature limit phase was most significant because we were uncertain about cell performance above 160° F. However there was never an inkling of failure as internal temperatures were gradually stepped up to 180°, then held for 24 hours in the 165–180° range.

Then with temperature returned to normal, we began purging the cell with doses of hydrogen and oxygen to simulate a severe internal failure. After 24 hours, when membrane dehydration should have put the cell out of order, it was still going strong.

Just what ion-membrane cell endurance limits are—especially in terms of temperature—still remain to be seen. The same stubborn cell subsequently went through 200 hours of life test at 170–180° F, producing its rated output of 16 amps at 0.8 volt. Further, since we are well aware that certain parameters of fuel cell life are not covered in single cell testing, a stack life test at 170–180° was then initiated.

Now it only remains for time to tell us the ultimate limits.

■ THE METHANE THAT WOULDN'T HAPPEN

Scientifically surprising are the "unknowns" we are often uncovering in fuel cell research. The electrodes of our hydrocarbon cells have been doing something sufficiently strange that we've had to unearth a little-known word for it: electrocatalysis.

A fuel cell's efficiency naturally depends on its ability to bleed a fuel of every last electron it can free up. In the case of hydrocarbon cells this means oxidizing complex molecules all the way down to CO_2 and water. But as our colleagues in petroleum refining circles well know, reacting complex hydrocarbons on common catalysts normally cracks them into smaller molecules that frequently include methane and a carbonaceous residue. For this to happen in a fuel cell is bad news, because methane is sufficiently stable to resist further decomposition. But fuel cells apparently don't read rule books. Through the phenomenon called electrocatalysis, our hydrocarbon fuel cells show nary a trace of methane around the catalyst while current is being drawn. (Open the circuit, though, and the old rule applies.) This unexpected find has bridged a broad chasm in our hydrocarbon fuel work, as well as once again underscoring the hard-learned fact that answers aren't always found from armchairs and slide rules.

* Bulletins GED-4111B (Some Plain Talk About Fuel Cells), and GEA-7538 (Fuel Cell Development Progress at General Electric). For copies, drop us a line at General Electric Company, Section 183-09, Direct Energy Conversion Operation, 950 Western Ave., Lynn, Mass.

Progress Is Our Most Important Product

GENERAL ELECTRIC

the 210 and are operated by a flap-shaped switch on the lower instrument panel.

Electrical system has a 12 v., 50 amp. generator. All-weather, radio-shielded ignition harness is standard equipment.

Radios have been moved forward to the area occupied in the Model 210 by the nose wheel well. The area has been sealed from the engine compartment, which is just above, and vented for cooling. A trap device also is incorporated to prevent water from reaching the radios.

205 Characteristics

A flight in the Wichita area with Cessna Pilot Jack Bledsoe showed these characteristics of the 205:

• **Stability and ease of handling** even in out-of-the-ordinary attitudes. The aircraft was put into a steep descent with full flaps and showed no tendency to overspeed or wind up into a tight spiral. Speed never exceeded 100 mph. IAS during the descent and stabilized at 90 mph.

• **Forgiving stall characteristics.** The 205, like other Cessna models, showed the ability to hang on the edge of a stall for extended periods before finally falling through. With power off, the aircraft exhibited a gentle buffeting and a shallow break, with the stall warning horn giving plenty of warning. With power on at 20 in. Hg. manifold pressure and 2,350 rpm., both hands were required to get sufficient back pressure on the control wheel to stall the airplane completely. Stall was preceded by a heavy buffet as well as ample warning from the stall horn. The 205 was stalled with the left wing low and tended to drop off on the left wing, but lateral recovery was made with ailerons alone. A stall was attempted from a turn, but the aircraft simply tightened its turn and the attempt was abandoned after turning through more than 360 deg.

• **Good balance of fuel** consumption to cruise speed. At the recommended economy cruise setting of 22 in. Hg. and 2,200 rpm., the 205 indicated 136-8 mph. (149 mph. TAS) and had a fuel consumption rate of approximately 10.5 gph.

Cabin of the 205 is longer than any ever built into a Cessna aircraft with the exception of the new Model 411 (AW July 30, p. 22). The cabin is 106 in. from the instrument panel to the bulkhead aft of the third row of seats. An 18-in. area extends forward of the instrument panel and there is a 13-in. carrying rack behind the last seats, making an over-all cabin depth of 137 in. The cabin has 115 cu. ft. of space.

There is a 6-in. wide aisle between the front two pairs of seats, making it possible for a person to move about in the cabin during flight.

Cessna believes the 205 will find a market with air taxi and charter operators, who have long sought an aircraft that could enable them to carry four persons at a cost lower than that of most light twins. Operators have told the company that two couples en route to college football games, for example, often choose not to fly because of the cost of twin-engine equipment and the unavailability of single-engine equipment of sufficient carrying capacity.

Cessna also hopes to sell the aircraft to present aircraft owners whose families have grown to the point where a four-place aircraft is impractical.

Although the 205 may cut slightly into sales of the Model 185 Skywagon, Cessna believes the two aircraft are suited to entirely different markets. The 185, basically a utility aircraft for use in back country and other areas where a bush plane is needed, is not available with a six-seat interior.

The 185 formerly was available in a six-seat, "deluxe" version, but the two rearmost seats were not separated and were fitted flush against a bulkhead, making them non-adjustable. This configuration now has been dropped and only a four-seat version is available.

The 205, on the other hand, is not designed for utility work and is available only in a passenger configuration.



SEATING CONFIGURATION shows 6-in.-wide aisle between seats for ease of movement. Windows offer passengers 360 deg. of visibility.

The 205 retains most of the familiar Cessna design features, including the conical camber wingtips with the pronounced droop noticeable on the 210.

Walk-around inspections are no different from earlier Cessna models. Bledsoe demonstrated the aircraft's ability to receive passengers through the third door. The 205 will remain balanced

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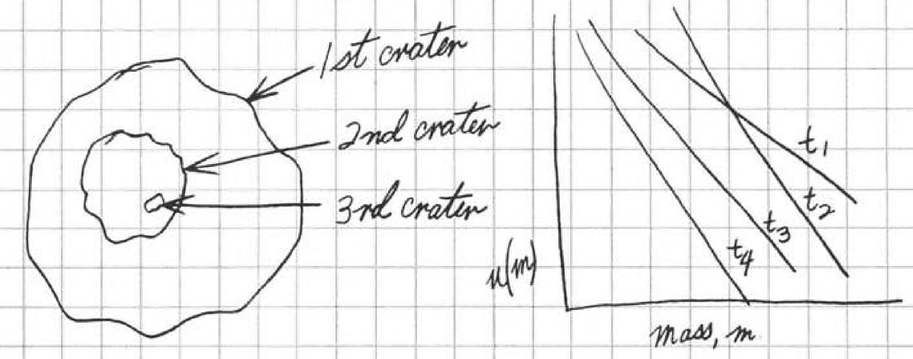
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Cessna 205 Performance and Specifications

Gross weight	3,300 lb.
Empty weight	1,750 lb.
Useful load	1,550 lb.
Wing span	36 ft. 7 in.
Wing area	175.5 sq. ft.
Length	27 ft. 9 in.
Height (with depressed nose strut)	9 ft. 9 in.
Propeller, constant speed, dia	82 in.
Wing loading	18.8 psf.
Power loading	12.7 lb. hp.
Fuel capacity	
Standard tanks	65 gal.
Optional oversize tanks	84 gal.
Oil capacity	12 qt.
Engine	Continental IO-470-S, 260 hp. at 2,625 rpm.
Speed	
Top speed, sea level	173 mph.
Cruise, 75% power 6,500 ft	163 mph.
Range, standard tanks	
75% power, 6,500 ft., no reserve	730 mi.
Maximum rate of climb, sea level	965 fpm.
Service ceiling	16,100 ft.
Takeoff	
Ground run	685 ft.
To clear 50 ft. obstacle	1,465 ft.
Landing	
Ground roll	625 ft.
Over 50 ft. obstacle	1,510 ft.

with two large persons in the rear seats, even if the front seats are unoccupied.

Automobile-type key starting allows one-hand engine starts if the pilot desires. Normal procedure is to move the mixture control to full rich and the propeller to high pitch, close the throttle and turn the key to the start position.

As the engine turns, the vernier throttle is turned to increase the fuel flow until the engine catches. Little adjustment was required to bring the engine to its warmup speed of 1,000 rpm. The auxiliary fuel pump switch, on low during engine start, may be turned off after the engine is running.

A mechanical hand lever to operate the cowl flaps is located on the right side of the center cockpit pedestal, and the flaps should be open during all ground operations. After takeoff, it may be adjusted to keep the engine cylinder head temperature within the green arc.

Taxiing is easy with the steerable nose wheel, and visibility during ground operation is excellent.

A simple run-up check was made at the end of the runway. The engine was advanced to 1,700 rpm. and checked for a maximum drop of 125 rpm. on each magneto. Since the 205 has a fuel injection engine, there is no need to check the engine heat. Operation of the engine air intake heater will produce a slight drop in rpm., however.

Takeoff, into a slight crosswind, was normal. The nosewheel was lifted at about 60 mph., and the 205 flew off easily at about 75 mph.

At 24 in. Hg. and 2,450 rpm., the 205 will climb in a comfortable attitude at more than 500 fpm., holding 120 mph.

At 3,500 ft., the speed checks were run with the outside air temperature 75F. The 205 indicated 153 mph. or 166.5 mph. TAS at 74% power—24 in. Hg. manifold pressure and 2,450 rpm. Fuel consumption at this engine setting is about 14 gph.

At 65% power, or 2,350 rpm. and 23.5 in. Hg., the aircraft indicated 150 mph. or 162.5 mph. TAS. Fuel consumption is just over 12 gph.

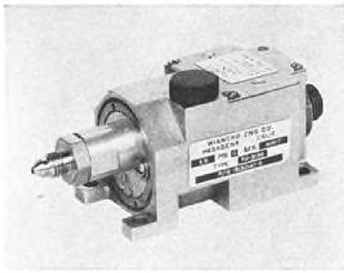
Economy cruise, 57% power, or 2,200 rpm. and 22 in. Hg., gave an indicated airspeed of 136.8 mph., which converted to 149 mph. TAS. Fuel consumption was about 10.5 gph. With the oversize fuel tanks on N 18022, endurance was about 7½ hr.

Only in landing was any change noted in handling characteristics from other Cessna aircraft. The 205, designed to take a heavy cabin load extending well aft, tends to hold a nose down attitude, even with flaps partially down. Use of trim eases control wheel landing force requirements, much as in a heavier aircraft.

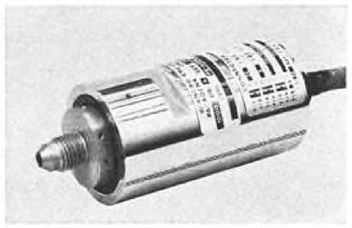
The 205 is a gentle aircraft to fly, is stable, and with the exception of one landing with the trim approximately neutral, never required more than minimum force on the controls.

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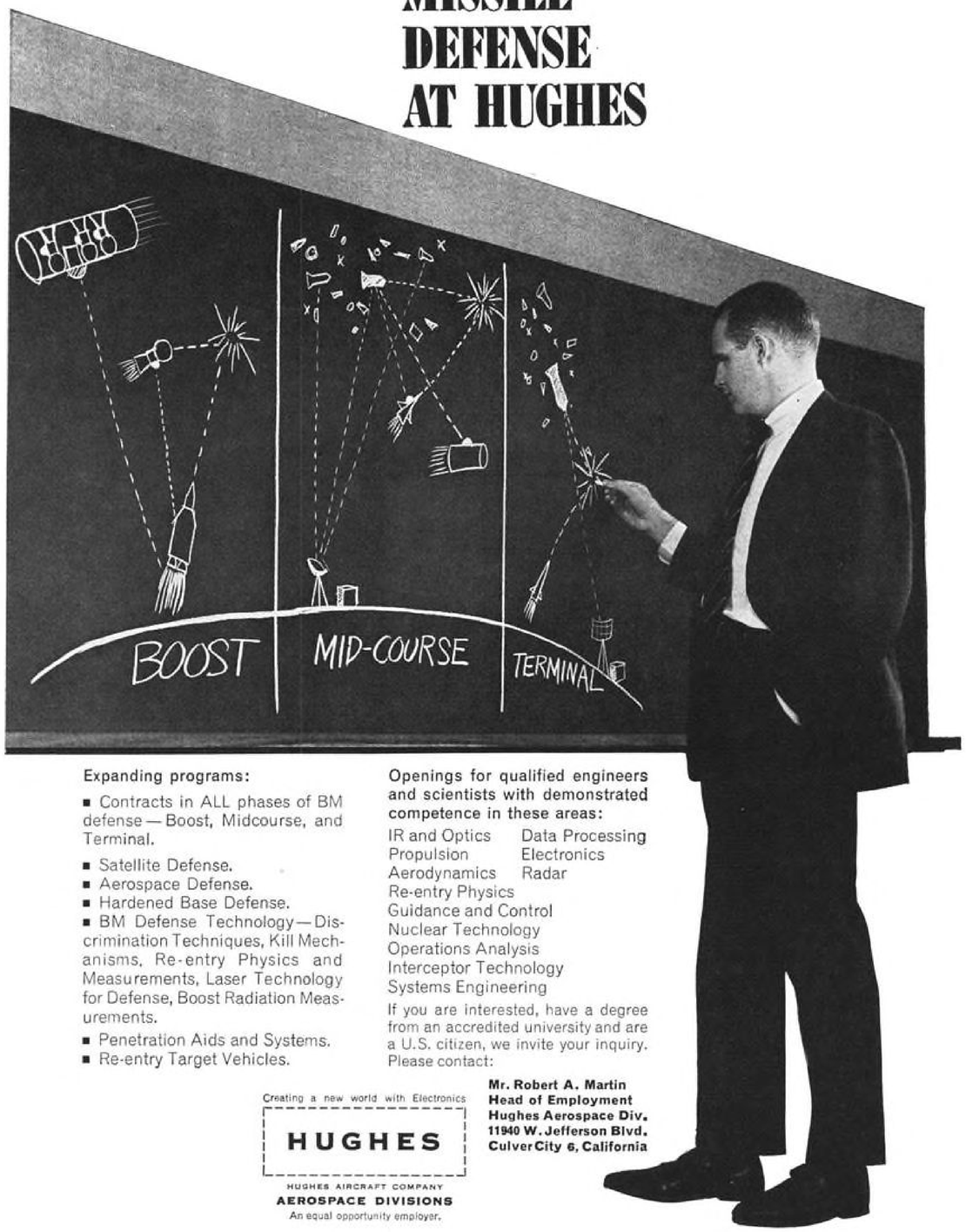
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WHO'S WHERE

(Continued from page 23)

Changes

Robert T. Delamater, Jr., Western area sales manager, Power Equipment Division, Lear Siegler, Inc., Elyria, Ohio.

Charles E. Sporck, operations manager, Fairchild Semiconductor, Mountain View, Calif., a division of Fairchild Camera and Instrument Corp.

Robert S. Carll, application-sales engineer for Agastat timing instruments, Elizabeth Division, Elastic Stop Nut Corp., Elizabeth, N. J.

Roland V Poisson, manager, Shafer Bearing Division, Chain Belt Co., Downers Grove, Ill.

Lt. Col. Ernest L. Smith, director of information, Aeronautical Systems Division, Air Force Systems Command, Wright-Patterson AFB, Ohio.

Carl David Todd, head of engineering, Packaged Assemblies Department, Hughes Aircraft Co.'s Electronic Products Division, Newport Beach, Calif., and **Richard S. Simpson,** supervisor of production engineering.

Donald S. Jones, assistant general manager, The Bendix Corp.'s Scintilla Division, Sidney, N. Y.

Harry A. Keit, director, System Design Division, International Electric Corp., Paramus, N. J., a subsidiary of International Telephone and Telegraph Corp.

Dr. J. M. Hirshon, associate director-active component development, International Resistance Co., Philadelphia, Pa.

George Carr, section chief-Air Force antenna program, Emertron, Inc., Silver Spring, Md.

William M. Magruder, director of military sales-advanced systems and research, Douglas Aircraft Division, Long Beach, Calif. Mr. Magruder continues as chief engineering test pilot.

Charles B. Slack, manager-aerospace products, Waugh Engineering Division, The Foxboro Co., Van Nuys, Calif.

Dr. E. C. Galloway, director of research, Plastics Division, Nopco Chemical Co., Newark, N. J.

Dr. Bruce B. Barrow, senior engineering specialist-advanced communication systems, Applied Research Laboratory, Sylvania Electronic Systems, Waltham, Mass., a division of Sylvania Electric Products, Inc.

E. Dana Gibson, assistant to the executive vice president, Thiokol Chemical Corp., Bristol, Pa.

Douglas Aircraft Division, Long Beach, Calif., has appointed the following managers in the Program Department: **W. E. Catlin** for special manufacturing programs; **A. R. Reaume** for aircraft service, overhaul and maintenance programs; **R. A. Spence** for schedules and change management.

Col. John K. Shelley (USAF, ret.), assistant to the vice president of engineering, Systems, Inc., Orlando, Fla.

Dean F. Horning, aerospace industry consultant, has been appointed to represent Rohr Corp. in Houston, Tex.

W. J. Martin, director of reliability, General Dynamics/Convair, San Diego, Calif.

Bernard Rider, director of research and development, Maryland Division of Litton Systems, Inc., College Park, Md.

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GUIDANCE ANALYSIS
BS or MS in engineering or math to develop families of equations for guidance of space boosters and simulation of vehicle and guidance system performance by application of digital computer techniques.

INSTRUMENTATION
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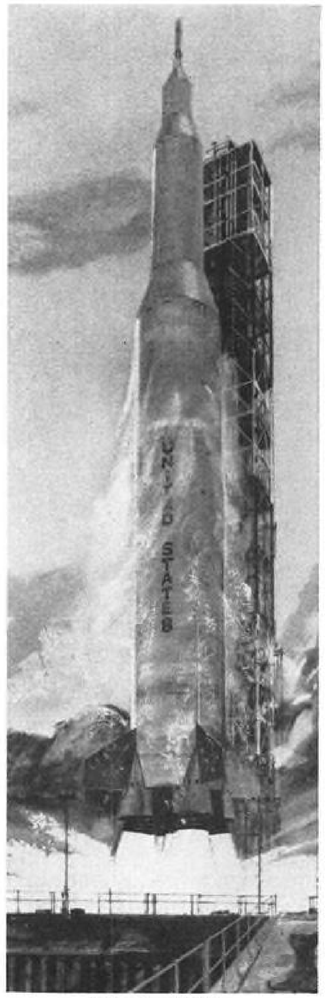
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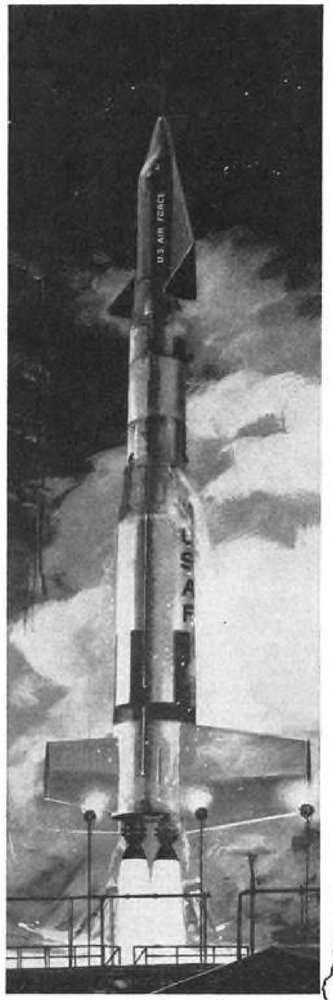
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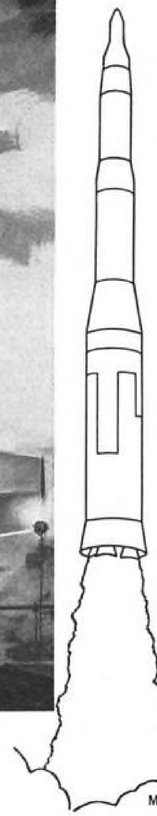
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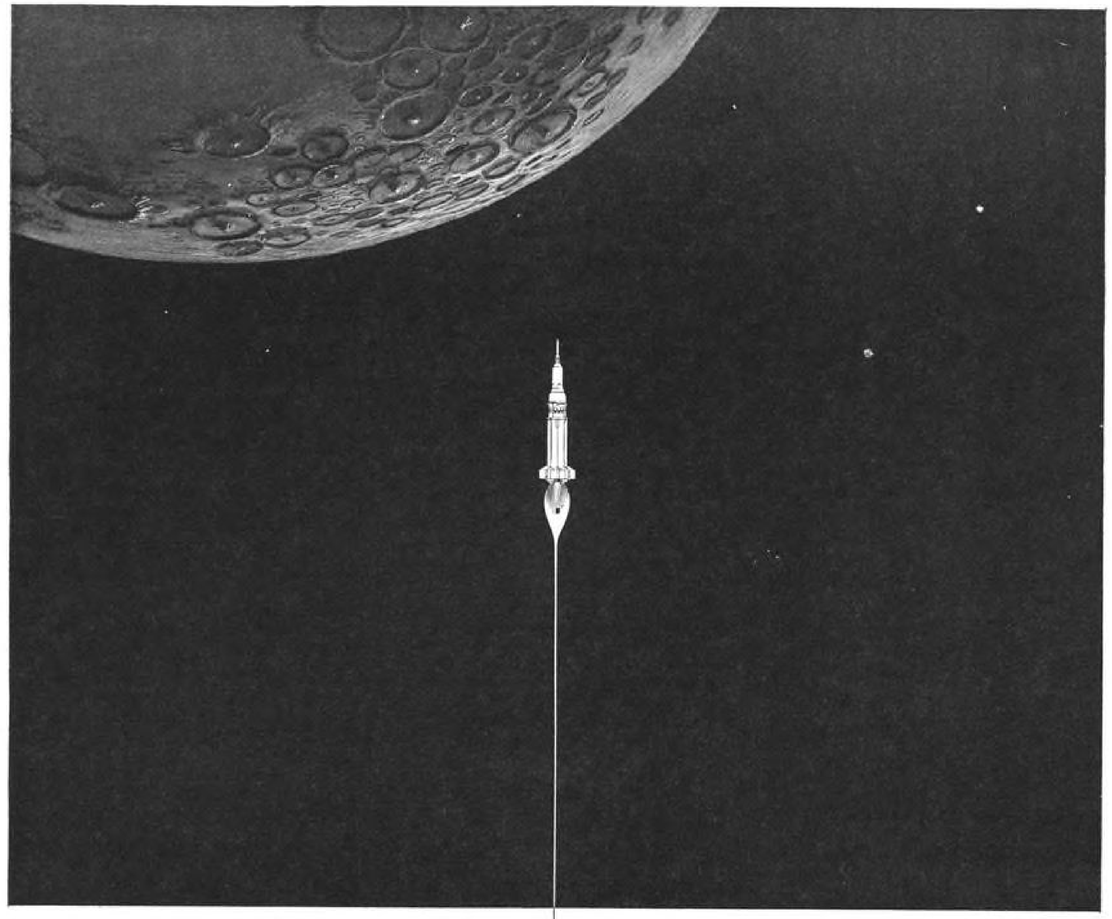
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LETTERS

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

Swinging Pendulum

The present squabble over the aerospace profit-on-profit situation seems to involve the basic question of what constitutes the best method of procuring military weapons.

It was not long ago when the Defense Department grew tired of buying a bare airplane and equipping it themselves. Government Furnished Equipment (GFE) was then provided to the airplane contractor for installation. However, the government was still responsible for the proper functioning of the GFE. When it didn't work, the airplane builder merely returned it to the government with a request for equipment which would function properly. Then the "weapons system" concept was evolved to put the responsibility for the whole works on some "prime contractor." The shift was so complete that one airplane contractor offered to "deliver your bombs on a cost-plus-fixed-fee basis if you will tell us where the targets are."

Now the profit-on-profit rumpus seems to be swinging the pendulum back towards the early system. This has my approval as a taxpayer providing proper management capability is maintained at all the necessary levels in the Department of Defense to properly administer the complicated and intertwining procurement programs. However, needless change is costly and we must choose a good system and *make it work!*

We will probably never agree on what constitutes the best system as long as new people filter through positions of control. In almost every case there are several different systems which will work if we can find people capable of making them work. Too often we think that our individual method is the only way.

Many times top management people have been heard to boast that they "straightened out" office after office as they moved about in management circles, implying that everyone else is incompetent. In actuality it is that person who is "incompetent" because he cannot make a system work which did OK for his predecessor.

Therefore, regardless of how the present defense procurement problems are settled, let us all then agree that we have a workable system evolved by intelligent people and stop this change for change's sake by each succeeding office incumbent. Then our tax dollar will go much, much further.

M. M. Furney
Cdr., USN Ret.
Wichita, Kan.

P. S. The Industry Observer section of the Aug. 6 issue of Aviation Week (p. 23) notes a departure from the USAF weapon system concept in an engine development program intended solely to advance engine technology. The pendulum is swinging!

Altitude Error

Aviation Week has boosted a high-flying pilot to new record heights. In the article "X-15, Soviet Fighter Claim New Records" (AW July 23, p. 25), you report that Joseph A. Walker had flown the X-15 to 284,000 ft. Mr. Walker actually flew X-15-1 to 246,700 ft. on April 30, 1962, some 37,300 ft. below the altitude you reported. Major Robert M. White flew X-15-3 to the same altitude—246,700 ft.—seven weeks later (June 21, 1962). Then, on July 17, Major White flew to 314,750 ft. It is anticipated that both marks—Walker's 246,700 ft. and White's 314,750 ft.—will be certified by the Federation Aeronautique Internationale as world altitude records for manned aircraft.

James A. Martin
X-15 Program Manager
NASA Headquarters

(Mr. Martin is correct. Aviation Week *erred in stating that the earlier flight by Walker reached 284,000 ft.—Ed.)*

Engineer Rebuttal

I enjoyed reading Capt. James A. Schmitt's letter (USAF Pilot) in the Aug. 6 edition of Aviation Week titled "Engineer Comment." To be more accurate, I suggest the title should have been "Illusion." I'm sure that Mr. Schmitt's use of Capt.-Pilot-USAF was intended to give the illusion that the letter was written by a disinterested neutral or outsider. To be completely fair, Capt. Schmitt should have mentioned that his name is on TWA's seniority list as a junior copilot, as well as being a dues-paying member of ALPA.

Capt. Schmitt suggests that the F/Es have a better public relations program than the pilots. The truth of the matter is that if you are morally and technically right (which would be a new experience for ALPA) you don't need the boys from Madison Ave.

The inference that the flight engineer is deteriorating because he doesn't want to become a "jack of all trades" and go on the bottom of the pilots' seniority list is merely a weak attempt at protecting his and the other junior pilots' place on the seniority list.

The statement that the third pilot or "featherbedder" has probably run more jet engines than all the F/Es combined is just "too much." Using a very conservative figure of 250 jet engineers, flying 60 hours a month each on TWA, Pan Am, American and Eastern, the figure comes out to 720,000 hours of jet engine running a year. If this junior pilot or featherbedder has this much time to his credit, I think he, not the flight engineer, should remain on the ground and get a much deserved rest.

Being a former Navy pilot myself, I have the greatest respect and admiration for the career service pilot. They are tops in piloting ability, and have chosen the service as a career for the love of flying and not for the money in it. So please, Mr. Schmitt, let's not use our affiliation with the armed forces to promote our individual selfish interests.

F/E J. M. Bockius, III
Greenlawn, N. Y.

Fluorescents Backer

As past Program Director for the Applied Psychology Corp.'s conspicuity research for the Federal Aviation Agency, I was gratified by your reporting of the essential findings as presented by Dr. van Saun at the recent collision-prevention conference in Washington (AW July 30, p. 51). Because of the sensitive aspects of the fluorescent paint discussion, I would like to offer one bit of clarification.

In the middle of column three, your article states, "Aircraft with a fluorescent orange-red empennage were visible on the average at distances of 2½ mi., . . ." Actually, the observed aircraft (numbering more than 500) were generally visible at greater distances. It was the red-orange color of the fluorescent paint that was correctly identified, on the average, 2½ mi. out. This was appreciably better than the correct identification of any color of non-fluorescent paint—for these the average range never exceeded 1 mi.

This distinction is of importance to operators about to choose paints. Although the fluorescents may be relatively costly and of variable service life just now, they do possess a visual range advantage. To whatever extent the detection and meaning ("this is the empennage") of the red-orange area can be of value to pilots flying VFR, the fluorescent coating of that color has an edge in distance and thus, for any given situation, in warning time.

John E. Robinson, Jr.
Hughes Aircraft Co.
Fullerton, Calif.

AD Infinitum?

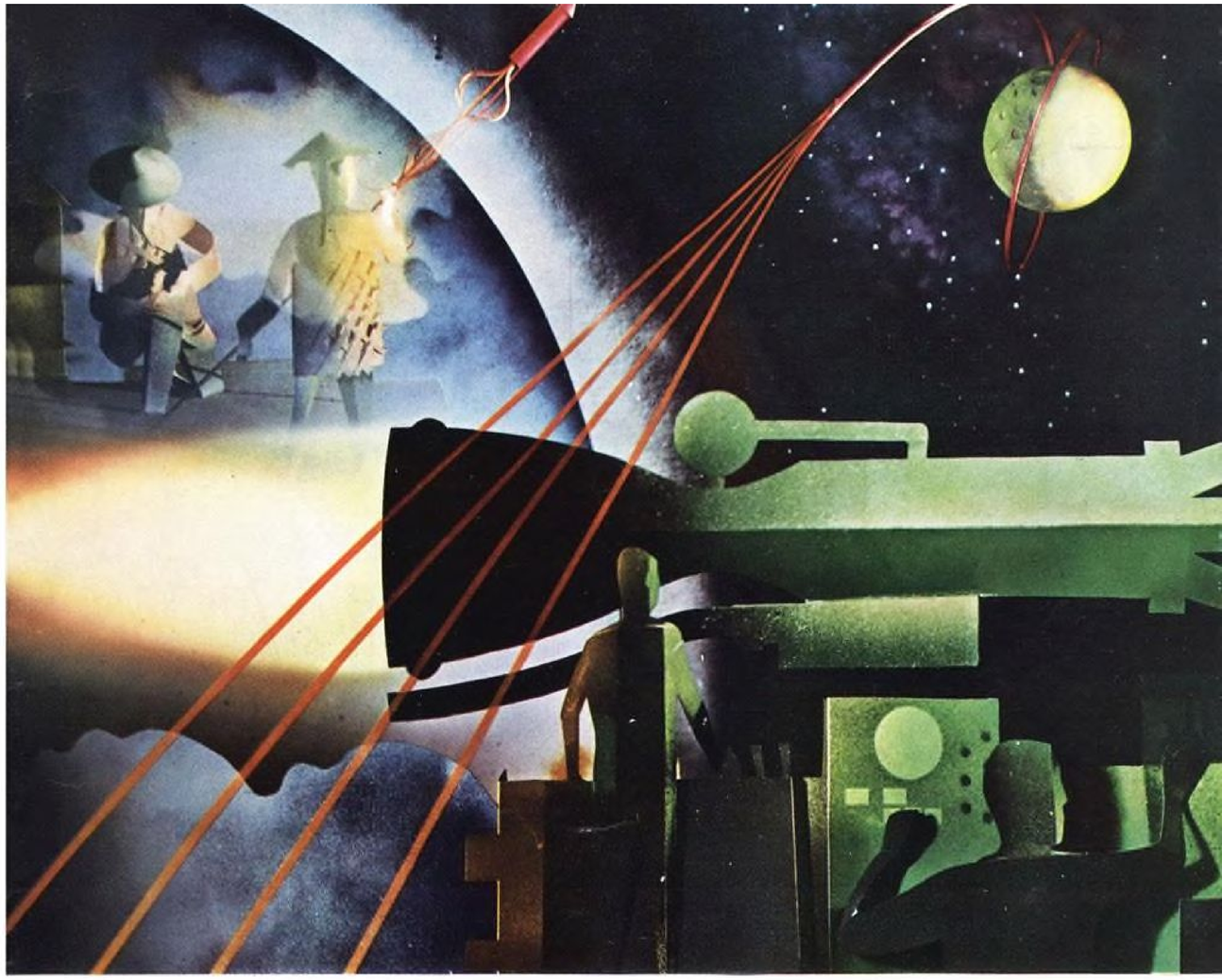
In your article on the F4H in the July 30 issue, a picture on p. 39 shows at least one squadron of AD attack aircraft on the aft deck of the supercarrier.

Will it not be true that this type will have been in longer continuous service than any other combat aircraft?

Do any other major military powers or services still employ single-seat propeller driven aircraft as front line weapon systems?

Finally, unless the military expects machines beyond the ultimate manned concepts of the RS-70 and the now-junked F-108, why will reason be served by calling the F4H (this, the last word in manned interceptors) the F4H-MC, while hundreds of predecessors had the simpler handles?

Paul A. Ludwig
Ex-AD Pilot
Minneapolis



• *History of rocketry from 13th Century China to the present symbolized*

Bell research makes MAJOR CONTRIBUTIONS to aviation, missile and space programs

AGENA ROCKET ENGINE – Stop-and-start engine for the Air Force and NASA satellite and space probe programs. It has put in orbit more payload than any other engine.

HIPERNAS – High Performance Navigation System. Designed for the U.S. Air Force, this self-compensating, pure inertial guidance system can pinpoint a long-range missile on target, or guide a satellite or space ship to any point in the universe.

VTOL AIRCRAFT – Bell built the X14A now being used by NASA to evaluate VTOL flight characteristics. First flown six years ago, it was followed by design of the 8 engine D188A VTOL Fighter-Bomber for the U.S. Air Force and Navy. Bell currently is competing for other contracts in the VTOL field.

STEERING GEAR FOR MERCURY ASTRONAUTS – Jet Reaction Controls, developed by Bell, control the roll, pitch and yaw of the Mercury capsule in space.

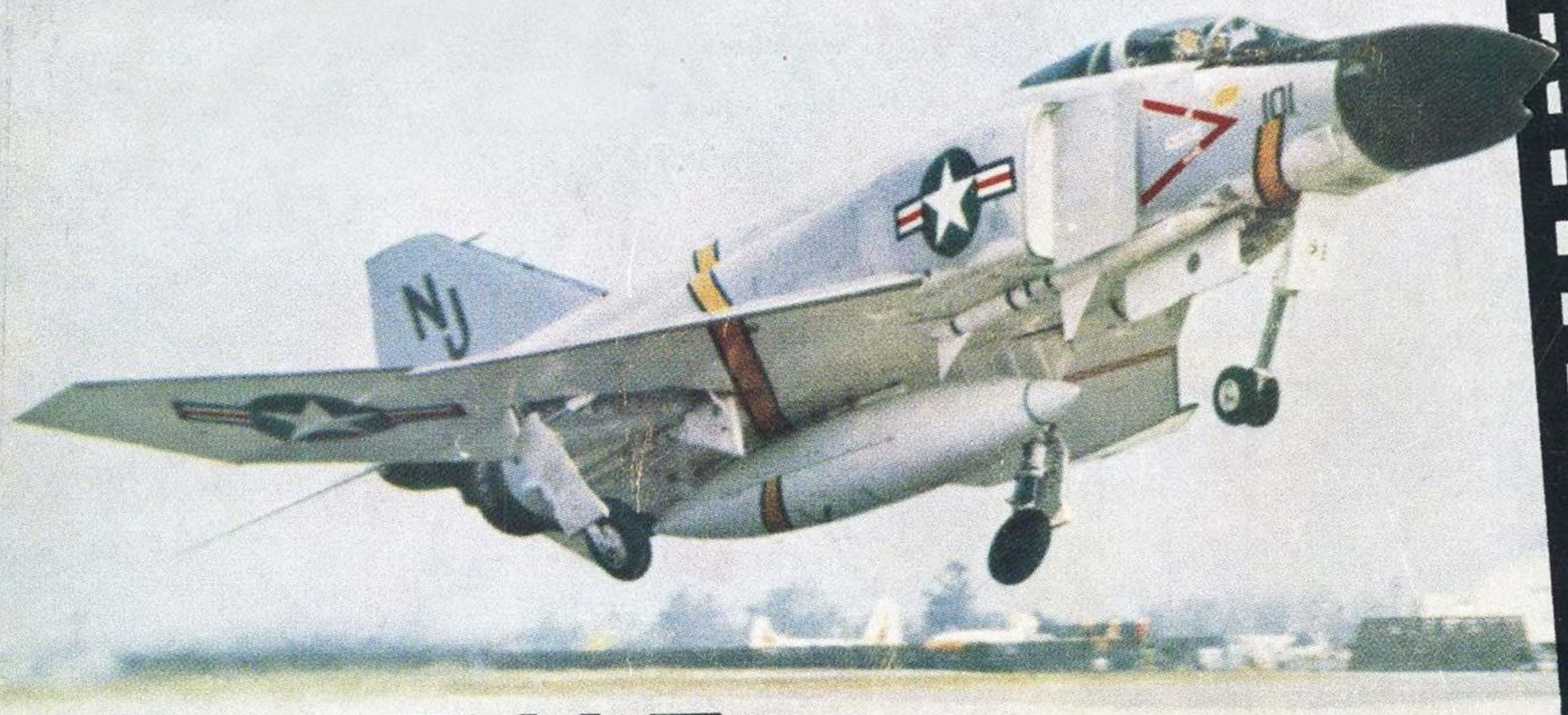
BELL ROCKET BELT – First portable rocket device to give man free flight. Publicly demonstrated at Ft. Eustis, Va., June 8, 1961, it is now being studied by the Army for ship-to-shore landings and carrying the foot soldier over streams and rugged terrain.

ALS – All-weather, automatic Aircraft Landing System. This electronic "window in the sky" automatically guides planes to safe landings in foul weather, at night, even in heavy seas. Purchased by Navy for installation on 10 modern aircraft carriers.

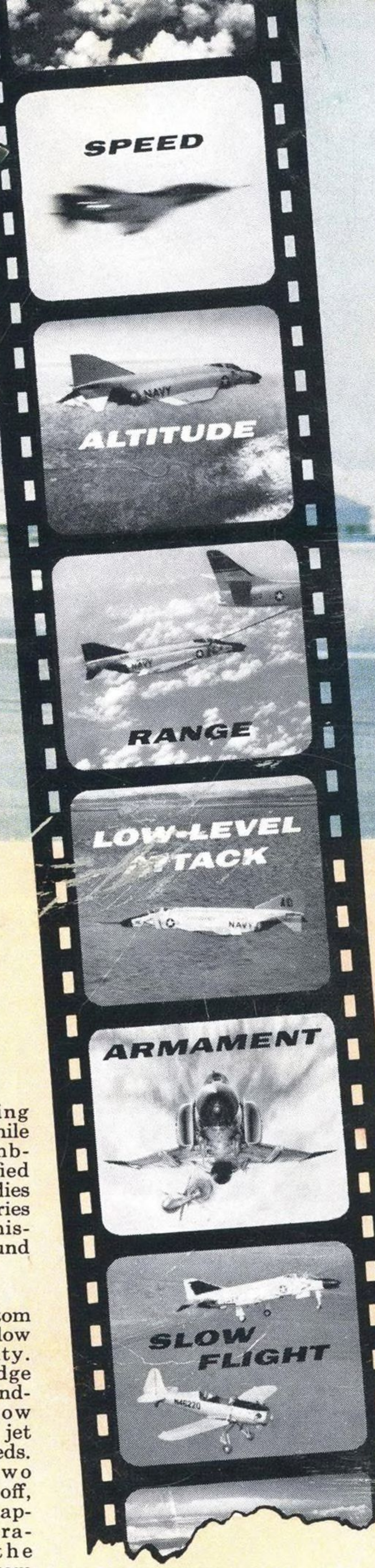
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DIVISION OF BELL AEROSPACE CORPORATION

A textron COMPANY

AUG. 28 1962



THE FEATS OF A PHANTOM



The feats of a Phantom measure its awesome combat capabilities. They are a testament to its structural strength, sheer power and armament versatility.

● Setting 100 and 500-kilometer world speed records dramatized the Phantom II's maneuverability at lightning speeds and ability to attack and re-attack evasive targets. Its intercept capability was exhibited in setting the world's absolute speed record of 1606.3 (Mach 2.5+). During this record flight the Phantom II reached peak speeds in excess of 1650 mph.

● The Phantom II holds the world's altitude record for sustained flight, maintaining 66,443 feet at Mach 2.2. It has established all eight recognized time-to-climb marks, including a climb to 30,000 meters in 6 minutes, 12 seconds, demonstrating the ability of the Phantom II to launch attacks quickly at all altitudes.

● To capture the Bendix Trophy, a Phantom II flew coast to coast in 170 minutes and set a new transcontinental speed record to demonstrate its deployment capability over great distances at high speeds.

● Low-level ground attack capability was emphasized by the Phantom II as it flew Mach 1.2, at times less than 125 feet above the ground, to shatter the 3-kilometer world speed record.

● The Phantom II Air Defense fighter has delivered conventional bombloads weighing twice that carried by World War II Flying Fortresses. Yet even while carrying multi-ton bombloads, the carrier-qualified Phantom II literally "flies its own cover" since it carries Sparrow III air-to-air missiles in addition to its ground attack payload.

● Final proof of the Phantom II's versatility lies in its slow flight and landing ability. Leading and trailing edge flaps, augmented by boundary layer control, allow slower than commercial jet transport approach speeds. The power of the two GE-J79 engines for take-off, matched by very slow approach speeds and para-braking, permits the Phantom II to operate from 5,000-foot runways.



In air defense, air superiority, long range attack or tactical ground support there is no match for the Phantom II.

MCDONNELL

Mercury, Gemini, Asset and Aeroballistic Spacecraft •
F4H and F-110A Fighter and Attack Aircraft • RF-110 Reconnaissance Aircraft •
Talos and Typhon Missile Airframes and Engines • Electronic Systems • Automation

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