Aviation Week & Space Technology

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April 15, 1963

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Marine/Sikorsky CH-53A Heavy Assault Helicopter



Sperry Airborne Anti-Collision System Displayed

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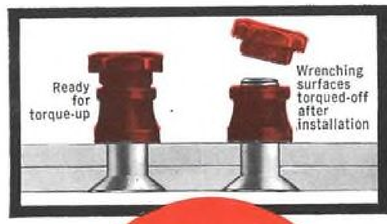
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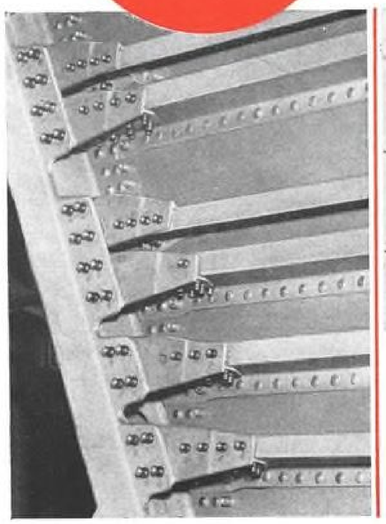


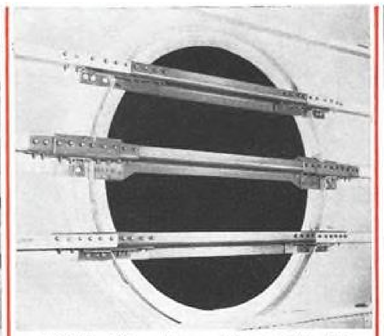
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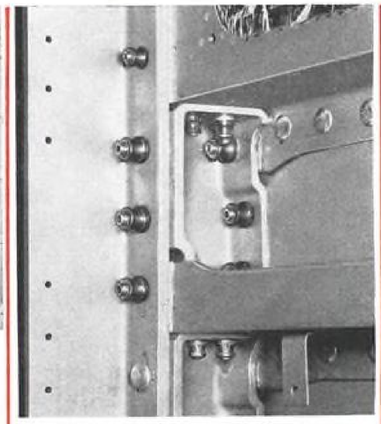
hi-Lok® REDUCES THE INSTALLED COST OF FASTENERS





ABOVE: Fiberglass stringers in the antenna area of the Fin Panel are spliced to aluminum stringers. Evenly controlled clamp-up of Hi-Lok prevents cracking or crazing.

LEFT: Wing rib structure assembled with Hi-Loks. High preload fastener is required in critical fatigue stress area.



ABOVE: Minimum tool clearances and return flanges in wing primary structure are easily overcome by Hi-Lok 90° and offset installation tooling.

● Hi-Lok Fasteners do many things in Boeing's expanding family of jet airliners. Basically, though, the Hi-Lok was selected by Boeing structural engineers to obtain a lower installed cost and for its high preload capability when compared to collar swaged fasteners.

The installed cost of the fastener includes hole preparation and the time to install and inspect as well as the fastener itself. All contribute to the price tag of assembled structure.

Versatility of Hi-Lok installation tooling permits the use of Hi-Loks in many areas not feasible to other fasteners. This versatility results from a successful marriage of Hi-Lok adaptor tools to standard light weight air motors. No bulky, single-purpose power equipment is needed.

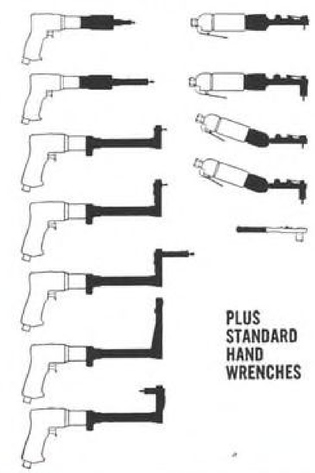
In open structural areas, Hi-Loks can be installed up to 45 per minute using Hi-Lok collar-feed tooling. This automatic equipment can install 200 Hi-Lok collars on Hi-Lok pins without reloading.

In fastening dissimilar materials such as combinations of wood, fiberglass and metals, the Hi-Lok is ideal because of its fundamental concept to control preload, eliminating the risk of crushing or crazing of softer materials. For these reasons plus ease of installation, the Hi-Lok Fastener has become officially approved for naval marine construction.

U.S. PATENTS 2,882,773, 2,927,491 AND 2,940,495
OTHER U.S. AND FOREIGN PATENTS GRANTED AND PENDING

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Fitted to Standard Air Motors



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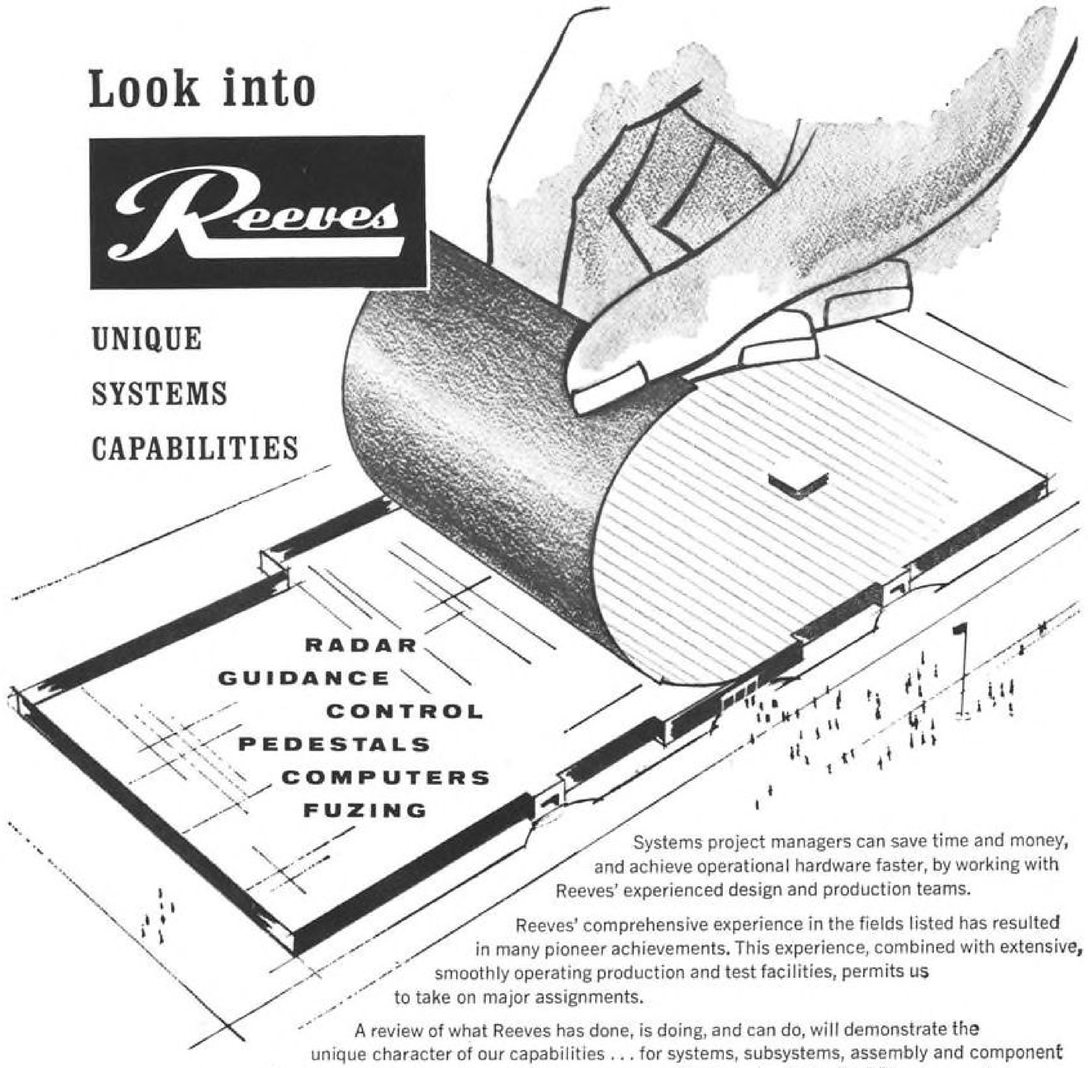
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AEROSPACE CALENDAR

Apr. 22-23—Annual Meeting, National Aeronautical Services Assn., Washington, D. C.

Apr. 22-24—Second Manned Space Flight Symposium, AIAA/NASA, Marriott Hotel, Dallas, Tex.

Apr. 22-24—Third Annual San Diego Symposium for Biomedical Engineering, Del Webb's Oceanhouse, San Diego, Calif.

Apr. 22-25—10th Weather Radar Conference, American Meteorological Society, International Inn, Washington, D. C.

Apr. 23-25—Hypersonic Ramjets Conference, AIAA/ASME, Naval Ordnance Laboratory, White Oak, Md. (Secret)

Apr. 23-25—National Conference on Electromagnetic Relays, Oklahoma State University, Stillwater, Okla.

Apr. 25-26—Annual Convention, Society of American Value Engineers, Americana Hotel, New York, N. Y.

Apr. 29-30—1963 Spring Meeting, Western States Section/The Combustion Institute, Vacation Village Motel, San Diego, Calif. Sponsor: General Dynamics/Astronautics.

Apr. 29-May 2—34th Annual Scientific Meeting, Aerospace Medical Assn., Statler Hilton Hotel, Los Angeles, Calif.

Apr. 29-May 2—22nd Annual National Conference, Society of Aeronautical Weight Engineers, Sheraton-Jefferson Hotel, St. Louis, Mo.

Apr. 29-May 2—Spring Meeting, United

(*Continued on page 7*)

AVIATION WEEK & Space Technology

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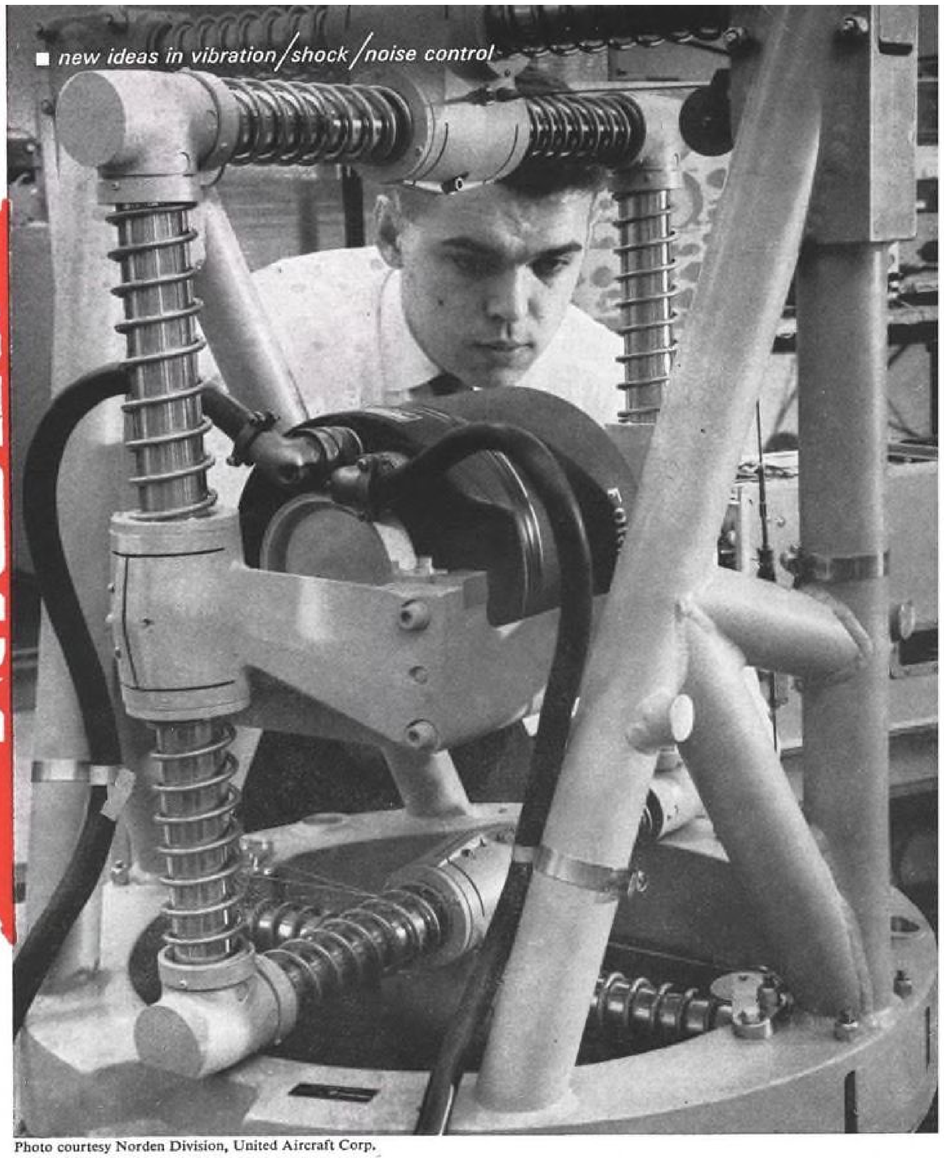


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LORD

AEROSPACE CALENDAR

(*Continued from page 5*)

States National Committee of International Scientific Radio Union (URSI), National Academy of Sciences, National Research Council, Washington, D. C.

Apr. 29-May 3—Annual Conference, Society of Photographic Scientists and Engineers, Ambassador Hotel, Atlantic City, N. J. Co-sponsor: Army Research Office.

May 1—Fifth Lester D. Gardner Lecture by Elmer A. Sperry, Jr., on Early Airplane Instruments, Kresge Auditorium, Massachusetts Institute of Technology.

May 1-3—19th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D. C.

May 1-9—Third National Conference on the Peaceful Uses of Space, Chicago, Ill. Sponsors: NASA; Committee for Economic and Cultural Development of Chicago.

May 2—Manned Space Laboratory Conference, AIAA/Aerospace Medical Assn., Statler-Hilton Hotel, Los Angeles, Calif.

May 2-3—Fourth National Symposium on Human Factors in Electronics, IEEE, Marriott Twin Bridges Motel, Washington, D. C.

May 2-5—International Travel Fair and Flying Display, Biggin Hill Airport, Kent, England.

May 5-8—1963 Annual Conference, American Assn. of Airport Executives, Galt Ocean Mile, Beach Club and Coral Ridge Hotels, Fort Lauderdale, Fla.

May 6-8—Aerospace Reliability and Maintainability Meeting, AIAA/ASME/SAE, Washington, D. C.

May 6-9—Ninth Annual Aerospace Symposium, Instrument Society of America, Jack Tar Hotel, San Francisco, Calif.

May 7-9—Electronic Components Conference, Institute of Electrical and Electronics Engineers, International Inn, Washington, D. C.

May 8-9—60th Meeting, National Aerospace Standards Committee of the Aerospace Industries Assn., Hotel Roosevelt, New York, N. Y.

May 8-10—Spring Meeting, Society for Experimental Stress Analysis, Hotel Benjamin Franklin, Seattle, Wash.

May 9-10—Quarterly Regional Meeting, Assn. of Local Transport Airlines, Fort Worth, Tex.

May 13-15—National Aerospace Electronics Conference, IEEE/AIAA, Dayton, Ohio.

May 15-16—Fourth Annual Symposium on High Speed Testing, Hotel Somerset, Boston, Mass. Sponsor: Plas-Tech Equipment Corp.

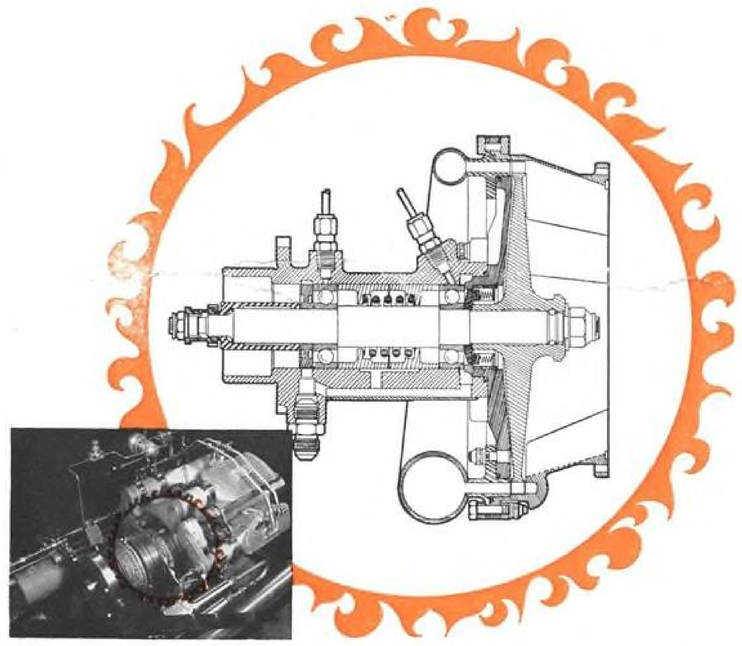
May 15-17—Connecticut General Flight Forum's Second National Symposium on Air Transportation, Hartford, Conn.

May 16—Second Annual Management Conference on Marketing in the Defense Industry, American Marketing Assn., Boston College Campus, Boston, Mass.

May 20-22—17th Annual Convention and Exhibit, American Society for Quality Control, Sherman House, Chicago, Ill.

May 20-22—National Symposium on Microwave Theory and Techniques, Institute of Electrical and Electronics Engineers, Miramar Hotel, Santa Monica, Calif.

(*Continued on page 9*)



THIS HIGH SPEED ASSEMBLY UNAFFECTED BY EXTREMES OF ACCELERATION AND TEMPERATURE

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Lubrication and cooling is provided by jets of oil impinging on each bearing ■ A face-type seal prevents loss of oil at the turbine wheel hub and prevents mixing of the prime-mover gases with the lubricant supply ■ Normal operating speed for this application is 60,000 RPM ■

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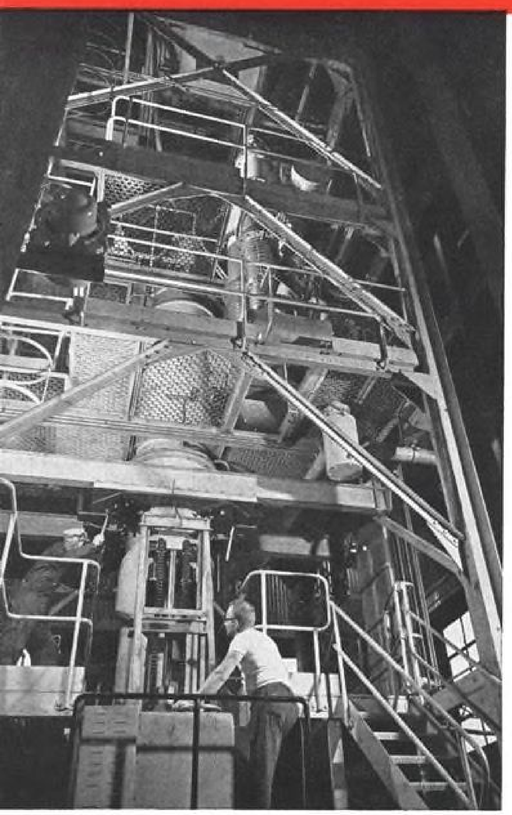
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AEROSPACE CALENDAR

(*Continued from page 7*)

May 20-22—National Telemetering Conference, Hilton Hotel, Albuquerque, N. M.

May 21-23—Spring Joint Computer Conference, American Federation of Information Processing Societies, Cobo Hall, Detroit, Mich.

May 21-23—Symposium: Characteristics of the Lunar Surface, Boston, Mass. Sponsors: Air Force Cambridge Research Laboratories; Arthur D. Little, Inc.

May 21-24—25th Annual Meeting and News Conference, Aviation/Space Writers Assn., Adolphus Hotel, Dallas, Tex.

May 27-28—Seventh National Conference on Product Engineering & Production, Institute of Electrical and Electronics Engineers, Continental Hotel, Cambridge, Mass.

May 27-29—17th Annual Frequency Control Symposium, Shelburne Hotel, Atlantic City, N. J. Sponsor: U. S. Army Electronics Research & Development Laboratory.

June 3-5—Symposium on Materials and Processes for Space Power and Primary Propulsion, Society of Aerospace Material and Process Engineers, Bellevue-Stratford Hotel, Philadelphia, Pa.

June 3-11—COSPAR Fourth International Space Science Symposium and Sixth Plenary Meeting, Warsaw, Poland.

June 6-7—Symposium on the Exploration of Mars, Denver Hilton Hotel, Denver, Colo. Sponsor: American Astronautical Society. Co-sponsors: American Astronomical Society, American Institute of Biological Sciences, AIAA Rocky Mountain Sections, NASA.

June 7-8—14th National Maintenance & Operations Meeting, Reading Aviation Service, Reading, Pa.

June 7-16—25th French International Air Show, Le Bourget, Paris, France.

June 11-14—Symposium on Plasma Space Science, The Catholic University of America, Washington, D. C., with the support of NASA and Goddard Space Flight Center.

June 12-14—Heat Transfer and Fluid Mechanics Institute, American Institute of Aeronautics and Astronautics, California Institute of Technology, Pasadena.

June 17-20—Summer Meeting, American Institute of Aeronautics and Astronautics (AIAA), Hotel Ambassador, Los Angeles.

June 17-21—Summer General Meeting, Institute of Electrical and Electronics Engineers, Toronto, Canada.

June 18-20—41st Meeting, Aviation Distributors and Manufacturers Assn., Chateau Frontenac, Quebec, Canada.

June 28-July 3—Second Annual Dorado Fly-In, Dorado Beach Hotel, Dorado, Puerto Rico.

July 7-11—Seventh National Conference on Aerospace Education, National Aerospace Education Council, Hotel Deauville, Miami Beach, Fla.

July 9-11—International Symposium on Space Telecommunications, Institute of Electrical and Electronic Engineers' Professional Group on Antennas and Propagation, Boulder Laboratories, Boulder, Colo.

Aug. 20-23—1963 Western Electronic Show and Convention (WESCON), Cow Palace, San Francisco, Calif.

PROBLEMATICAL RECREATIONS **166**



A flag-maker made an American flag with the red stripes accounting for $\frac{23}{65}$ of the total area. How does the area of the white stripes compare with the area of the blue field (with stars)? — *Contributed*

ANSWER TO LAST WEEK'S PROBLEM: Starting from his home country the traveler has three possible choices. After visiting the second country he has two choices, and after visiting the third country, two more choices. But after the first four countries have been visited, the second half of his trip is uniquely determined. There are, therefore, 3x2x2 = 12 possible ways of making the trip.

The field of inertial systems continues to broaden and advance at our Guidance and Control Systems Division. May we suggest you investigate presently available positions there in the area of gyro development and gimbal system engineering. Simply mail your résumé to Mr. J. T. Lacy and you will receive prompt attention.

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Gyro Table Servo (Model 101B) . . . for controlling table position during gyro drift measurements . . . includes high power output stage. Requires no motor-generator set. Frequency range — 400 to 10 kc — accommodates wide range of gyros. Static stiffness — 2000 to 5000 ft/lb/m rad — results in high performance. Compensation selector stabilizes servo for gyro time constants from 0.5 to 200 msec.

Tumble Servo (Model 103) . . . for closing loop around integrating gyro during tumble or static tests . . . features chopper stabilized DC amplifier for high gain and low drift.

PIGA Servo (Model 102) . . . for use in testing 16 and 25 PIGA accelerometers . . . has dissipation-limited all-transistor circuitry for maximum reliability.

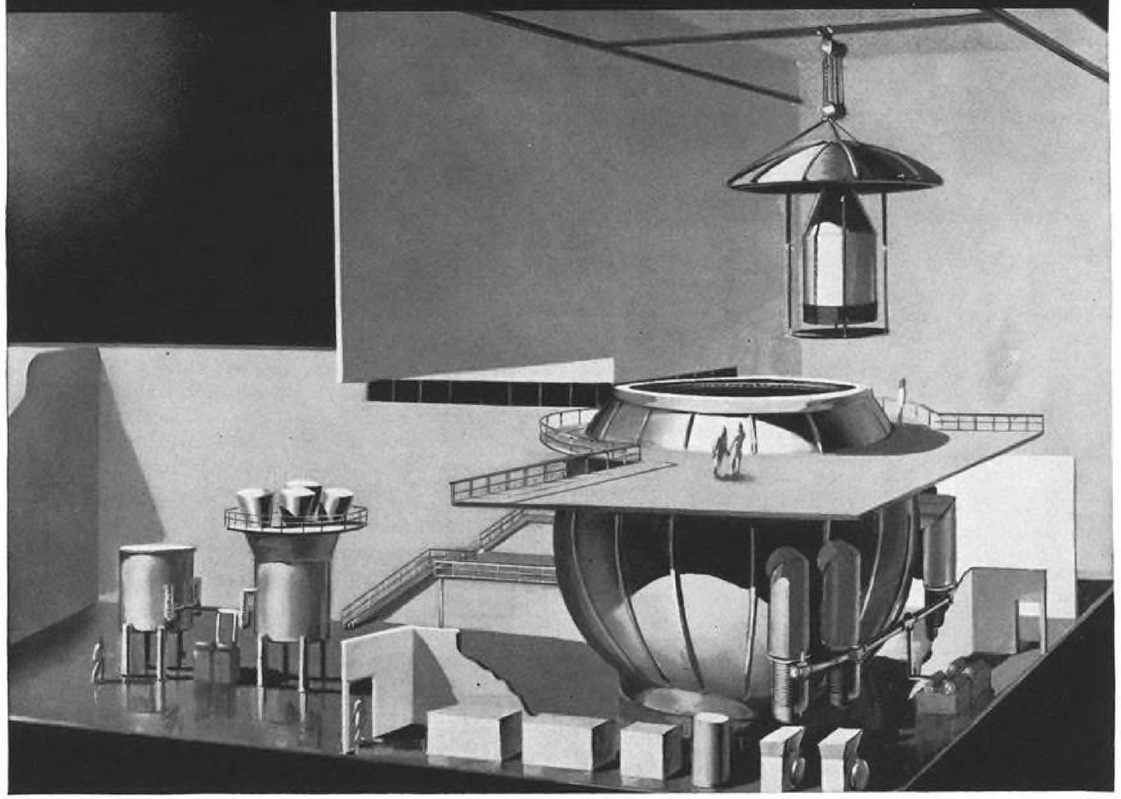
Gyro Wheel Supply (Model 200A) has amplitude stability of 0.01% for 200 hours. Used to supply power to 2 or 3 phase gyro wheel motors.

Microsyn Supply (Model 202A) is an amplitude stabilized AC amplifier for exciting microsyn signal generators, resolvers and industosyns.

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STOKES NAMED PRIME CONTRACTOR FOR NEW DOUGLAS SPACE FACILITIES



Artist's concept of Douglas Aircraft Environmental Test Center. Sketch shows test model of vehicle attached to lid and being lowered into 39' Stokes chamber. To the left are two Stokes "5 x 5s." One is shown with the solar simulator now being designed for it.

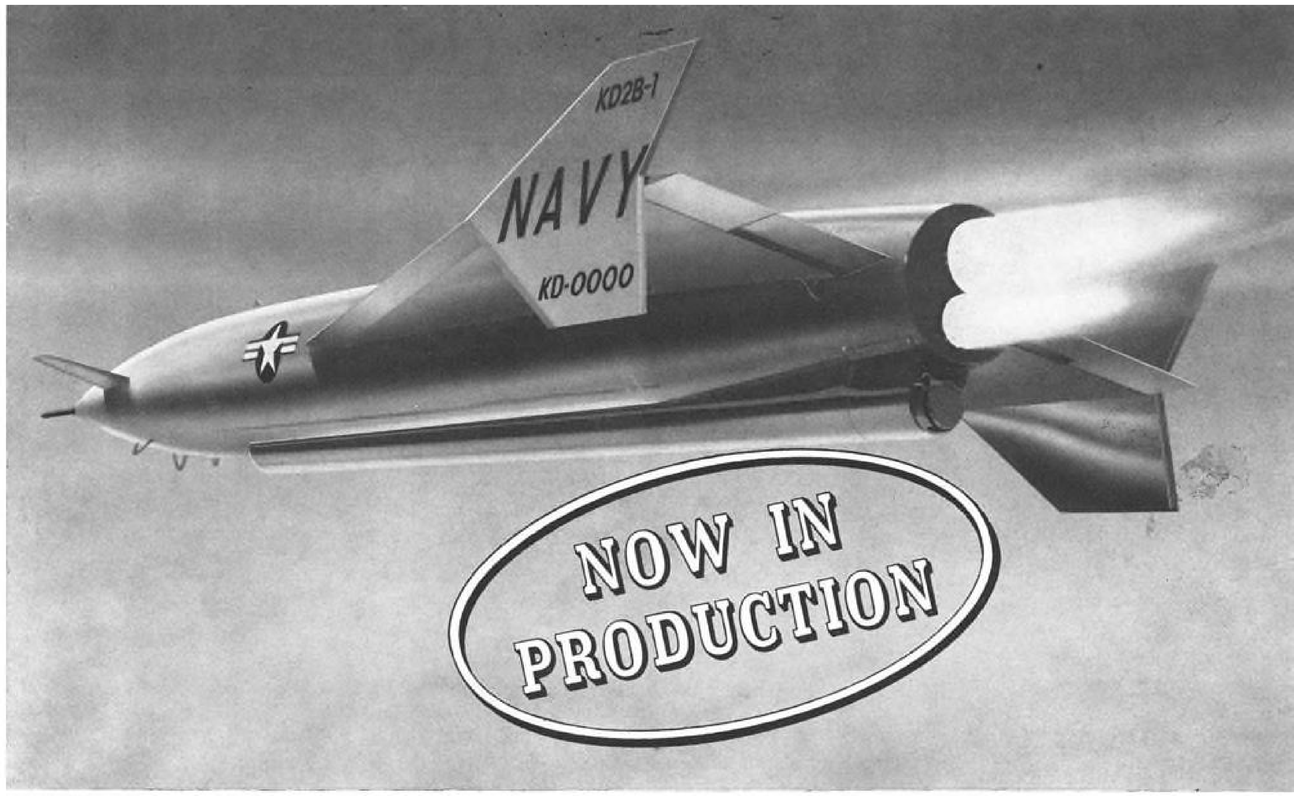
The Stokes Space System Department has been named prime contractor for the design and installation of three new space environment simulation chambers, key elements in Douglas Aircraft Corporation's privately financed Space Systems Center at Huntington Beach, California. The largest and most technically advanced space-test laboratory on the West Coast, the Center will be an integral part of Douglas' Missile and Space System Division.

The largest chamber, 39 ft. in diameter, will be capable of testing fully assembled vehicles scheduled for manned flight. It will be used in the Saturn program, and in the development of lunar and planetary probe vehicles. The Stokes systems will represent the most advanced state-of-the-art on completion, and are designed for updating to even higher simulation parameters in the future. Stokes units similar to these are now achieving vacuums in the 10^{-10} Torr. range. High-speed cryopumping on all three chambers at 20°K will assure the attainment of true orbital vacuums, even under high gas loads. Stokes has assigned CryoVac, Inc. the design, fabrication and installation of cryogenic systems, and named Pittsburgh-Des Moines Steel Company to furnish and erect the large steel sphere.

A deciding factor in the selection of the prime contractor was Stokes' experience in designing and building large, first-of-a-kind space test facilities, such as those installed at G.E.'s Space Technology Center. Another was Stokes' related background in space vacuum and cryogenics, as represented by General Electric's and Goddard's SES and DTC systems. To this experience, Stokes adds its long and successful history in the development of large-scale industrial equipment utilizing ultra-high vacuum, thorough engineering design and coordination, fabrication facilities, and field erection service . . . an integrated, start-to-finish capability unique in the entire area of space environment simulation. **Space Systems Department, F. J. Stokes Corporation, 5500 Tabor Road, Philadelphia 20, Pa.**

F. J. STOKES CORPORATION: PHILADELPHIA / LONDON / TORONTO **STOKES**

See the model of the Douglas installation in Stokes Booth #5 at the I.E.S. Show.



Beech-built "missing link" ends make-believe training

KD2B-1, now being produced under U. S. Navy contract, is another example of Beech's systems management capability

The Beech KD2B-1—shown above—is America's first missile target system to match the performance of the fastest enemy jets. **It ends the need for target towing, faking, or simulation of any sort.** By matching actual supersonic aircraft speeds, altitudes and target characteristics, it makes possible low-cost realistic training. It can evaluate proficiency of every advanced weapons system, including radar-directed and heat-seeking missiles.

But weapons evaluation is only one of the many jobs the Beech KD2B-1 is capable of doing. It has capabilities for use as an inexpensive operational missile. Its payload capacity and low-maintenance design fit it admirably for a wide range of tactical missions.

The KD2B-1 is easily adaptable to air-launching, surface-launching, or ship-launching with existing equipment. It is capable of Mach 2 speeds at 70,000 feet and Mach 3 speeds at 100,000 feet.

Designing, developing and building missile systems is one of the many elements that make up the comprehensive Beech capability. It's one reason Beech is prepared to undertake complete systems management responsibilities for a wide range of space-age projects.

Beech *Aerospace Division*

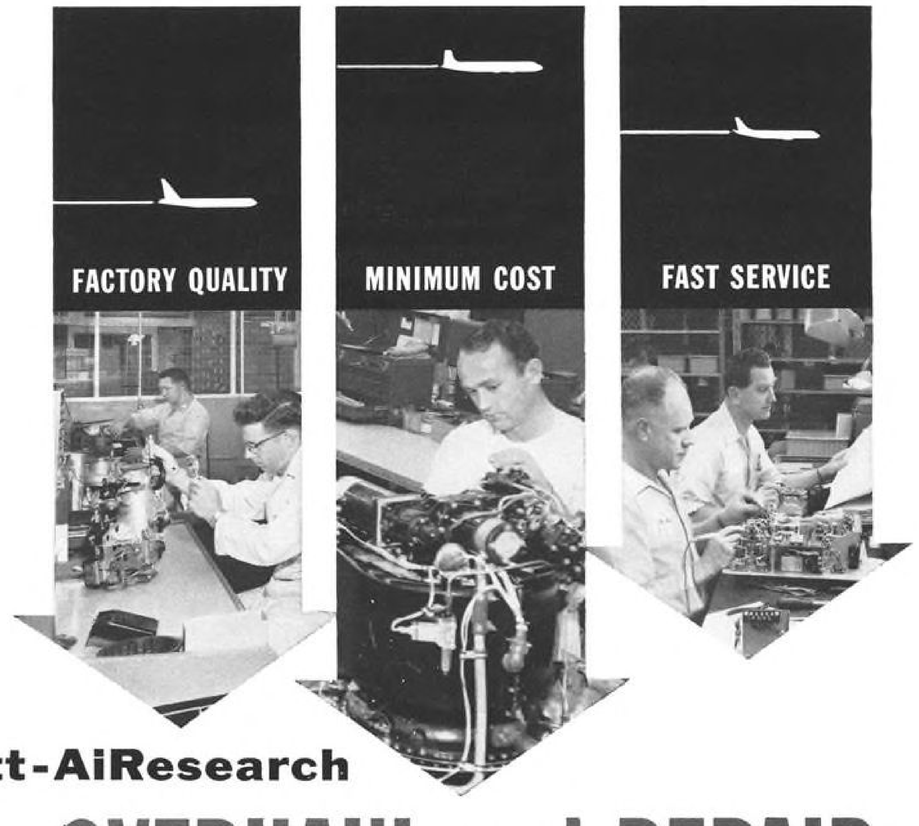
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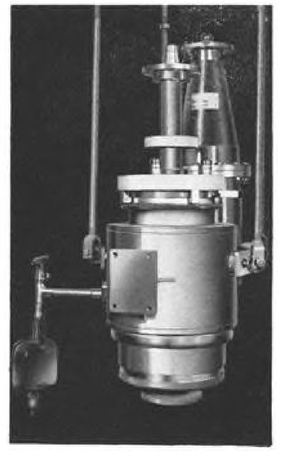
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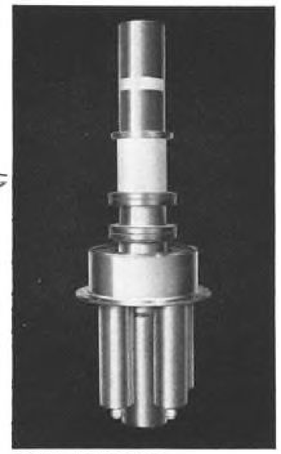
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RCA—A2696	205-225	1	15	15	004

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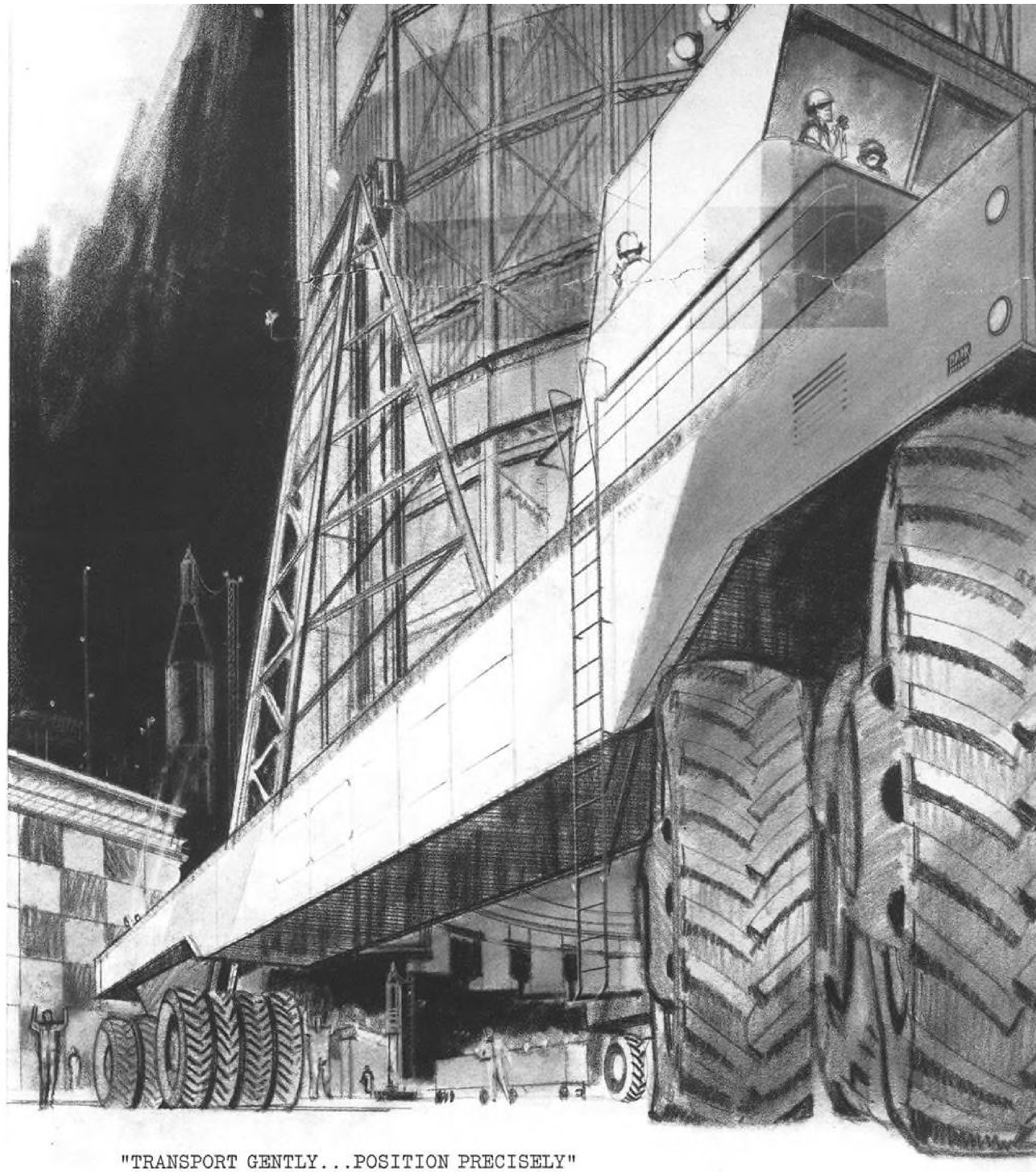
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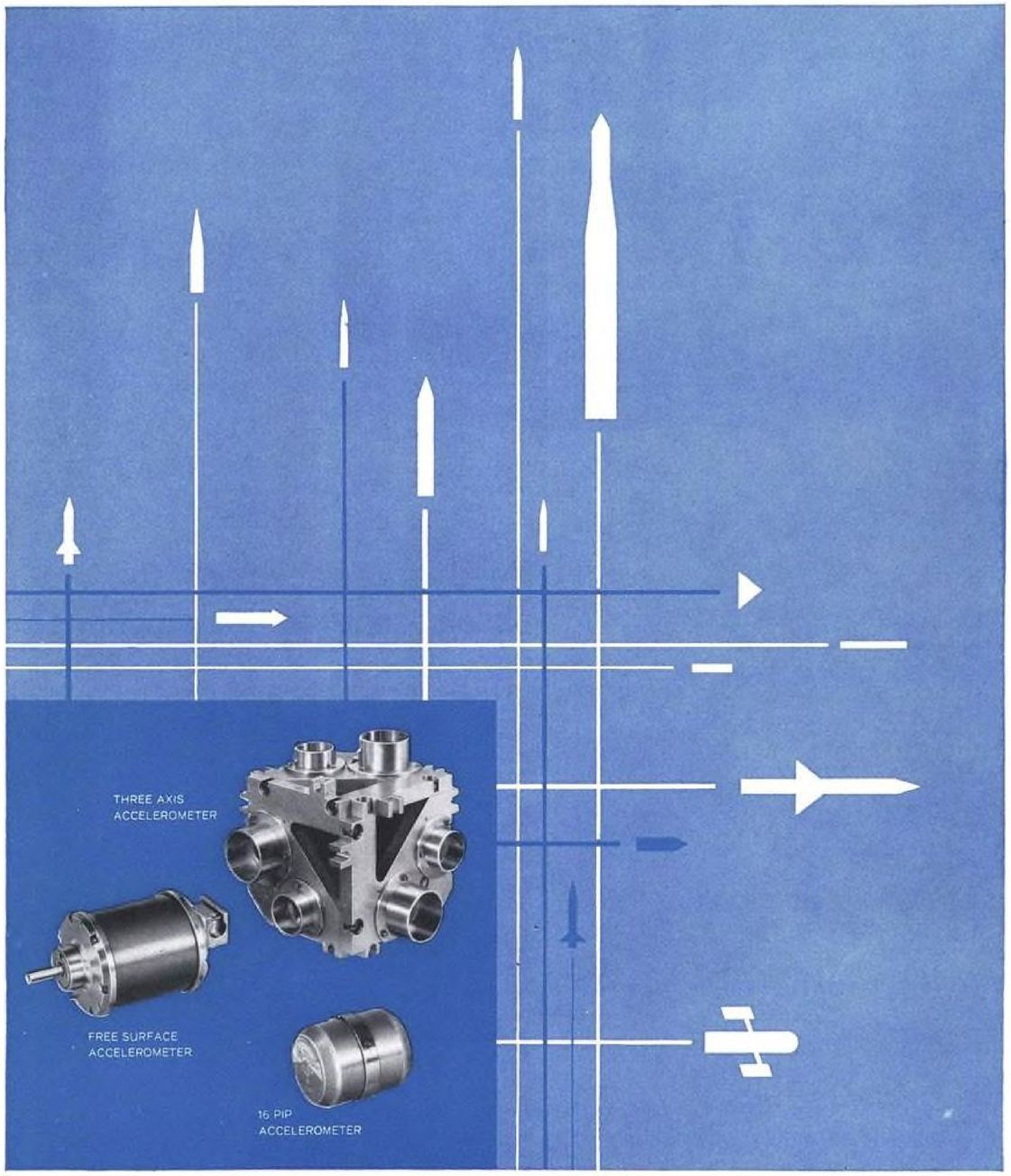
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Aviation Week & Space Technology

Volume 78
Number 15

April 15, 1963

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COVER: First photo of the full-scale, metal mockup of Sikorsky Aircraft's CH-53A Marine Corps heavy assault helicopter shows general appearance of the four-ton capacity aircraft which will have a top speed of 170 kt. Mockup has only three blades, shown folded. Operational helicopter will utilize six-bladed rotor system. For more details see p. 85.

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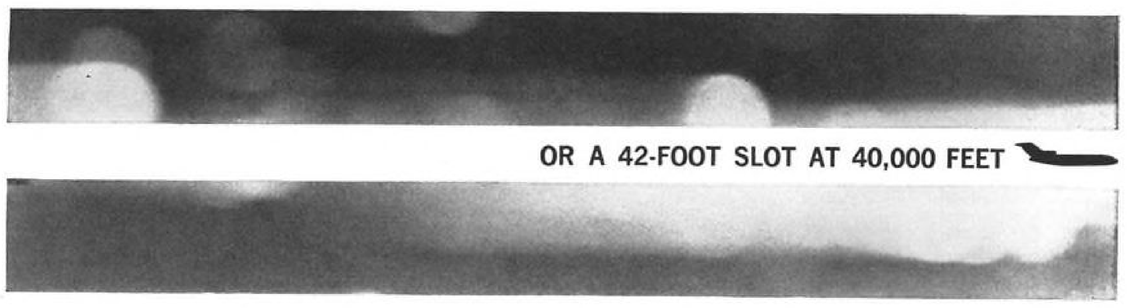
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EDITORIAL

The Brittle Brilliance

It is sad for anybody who watched President John F. Kennedy inaugurated that frosty January day in 1961, with the words of his address glittering with the same brilliance as the bright winter sun reflecting from the snowbanks on Capitol Hill, to measure the low estate to which this Administration has fallen as it passed mid-course and headed down the homestretch toward the 1964 accounting with the electorate.

So much of that early brilliance has proved too brittle under the stress and strain of international and domestic pressures; so much of that intelligence lacked sufficient control to prevent its growth into smart-aleck antics; so much of that apparent candor and refreshing frankness degenerated so quickly into the sly half-truth, the calculated falsehood and the crude stage-management of news; so many of the early achievements have proved so much less substantial under the erosion of time and truth; and so many of them have been exposed for simple political legerdemain in lieu of the courageous national leadership that was promised.

When the epitaph of the Kennedy Administration is written, certainly "Cuba" should be chiseled in the largest letters. From the Bay of Pigs invasion through the latest phase of curbing anti-Castro guerrillas this Administration has flim-flammed the American people in a shameful manner. This, more than anything else to date, has backfired with such vigor that the Administration's original popularity has hit the skids. It is difficult for the American people to stomach the spectacle of this government and its allies doing Castro's police work for him while at the same time permitting him to export saboteurs and Communist agents by the thousands all over Latin America.

Skybolt Jolt

The jolt of the Skybolt cancellation is still reverberating among our allies and has further reduced the credibility factor of this Administration. Other nations must wonder at the Administration logic that scrapped Skybolt before its test program had reached full stride while at the same time it placed its major nuclear force into the Minuteman missile which, after two years of intensive testing and frantic developmental fixes, still cannot meet its range and payload requirements.

If the Administration's antics over Bomarc were intended to measure how severe a strain U.S.-Canadian relations could endure without breaking, they accomplished their purpose.

Despite all of the fast-talking presentations on economy in the Defense Dept., this budget continues to climb sharply. The Senate investigation of the TFX contract award has revealed just how spurious most of this Pentagon cost-effectiveness doubletalk really is. The TFX investigation has also raised the question as to how a Secretary of Defense who is so obtuse in his relations with the legislative branch of the government can really be as infallible as he claims on other more complicated issues. It is evident that no matter how brilliant their computer exercises or back-of-envelope pencil calculations may seem to them, the top civilian leaders of the Pentagon have failed to win the respect, loyalty and confidence from the working levels that any commander needs from his troops to operate successfully. This is a situation that the country cannot safely endure for very long.

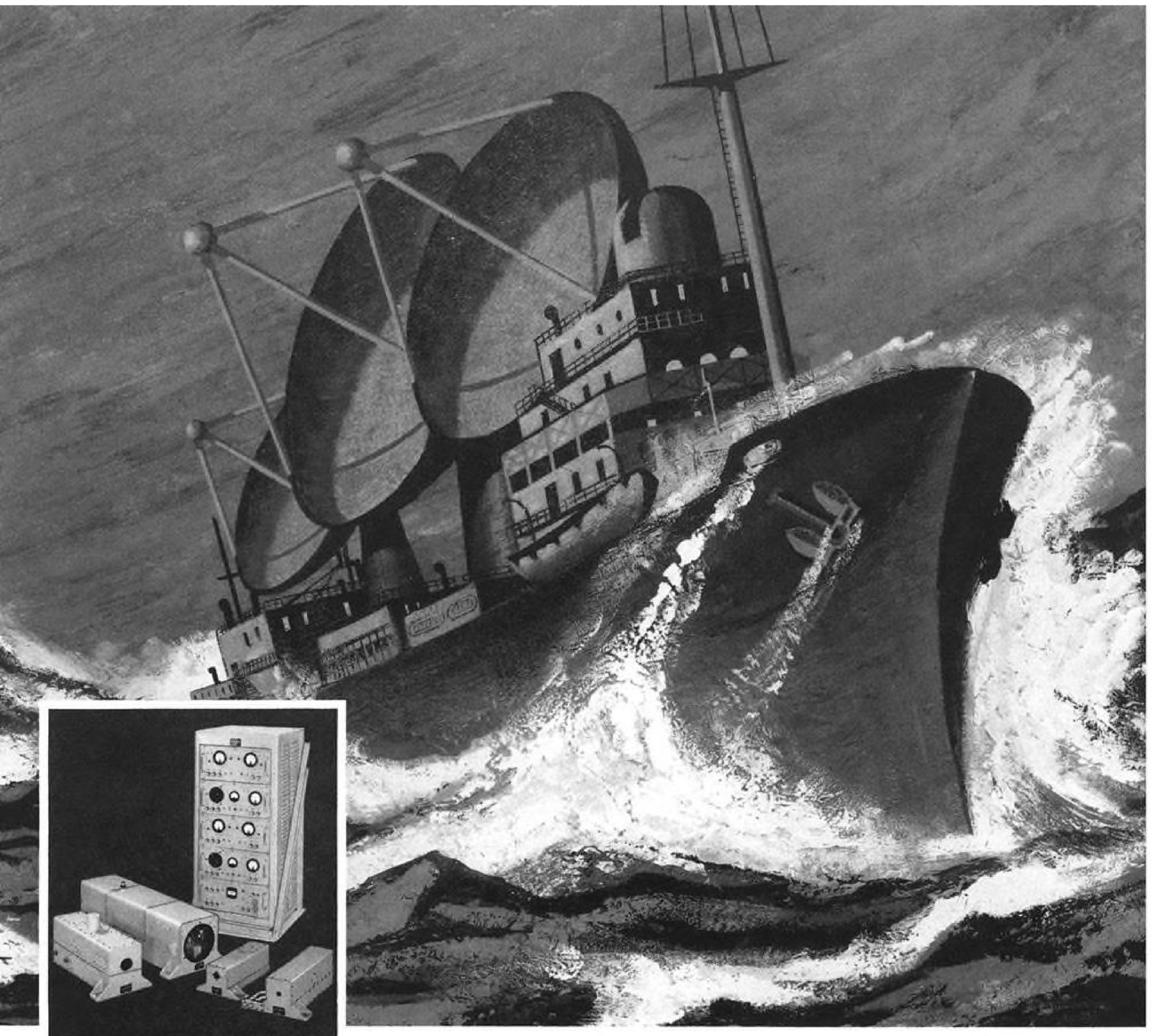
Space Budget Problems

After a brilliant, courageous start in the space business, the Administration is being effectively challenged both on the management of this vast expenditure of public funds and also on the value of the goals it has set. It is doing an increasingly bumbling job of handling these criticisms and explaining to the taxpayers what the space race is really all about. Its original thin veneer of ballyhoo has become transparent and there appears to be no solid substance to replace it. Again the nation will be the ultimate loser if these space technology goals are lost because of an ineffective defense of their validity.

Now, to give the American people further wonderment over what kind of people they have governing them, comes the episode of the Starad satellite (see p. 26) where the launch of a purely scientific satellite and the results therefrom were kept secret for months by Administration scientific advisers. This certainly looks like another clumsy attempt to conceal bad news about the effects of a basic technical miscalculation. Perhaps the men who tried to keep these results secret will eventually come forth with a more cogent reason for this cloak and dagger technique but the odds are against it.

As this Administration flounders toward 1964 and its day of reckoning at the polls, it can look back on an incredible trail of political, technical and moral wreckage that will leave even its most ardent supporters wondering how it all could have happened since the snow-sparkling brilliant promise of inauguration day.

—Robert Hotz



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In the Front Office

Thomas F. O'Neil, board chairman of General Tire & Rubber Co., elected a director of Aerojet-General Corp., Azusa, Calif., a subsidiary of General Tire & Rubber Co.

Dr. James Earl Rudder, president of Texas A & M College, elected a trustee of Research Analysis Corp., Bethesda, Md., succeeding **John T. Connor,** retired.

Lt. Gen. Laurence C. Craigie (USAF, ret.), vice president of American Machine & Foundry Co., named director of the AMF-Chromalloy Smog Burner exhaust control device program, Los Angeles, Calif.

Kenneth A. Roe, president, Burns and Roe, Inc., New York, N.Y., succeeding **Ralph C. Roe,** who continues as board chairman. Elected vice presidents: **T. Y. Mullen**-power engineering; **Dr. S. Baron**-nuclear, process and aerospace engineering.

Dr. Chalmers W. Sherwin, vice president and general manager of Aerospace Corp.'s Laboratories Div., will become Deputy Director of Research and Engineering for Research and Technology, Department of Defense, as of June 1.

John Oster Manufacturing Co.'s Avionic Div., Racine, Wis., has appointed the following as vice presidents: **I. G. Epstein**-marketing; **S. R. Hill**-finance; **R. J. Hanville**-manufacturing; **F. M. Bender**-engineering.

Douglas Stockdale, vice president and general manager, American Airlines de Mexico, succeeding **A. Sanchez Llorente,** resigned.

Hazeltine Electronics Div., Hazeltine Corp., has appointed **Vice President D. M. Stuart** to the Washington, D.C., office to coordinate the company's activities in civil aviation electronics. **J. B. Winningham,** elected vice president of Hazeltine Electronics Div., succeeding Mr. Stuart as general manager of the Technical Development Center, Indianapolis, Ind., and **G. B. McClellan,** assistant vice president.

Dr. Donald W. Gade, senior vice president, California Computer Products, Inc., Anaheim, Calif.; he continues as the company's chief engineer.

Arnoux Corp., a subsidiary of The Electrada Corp., Los Angeles, Calif., has appointed the following vice presidents: **Joseph I. Davis**-engineering; **Robert L. Feagins**-marketing; **North S. Hinkle**-administration; **William A. Wilkinson**-manufacturing.

Stuart H. Smith, vice president and assistant to the president, SKF Industries, Inc., Philadelphia, Pa., and **Thomas F. Morris,** vice president-distribution.

R. G. Johnson, vice president-finance, Information Systems Group of General Precision, Inc., Glendale, Calif.

Robert J. Murphy, vice president of The Boeing Co., has been appointed manager of the Washington, D.C., office, replacing **Clifford E. Roberts** whose new appointment will be announced.

E. P. Wheaton, vice president and general manager, and **Dr. John P. Nash,** vice president and assistant general manager of a new Research and Development Division of Lockheed Missiles & Space Co., Sunnyvale, Calif. **Dr. Roy A. Smelt** will succeed Mr. Wheaton as vice president and general manager of the Space Programs Div.

(Continued on page 127)

INDUSTRY OBSERVER

► Martin-Orlando's winning proposal for development of Army's Sprint high-acceleration anti-missile missile specified a silo-launch technique similar to that of the Navy's Polaris. Gas would blast the missile from the silo for ignition in the air. Sprint will be relatively small and use high mass-fraction motors loaded with Hercules Powder Co.'s fast-burning, double-base Class 9 propellant.

► **Second North American X-15, which crashed last November, will be rebuilt as a hypersonic research vehicle by the Air Force. One mission will be to test external ramjet engines for aerospace plane concepts. External tanks will be added to increase rocket engine burning time by more than 1 min., boosting top speed from Mach 6 to about Mach 8. NAA's Los Angeles division will rebuild the plane.**

► USAF Space Systems Div. decision on use of General Dynamics/Astronautics Atlas Mark 2 as a space booster is expected early next month. Vehicle would incorporate cluster of four boosters around a central sustainer. Using liquid oxygen and RP-1 fuel, it could put a 20,000-lb. payload into a 100-mi. orbit. This performance would be increased greatly by a fluoride propellant additive which could boost specific impulse by about 25%. Over-all length of vehicle without payload would be about 80 ft., and diameter would be 16 ft. Atlas F is 70 ft. long, has 10-ft. diameter.

► **Avro 748 design team has submitted two jet versions of the transport to Hawker Siddeley Group board of directors for consideration. One design features aft-mounted turbojets, the other uses podded units under the present wing. Both versions make maximum use of the Avro 748 wing and fuselage. Airplane is intended to compete with the Fokker F-28 and the Handley Page Jet Herald.**

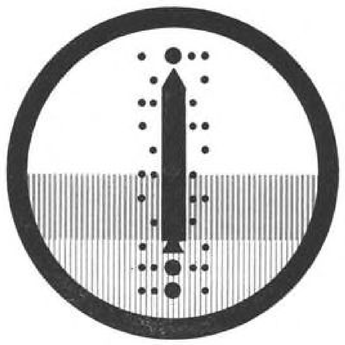
► Stellar inertial guidance system being developed by General Precision for the mobile medium-range ballistic missile will be flight-tested aboard a Lockheed Polaris missile as part of the system's flight feasibility program. MMRBM guidance will ride piggy-back on Polaris, with its control signals telemetered to ground stations.

► **Short Bros. and Harland, Northern Ireland airframe manufacturer, is tooling for about one-third of the airframe work on 11 Vickers VC.10 four-jet transports for the Royal Air Force. Splitting work between Vickers' Weybridge plant and Belfast will add about $7.8 million to the block cost of about $84 million, but British government has accepted the costs to help maintain employment levels in the Belfast area. Extra charges will be written off on the RAF budget.**

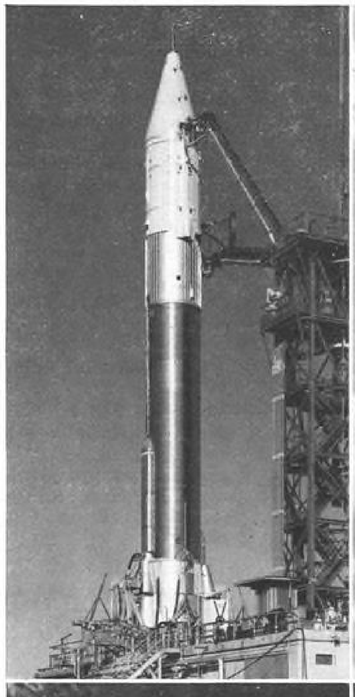
► Bell Aerosystems is developing a technique for throttling liquid-propellant rocket engines and still obtaining better combustion and control of engine temperatures. Scheme is to throttle and burn two propellant mixtures, one oxidizer-rich and one fuel-rich, in separate pre-combustion chambers, followed by mixing and burning the two exhausts in the main combustion chamber.

► **North American RS-70 has an automatic engine restart system to minimize stability disturbances caused by sudden engine flameouts from shock expulsion or other causes. Cycle takes about 5 sec. to restart the engine. One example of a typical disturbance: if the shock wave were expelled from one of the plane's two inlets, the pilots would experience a lateral acceleration of 0.3g due to the differential drag.**

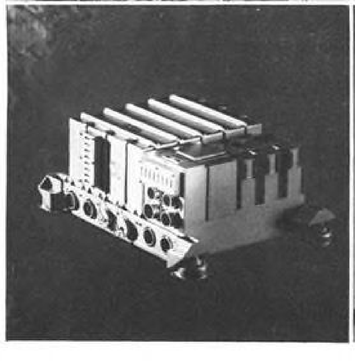
► Program for Army air-defense system for 1970 (AADS-70) is planned as a three-part task. First phase will be three-month technical feasibility studies by three contractors funded at about $500,000 each. Second phase will be three-month program-definition effort by two contractors funded at about $500,000 each. Third phase will be a four-year mobile system development by one contractor, involving a cost of about $300 million, and beginning in the middle of 1964. Industry proposals in competition are due Apr. 22, and three contractors are expected to be selected within a month.

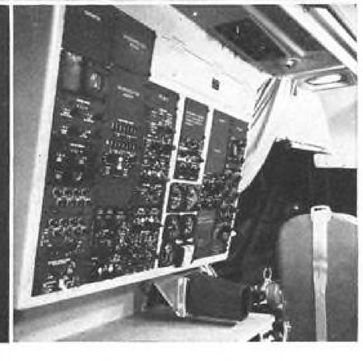


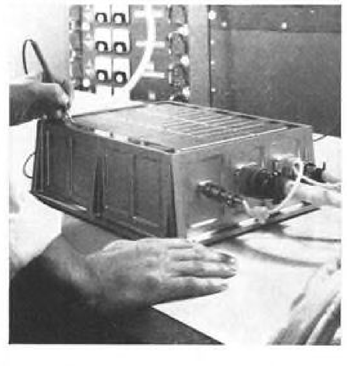
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Washington Roundup

NASA Budget Cuts

House space committee may cut National Aeronautics and Space Administration's $5.7-billion Fiscal 1964 budget request by about $200 million–$115 million from the manned flight program and $85 million from other areas.

Senate space committee, which is to begin authorization hearings on NASA's budget on Apr. 22, intends to take a closer look than it has in past years, chiefly because of the increasing demands for economy in government.

Rep. Joseph Karth, chairman of the House subcommittee on space sciences and advanced technology, summarized the dilemma of Congress in trying to determine what is absolutely necessary in NASA's budget. He told one witness:

"We would like to help you, if you think you need help. I find it very difficult to find areas where we should reduce, because no matter what the budget request is, [NASA officials] will defend it to the last breath in them; and when we try to help somebody, I find it is extremely difficult to do that, too. I am not sure we can accomplish either of these goals unless we get some of the information we request."

Gilpatric's Successor

Paul H. Nitze, assistant secretary of defense for international security affairs, is considered the most likely candidate to succeed Deputy Defense Secretary Roswell Gilpatric, with William P. Bundy–Nitze's deputy assistant secretary–moving into Nitze's spot. Nitze's strong background in international affairs, which includes direction of State Dept's policy planning staff, would supplement Defense Secretary Robert McNamara's limited experience in this field at a time when closer coordination between Defense and State Dept. efforts is needed. Bundy is a brother of McGeorge Bundy, the President's special assistant for national security.

Watch for Lawrence L. Kavanau, special assistant for space to the director of defense research and engineering, to leave his Pentagon post in the near future.

Joint Chiefs of Staff have given all unified and specified commands one month to study ways to reduce expenditures which adversely affect the U. S. balance of payments. The studies could result in cutbacks in spending for overhaul of aircraft and other equipment outside U. S. territories, reduction of overseas forces and cuts in the number of dependents overseas.

Sic Transit Gloria

Secrecy and accompanying confusion have descended over the Transit navigation satellite program. Until last week, Transit had not been covered by Defense Dept. Instruction 5200.13, which imposes secrecy on even the project names of all military space programs except the Air Force X-20 and the Defense Dept.-NASA Anna satellite. Some Navy officers are questioning whether the secrecy order will prevent use of operational Transit satellites by commercial shipping. NASA, which signed a joint Transit development agreement with Defense Dept. just last month, said it does not know the ultimate effect of the secrecy order, but said Navy has indicated that the classification will be removed when the system becomes operational.

Critical Gemini review meeting was held Apr. 11 by NASA to update launch schedules because of development slippages, and to determine the sophistication of the first flight vehicle. Question is whether the first shot, a ballistic lob, should be a "tin can" solely to qualify the Titan 2-Gemini configuration or a man-rated capsule to qualify systems as well as design.

General Accounting Office is urging Defense Dept. to place procurement and management of aircraft engines and aeronautical supplies and equipment under centralized management. A comprehensive Defense Dept. study to determine if and how this can be done is due for completion by October. It covers 11 classes of equipment involving 150,000 different types of items costing about $6 billion.

In TFX Circles . . .

Senators investigating the TFX contract award (see p. 28) are having their troubles trying to understand some of the technicalities. Sen. Edmund Muskie said: "I have been on more merry-go-rounds on these hearings than I have been ever before in my life." He told one witness: "You fellows would drive a lawyer crazy with some of these words or terms."

Sen. Karl Mundt was even more eloquent. He said to Adm. George Anderson, chief of naval operations: "On page 8 you say among the various qualities that appear to indicate Boeing to be a more serviceable and effective plane: 'Its accessibility for electronic maintenance was far superior.' That might almost as well be written in Chinese as far as I am concerned. Can you tell us what the [blank] it means?" Adm. Anderson explained that it meant it was easier to work on the black boxes. "I know exactly what you mean," Sen. Mundt said, "because my new Chrysler automobile has left and right signal indicators hidden on the dash so well I cannot find them with a flashlight at high noon. I am in favor of having these gimmicks up where you can find them."

–Washington Staff

Wiesner, Charyk Ordered Starad Secrecy

USAF satellite's discovery that Starfish radiation may last 10 years proves embarrassing to Administration.

By Larry Booda

Washington—Existence of the unclassified scientific satellite Starad, designed to measure contamination of the ionosphere, was kept secret until recently on orders of former Under Secretary of the Air Force Dr. Joseph V. Charyk. Its politically embarrassing findings that radiation produced by the U.S. Starfish high-altitude nuclear explosion last July 9 may last at least 10 years also were kept under wraps, by order of Dr. Jerome B. Wiesner, science adviser to the President.

First general information based on Starad's observations—that radiation within the magnetic shell in which Starfish was fired is considerably higher than the level prior to the shot—was revealed at the Air Force Cambridge Research Laboratory on Apr. 5. Details will be given in five scientific reports before the American Geophysical Union meeting here Apr. 17-20.

Starad also immediately detected increased radiation from Russian high-altitude nuclear explosions fired last Oct. 28 and Nov. 1. The satellite was placed in orbit last Oct. 26, too late to measure the effects of the Oct. 22 Russian shot.

Starad (for Starfish radiation) was a hurriedly assembled package of nine experiments prepared for flight in a Lockheed Agena D space vehicle after Air Force officers convinced Administration officials that they could get a scientific payload in orbit quickly by using standard components.

Starad was approved because of a desire to provide a backup to the Explorer 15 satellite of the National Aeronautics and Space Administration.

Starad Launch

Starad was launched by a Douglas Thor booster from Vandenberg AFB, Calif. Initial perigee was 120 mi. and apogee was 3,452 mi. Inclination was 71.41 deg. Starad transmitted until Jan. 18 when its batteries wore out.

Starad was the only satellite to furnish comprehensive information on the radiation level occurring from Starfish and the two Soviet shots. Explorer 15 was placed successfully into orbit Oct. 27 but failed to despin. It continued to rotate at 60 rpm. instead of slowing to the intended 6 to 10 rpm. Thus, only wide-angle observations were possible.

Starad was designed to make most of its readings along the magnetic shell that lies at a geomagnetic altitude of $L = 1.25$. $L = 1.0$ is the radius of the earth at the magnetic equator. Thus the magnetic shell $L = 1.25$ lies 0.25 earth radii above the earth's surface at the magnetic equator, but bends closer to the surface near the poles, where the magnetic lines of force converge.

Starfish was exploded in the $L = 1.12$ magnetic shell. The Russian shots, fired at Novaya Zemlya near the North Pole, were in the $L = 1.8$ shell.

It was discovered that the decay rate of charged particles at $L = 1.25$ is rapid at first after a nuclear explosion, but then became negligible. Ludwig Katz, Starad project director at Cambridge, said an apparent state of equilibrium has been reached in this magnetic shell. There is either no decay in radiation, or so little change as to be within the narrow margin of experimental errors of observation. The level is considerably higher than that prior to the shot.

Because the Russian shots were made at a higher geomagnetic latitude, most of the particles injected by them were not trapped. Those that were remained trapped only a few days. The Oct. 28 Russian shot increased the radiation by a factor of two for electrons having energies above four million electron volts. At lower energies, about 50,000 electron volts, the factor was 10 over the readings of Oct. 27. By Nov. 4, the readings had dropped almost to the Oct. 27 levels.

The U.S. at one time had planned to fire at least three thermonuclear devices at high altitudes last summer—a kiloton yield device below the inner Van Allen belt; a kiloton device within the inner belt, and a megaton device in the outer.

An international scientific controversy over the contamination that these shots were likely to produce began even before the first shot was fired. Failure dogged the attempts to launch the first device to altitude, due partly to the haste with which Thor boosters—some of them old training vehicles from storage—were adapted for the mission.

For reasons that have never been announced, the 1.4-megaton Starfish device was exploded at 250 mi. over Johnston Island in the Pacific—below the inner belt. It created an artificial belt and enhanced the radiation in the natural belt.

Wiesner Position

Dr. Wiesner, who originally had advised the President to go ahead with the high-altitude shots in spite of the controversy, is understood to have wanted at least one successful explosion in the belt to measure effects on communications. His position was that there would be no lasting change in the natural environment. This opinion was supported by Dr. James A. Van Allen of Iowa State University, for whom the natural radiation belts are named.

Dr. Van Allen maintained his position that the Starfish radiation was relatively insignificant as late as last Feb. 1, when he published a paper in the Journal of Geophysical Research that the intensity had fallen to between 10% and 1% of peak intensity at various altitudes. He disagreed with earlier findings of Wilmot N. Hess of NASA's Goddard Space Flight Center.

It was at this time that detailed findings of Starad were being collated. Then on Mar. 15, Dr. Van Allen said the artificial belt created by Starfish might last for a decade or so (AW Mar. 25, p. 26).

Release of information about radiation in the Van Allen belts through scientific papers, rather than by press release or news conferences, stems from the pressures that some Administration officials have applied to the science advisers headed by Dr. Wiesner.

The politicians maintain that the image of the United States has suffered abroad because the Starfish explosion has upset the balance of nature. The scientists, in a sense, have retreated behind the protection of delayed release of unfavorable information. Starad's initial findings were quickly interpreted after its placement in orbit, but they were kept secret. Experiments were:

- **CRM2C**—proton-alpha spectrometer, assembled by F. Paolini and R. Giacconi of American Science and Engineering Co. and L. Katz and D. Smart of Cambridge Research Laboratory. It measured the proton spectrum above 0.5 million electron volts and carried out particle type and energy analysis.
- **CRM 11B**—beta-beta-gamma detector, assembled by the same team. This experiment carried three scintillation counters, two of which were shielded for 50,000 electron volts and the third for 4,000,000 electron volts. Each measured the total energy deposited.
- **CRM 23**—electron solid-state spectrometer, S. Bloom, H. West and L. Mann of the Lawrence Radiation Laboratory of the University of California. This instrument utilizes 180-deg. magnetic focusing to divide a collimated electron beam into five energy channels centered about 325,000, 955,000, 1,630,000, 2,400,000 and 3,250,000 electron volts.
- **TEC 3**—tissue equivalent chamber. B. Clark of the Air Force Special Weapons Center constructed two cylindrical "tissue equivalent" ionization chambers whose walls are covered with a plastic. The atomic composition of the plastic resembles human muscle tissue. An electrometer circuit provides data on radiation dose-rate.
- **CRM 24—total energy detector,** assembled by R. Smith and W. Imhoff of the Nuclear Physics Div., Lockheed Missiles and Space Co. Five scintillators were carried. Three of them had thresholds of 1,000,000, 2,000,000 and 5,000,000 electron volts. They are viewed by photomultipliers. The others count particles of 1-5 mev.
- **CRM 20—total energy detector,** assembled by P. Dyal of the Special Weapons Center. A solid state detector measures electrons from 20,000 electron volts to 1,000,000 electron volts and protons of the same penetrating power.
- **CRM 23**—scintillation spectrometer, same team as the first two experiments. A single thick scintillator surrounded by a steel shield except for a small opening measured 600 kev. electrons, 10 mev. protons and pulse analysis in seven energy levels from 1 to 70 mev.
- **IP 2—impedance probe.** Assembled by O. C. Haycock of the University of Utah and J. C. Ulwick of the Cambridge Research Laboratory. A 20-ft. dipole antenna was used to measure electron density by detecting changes in impedance in the antenna.
- **SEE 1—solar environment** experiments. R. E. Fischell, Applied Physics Laboratory, Johns Hopkins University, tested the performance of various types of solar cells and transistors in the belt.

XB-70A Rollout

Rollout of the North American XB-70A has been postponed to late May or early June and first flight could be as early as July if no further difficulties are encountered. Rollout had been scheduled for late this month, after fuel tank leakage problems had delayed the rollout planned last December (AW Nov. 26, p. 35).

Tank sealing probably will be finished by middle of May and wing-to-fuselage mating will begin as soon as tank sealing job is completed. Some misalignment of wing and fuselage has been indicated in prefit trials, but is termed normal for wing of this size. Welded stainless steel rather than conventional aluminum alloy construction further complicates alignment problem.

Defense Wants Comsat System With 24 to 30 Satellites by 1965

By Alfred P. Alibrando

Washington—Defense Dept. will start work in May or June on a military communication satellite program based on a goal of putting 24 to 30 operational spacecraft into 6,000-mi. circular polar orbits by the end of 1965.

John H. Rubel, deputy director of defense research and engineering, last week told the House space subcommittee on applications and tracking that the program schedule calls for:

- **Program definition study** beginning in May or June on which "firm decision to proceed" will depend; and a follow-on study in August and September.
- **Initiation of hardware development** program about November.
- **First launch** early in 1965, placement in orbit of about half of the system by mid-1965 and completion of an operational system by late 1965.

Rubel said DOD is thinking in terms of an 80- to 120-lb. satellite.

"Approximately six satellites will be launched per booster," Rubel said, "using the . . . Atlas Agena D. The six satellites will be ejected at slightly different velocities into an approximately 6,000-mi.-altitude circular polar orbit, where they will gradually spread out. The successive clusters will be injected into orbital planes spaced 45 deg. apart."

Satellite would have 2.5 w. output, nearly omnidirectional antenna and solar cell power source. It would be spin stabilized and provide two duplex voice and teletype circuits.

The House space committee has been opposed to development of a medium-altitude communications satellite system by the military. In a report on reorientation of the Defense Dept. program following cancellation of Advent last June, the committee said a separate medium-altitude military communications satellite could not be justified on a cost-effectiveness basis. The report also contended that "to develop a new satellite . . . when the Relay, Telstar and Syncom [civilian satellites] . . . would be available with modification . . . appears to be disregarding the development that has been carried out by others."

This and earlier committee reports questioned the wisdom of developing a medium-altitude system when "the communications community is agreed that the synchronous [22,300-mi.] . . . system has technical and cost advantages over the medium-altitude system, provided the difficult launch and control problems are overcome."

Rubel's testimony last week attempted to answer most of these objections. He said the system concept is based on utilization of the demonstrated technology of Courier, Telstar and Relay, and that work done on the traveling wave tube for Advent would be applied to design of the tube for the new medium-altitude satellite.

Other requirements that could not be satisfied by commercial system, he said, included "privacy, reliability, security, ECM [electronic countermeasures] resistance . . . and military control of circuit terminals."

The Defense Dept. system, which will cost an estimated $200 million to $250 million, will be developed jointly by the Air Force and Army. The Air Force is responsible for all space-related activity and the Army for ground stations.

Rep. William F. Ryan (D.-N.Y.) urged Rubel to "come to a clear understanding with the Communications Satellite Corp. that the government at least have some preferential rate" for whatever use it makes of the commercial system. He also asked that the government be reimbursed for its support of the corporation's development and operational activities.

Reviewing Defense Dept. communications programs, Rubel said the Air Force would try twice this year to inject packages of Project Westford dipoles into earth orbit. He said the tiny, needle-like dipoles would be made of sublimable tin which would "evaporate in a few years." Previous attempt to orbit dipoles, which failed, irritated some astronomers who contended that the millions of tiny bits of metal might interfere with radio and optical telescope observations.

In other testimony last week, NASA officials said:

- **Development of the 84-ft.-dia.** Northrop parachute to be used in early Gemini flights has been completed and testing will begin soon.
- **Lockheed Agena upper stage** will be modified to allow five or six restarts on command from the ground or from Gemini spacecraft in rendezvous missions.
- **Requirement for 700 lb.** of fuel for maneuvering on Gemini rendezvous flights will cut mission to no more than five or six days.
- **One reason for removing slight** vertical vibration from the Martin Titan 2 booster is to ensure that the Gemini pilot will be able to read abort-sensing instruments during the boosted phase of flight.

Performance Edge Stressed in TFX Quiz

By George C. Wilson

Washington—Key question as the F-111 (TFX) hearings enter their final stage is whether the cost-effectiveness arguments of Defense Secretary Robert S. McNamara can overcome testimony by the nation's military leaders that McNamara chose the inferior of two proposed fighting machines in awarding the contract to General Dynamics-Grumman rather than Boeing.

Chairman John L. McClellan (D.-Ark.) recessed the F-111 hearings of his Senate Permanent Investigations Subcommittee last week after hearing the military chiefs of the Air Force and the Navy testify that they felt the Boeing design promised the type of performance edge the Japanese enjoyed early in World War 2 with the Zero fighter aircraft.

Some committee members, including Sen. McClellan, began asking publicly whether it might be advisable to let both contractors develop test aircraft before committing the U. S. to spending $6.5 billion for 1,700 planes of the General Dynamics-Grumman design.

Although spokesmen for both General Dynamics-Grumman and Boeing are among those still to be heard by the subcommittee, the 2,146 pages of testimony already taken have drawn clear battle lines which put the future operators of the aircraft on one side and the civilian administrators of the Defense Dept. on the other.

Unanswered Questions

McNamara's two statements before the subcommittee—one read for him and the other delivered in person—left many questions unanswered in the opinion of the subcommittee. Also, the questions he submitted for the senators to ask of Defense Dept. witnesses backfired in several instances (AW Apr. 8, p. 26).

This background, plus Sen. McClellan's decision to keep the hearings going until the technical contradictions are explored, makes McNamara's final presentation probably the biggest challenge he has faced in Congress since taking office. He must rely on technical facts and figures in this summation to the Senate and the public to overcome the recent testimony that his F-111 decision will put a second-best aircraft in the hands of U. S. fighting forces.

McNamara already has denied that economic needs of the General Dynamics Ft. Worth Div. figured in the award, so he cannot defend his decision on grounds that he wanted to keep the U. S. defense arsenal strong.

The defense secretary must be prepared to answer questions on several points which were raised just before the subcommittee recessed last week for the Easter holidays. The most important of these is the operational edge attributed to the Boeing proposal.

Adm. George W. Anderson, chief of naval operations, said he recommended the Boeing design because of its promised edge in performance, declaring: "If a potential enemy either believes or knows his prospective adversary possesses such an edge, he thinks twice before committing himself to armed conflict. If other considerations compel him to act, this edge can make the all-important difference between being able to defeat the aggressor, or blunting his attack while production and manpower can be mobilized, or, lacking the edge, losing quickly. The latter alternative being unacceptable, we must insure this edge is available to us.

"As a one-inch longer reach is to a boxer," Adm. Anderson continued, "this edge often is very small when measured in terms such as altitude, miles per hour, range, time on station, operating depths and the like. The Japanese Zero initially enjoyed an edge in maneuverability—small, but most serious in terms of pilots killed, aircraft lost and ships sunk by the torpedo planes and bombers the Zeros escorted.

"Many Soviet aircraft enjoy performance edges over U. S. aircraft now in service," Adm. Anderson said. "They do not, however, at the present time enjoy an advantage over the new Navy F4H [McDonnell F-4B Phantom 2]. Stand-off ranges of the Soviet air-to-surface missiles have demanded exploitation of our available air-defense-aircraft edge today. We now must be able to intercept and destroy the missile-carrying aircraft farther out from his launch point. As the edge shrinks, we must recreate it by an appropriate next step in development. The state of the art is being extended to its elastic limit."

In what appeared to be a rebuttal to McNamara's charge that military leaders were inclined to favor weapons far superior to those actually needed—and thus more costly than necessary—Adm. Anderson said: "Those of us who have learned the hard way of the importance of this edge attach great signficance to what might otherwise appear inconsequential differences between two competing pieces of military hardware. I know of no way to attach numbers, weight or scores to such intangibles, but their importance has been written in the record of military history."

Cuban Crisis

He cited the Cuban crisis, declaring: "We put the best aircraft we could get into the area, the Navy F4H, because we knew that the aircraft had the edge over the MiG-21 which the Russians had placed in Cuba. This is what I mean by edge . . . What we want to have in the future is the same superiority that we have today in our F4H over the current Russian planes."

Gen. Curtis E. LeMay, Air Force chief of staff, said he also favored the Boeing design because of its superior operational promise, but agreed that by refining the General Dynamics proposal, "we will get a weapons system that is in the same ballpark, performance-wise, that we would have gotten from Boeing. However, I think we could have gotten it easier with Boeing."

Gen. William F. McKee, Air Force vice chief of staff and chairman of the Air Force Council, said "operational factors should be overriding considerations to all others in choosing between the two systems because these aircraft are being produced for use in event of war."

Adm. Anderson said that although he followed McNamara's orders and went along with the bi-service concept for the F-111, the resulting Navy version of the winning General Dynamics-Grumman aircraft has these shortcomings:

• **Weight.** Proposed aircraft will be 13,500 lb. heavier than Navy's original specification and 8,500 lb. more than the revised requirement. "Further," Adm. Anderson said, "we can expect to be faced with the problem of coping with additional weight in the years to come."

• **Suitable carriers.** This extra weight plus other characteristics will limit the use of F-111s to the three attack carriers in the Midway class, the six in the Forrestal class and the nuclear-powered Enterprise. Adm. Anderson said neither the proposed Boeing nor General Dynamics aircraft, because of their size and weight, could be used on the modernized Essex class attack carriers. He said Boeing's Navy version would be "more feasible" to operate from Midway class carriers because of its lighter weight and less wind-over-the-deck requirement.

• **Radar.** To meet the common USAF-Navy requirements, Navy had to settle for a detection and fire control radar 18% less effective than originally specified. He said the size of the radar had to be reduced in order to afford the aerodynamic form that is needed to give the Air Force its high dash speeds.

• **"Black box" accessibility.** Adm. Anderson said the Boeing design offered an accessibility for electronics maintenance "far superior" to General Dynamics', and called this "a most important consideration." He said the shock Navy aircraft absorb in landing and catapulting often damages electronic equipment and requires speedy repairs in the dark. "In the final analysis, the airplane can't cut the mustard unless the electronic material functions," he said. An effort is under way to improve the electronic accessibility in the General Dynamics design.

The Air Force, too, detailed to the committee the shortcomings it sees in the General Dynamics proposal. Gen. Walter C. Sweeney, commander of the Tactical Air Command, called the Boeing design "a much better aircraft" and cited these specific advantages from an operational standpoint:

• **Fire control.** He said the Boeing design would provide more accuracy because the pilot, while attacking a ground target, would see in front of him a slant range reading as well as his dive angle. The instrument would be placed directly in front of pilot's eyes, while the General Dynamics design provided the data on the instrument panel, requiring the pilot to take his eyes off the target. He said the Boeing arrangement "is a distinct advantage in close support where you are attacking a target that is very easy to become obscured, and you want to keep your eyes right on it so you don't lose it." He said this Boeing feature probably will be incorporated in the General Dynamics proposal.

• **Thrust reversers.** Gen. Sweeney said Boeing's proposed use of them promised "better deceleration both in air maneuvering and landing. The latter is especially important on wet or icy runways." Gen. McKee said "I see no serious technical problems in adapting this excellent device to fighter aircraft. Boeing has pioneered in this field and is designing, manufacturing and using thrust reversers on all of their com-

TFX Semantics

Washington — George Spangenberg, Bureau of Naval Weapons' evaluation division director, has been trying for weeks to explain to senators investigating the F-111 (TFX) contract award why he disputes Defense Secretary Robert S. McNamara's "commonality" theories. At a recent hearing he abandoned reasoned arguments for the moment and said "this commonality that is being thrown up is a driving wedge between people, between services, between the military and the civilians. . . It is all poppycock. . . We think that Boeing gave us a better proposal at a lower price. You certainly don't want to pay more money to get an inferior product just because it meets some word 'commonality' better."

McClellan Says Pentagon Civilians Abused Powers

Washington—Chairman John L. McClellan (D.-Ark.) of the Senate Permanent Investigations Subcommittee has charged that civilian Defense Dept. secretaries abused the powers of office by not consulting the top military officers they reversed in awarding the $6.5-billion F-111 (TFX) contract to General Dynamics-Grumman rather than Boeing.

Sen. McClellan made this charge after both Gen. Curtis E. LeMay, Air Force chief of staff, and Adm. George W. Anderson, chief of naval operations, testified that they had no opportunity to argue their case between the time they recommended Boeing and the time the civilian secretaries chose General Dynamics-Grumman. Both officers said the Boeing design appeared substantially superior from an operations standpoint.

"Power doesn't mean that you disregard and exercise it arbitrarily," Sen. McClellan said. "I have no interest in the world in Mr. Boeing or Mr. Dynamics or Mr. Anybody Else. But I think the system is wrong that you have down there, it is a futility, or else it ought to be respected enough when there is disagreement, and there might be times when it should be disagreed with, it does seem to me that common courtesy would indicate there should be a consultation, a consultation at least, before a decision is made and stamped final.

"I hope a lesson at least will come out of this," Sen. McClellan said, "that when such a situation arises again there will be those consultations. Whatever the outcome would have been, I think we would all have been in a better position here today" if it had been shown "that the most consideration, the best and most judicious consideration was given before a final decision was made."

Gen. LeMay said he recommended Boeing last Nov. 8 after the fourth evaluation, and was not consulted between then and Nov. 23, the day he learned that Defense Secretary Robert S. McNamara and the Air Force and Navy secretaries had chosen General Dynamics-Grumman. The award was announced the next day.

"I don't consider this normal procedure," Gen. LeMay told the subcommittee. He said that as soon as he heard of the choice, he went to see Air Force Secretary Eugene M. Zuckert. "We told him we thought he had made a wrong decision," Gen. LeMay said. "He didn't discuss any details with us at all . . . He stood by his decision and that ended the conference . . . I thought we had such a clear-cut and unanimous opinion all up and down the line that I was completely surprised at the decision. I expected to have some reason that wasn't apparent to me or all the rest of the people who had worked on the case. If there had been, I would have expected the secretary to tell us about it at that time. He did not."

Gen. William F. McKee, USAF vice chief of staff and chairman of the Air Force Council, said Zuckert called a meeting of the Air Force Council at 5 p.m. Nov. 23 and told the military officers there that General Dynamics-Grumman was going to get the contract because of that design's promise of more commonality and Boeing's lack of realism on cost.

Gen. LeMay, who came to the meeting late, learned of the decision from Gen. McKee. Gen. McKee said Zuckert told the council that he had expected to see Gen. LeMay before the meeting. Right after the council meeting, both Gens. LeMay and McKee went to Zuckert's office and tried to change his mind. Gen. McKee said he knew of no other case where unanimous military recommendations for a major weapons system were rejected by civilian secretaries.

Adm. Anderson said he would have pressed harder had he realized his recommendation for Boeing was going to be reversed. "In retrospect," he said, "perhaps when discussing the final round recommendation with the Secretary of the Navy we did not reiterate and review our record of compromises and consequently did not make sufficiently clear to him the importance of those areas in which the Boeing design appeared superior from the operational point of view." He said the experience "taught me a lesson to perhaps be more contentious in matters in the future."

Sen. McClellan asked: "Is it too much to hope or expect that you or those who will have to command and operate this weapon in combat might have been called and consulted and given an opportunity, some indication that you needed to prove your case better?"

TFX Thrust Reverser Cost, Weight Cited

Washington—Pratt & Whitney estimates that installation of thrust reversers on the proposed General Dynamics-Grumman F-111 (TFX) fighter would add 500 lb. to each engine and cost an additional $425 million for the entire expected order of about 1,700 aircraft. Research and development costs would be $21.7 million additional if Pratt & Whitney were made responsible for the entire thrust reverser project.

Donald J. Jordan, chief engineer at Pratt & Whitney, gave these estimates last week while testifying before the Senate Permanent Investigations Subcommittee reviewing the F-111 contract award to General Dynamics-Grumman. The General Dynamics design calls for air brakes and spoilers, while the Boeing proposal included thrust reversers. Defense Dept. and General Dynamics are now exploring the possibility of placing thrust reversers on the General Dynamics design (AW Apr. 8, p. 26).

Navy already is concerned about the weight of the F-111 design. Jordan said the Boeing-type reverser would weigh 500 lb. per engine, or 1,000 lb. per aircraft, but a more limited reverser for decelerating the aircraft once it touches down would weigh about 300 lb. The net weight increase from the reversers would be their weight minus the air brakes and spoilers in the current General Dynamics design.

Pratt & Whitney arrived at the $425 million cost estimate by figuring reversers for 3,400 engines, two for each of the 1,700 aircraft, plus 25 spares. Jordan estimated the unit price for the reverser at $100,000. This compares with Boeing's unit estimate of $14,500 for the reverser at the start of production, with the possibility of reducing this to $8,500. Reversers were included in Boeing's bid for the F-111 contract. Defense Secretary Robert S. McNamara has said Boeing's cost estimates generally were unrealistic. Cost of the thrust reversers on the Douglas DC-8 are about $95,000 each.

mercial aircraft throughout the world."

• **Dual wheels.** Boeing proposed dual wheels, two on each side of its landing gear, while General Dynamics proposed a larger single wheel on each side. Gen. Sweeney said dual wheels would be safer for landing and easier to maintain.

• **Air scoops.** Gen. Sweeney said General Dynamics' placement of these so near the missiles being carried under the aircraft might cause a flameout as the engines ingested exhaust from the missile as it was launched.

• **Ferry range.** He said other advantages of the Boeing design were the longer ferry range and greater ordnance-carrying ability.

In discussing the general capabilities of the competing contractors, Gen. LeMay said that "going back to the original proposal, the Boeing team had a much better knowledge of what was required in this sort of an airplane. They had a more flexible system, better ideas, I think, to produce it, and came forward with a much better proposal than did the General Dynamics team." He agreed with a statement by Sen. Henry M. Jackson (D.-Wash.) that the four evaluations of the F-111 helped the lower-rated proposal of General Dynamics catch up to Boeing's higher-rated one.

Gen. McKee, in a sworn statement filed with the subcommittee Feb. 13 and discussed Apr. 5, said "there was no dissent within the Air Force Council [at its meeting Nov. 8], including the Navy members, on the 'clear and substantial advantage of the Boeing proposal over the General Dynamics proposal which is magnified by the environment found under the austere conditions usually inherent in limited war actions.'" He said General Dynamics did "a creditable job" in producing the USAF B-58 supersonic bomber, "but the aircraft was a lot more expensive than originally planned. Part of this increase was the fault of the government. It is my view that, all things being considered, Boeing is a better producer."

Gen. McKee said that "during the source selection procedure there were no political pressures brought to bear on me, or, as far as I know, any of the uniformed personnel within the Air Force.

In response to the expressed preferences for Boeing among Air Force and Navy officials, Sen. Karl E. Mundt (R.-S. D.), ranking Republican on the investigating subcommittee, asked Rear Adm. Frederick L. Ashworth, assistant chief of the Bureau of Naval Weapons for research and development, whether he would prefer to test prototypes of the competing designs "instead of comparing them in the conjectural basis that you have to do as long as they are paper planes."

Adm. Ashworth said "perhaps the more difficult part of creating a weapons system of this kind is not the airframe and its flying capabilities, but the combat systems that are involved in this—the missile system and the fire control systems and the bomb-carrying capability and the like." Consequently, Adm. Ashworth said, the question is whether the U.S. should go through the "very expensive operation" of building two completely equipped prototypes. He said "there are certain attractivenesses to a competition of this kind," and added that "this is the way the Russians do the business . . ."

Adm. Anderson said in his prepared statement that the McDonnell F-4B was flight-tested against competing aircraft before it went into quantity production and "the end result was the finest aircraft of its type in the world today." He said the "true worth" of the F-111 "can only be determined when there is available to each service an actual flying machine on which flight evaluations can be accomplished by qualified test personnel and when it is combined with a suitable missile system."

The Senate subcommittee may ask Boeing and General Dynamics to estimate how much it would cost to build fully equipped prototypes which could be tested against each other.

Witnesses made it clear that the Defense Dept. has decided to incorporate as many of the superior features of the Boeing proposal into the General Dynamics design as possible. "Undoubtedly," Gen. LeMay said, "we will try to apply the good points that we found in the Boeing design as far as we can to the General Dynamics design so that we can produce the best possible airplane . . ."

In this connection, Sen. Mundt told Adm. Anderson: "If what you come up with ultimately is a Boeing plane with a General Dynamics label and a General Dynamics price tag on it, so be it. You properly are trying to move in the direction of improving it, and you would have done the same, I am sure, had the Boeing design been selected." Adm. Anderson replied: "That is correct, sir."

Large Solids Contracts

Washington—Thiokol Chemical Corp. was expected to win the major share of Air Force large solid propellant rocket motor development contracts. Thiokol was expected to be awarded package 2, static firing of a 3 million-lb. thrust, 156-in. dia. fixed-nozzle motor, and package 3, demonstration of a 1 million-lb. thrust, 156-in. dia. movable-nozzle rocket. Thiokol and Aerojet-General Corp. are expected to conduct parallel developments for 260-in. dia. half-length motors generating 3 million-lb. thrust, under bid package 1.

Lockheed Propulsion Co. was expected to win bid package 4, calling for demonstration firing of a 1 million-lb. thrust, 156-in. dia. motor with jet tabs.

Source selection board recommendations (AW Apr. 8, p. 29) were believed to have been accepted only for package 1. The board recommended Aerojet for package 2, Lockheed for package 3 and United Technology Center for package 4.

Japan Early Warning Competition

Tokyo—Japanese Self-Defense Agency has asked General Electric, Litton and Hughes—the three major companies bidding on an early warning and air defense control system for Japan—for a third round of proposals in the competition.

Companies had submitted proposals twice before but in each instance the Japanese agency delayed any final decision (AW Mar. 4, p. 29). The program, to modernize and supplement the existing manual early warning and weapons control systems with a semi-automatic complex resembling a small Sage system, has been under study since 1959.

Contractors are required to deliver their latest bids by Apr. 27 and Japan is expected to make a final decision by the end of May. The Japanese calculate that an early selection will pave the way for appropriation of U.S. funds in the Fiscal 1964 budget to help defray the cost to Japan.

Request now calls for a smaller system than previously envisioned. Second configuration was based on a projection of the system handling up to 600 fighters in 1967. Current Japanese thinking is that this figure was exaggerated because the number of aircraft will decrease, by normal attrition, to 500 by 1970. Third configuration, therefore, will be designed to handle 500 planes, although Japan expects to have more than 500 aircraft flying during the interim period before 1970.

Specifications given out by the defense agency for the third configuration are more concrete than those for first two configurations. Previously, the defense agency merely specified the number of radar sites, number of its planes to be controlled, and number of enemy planes expected. It then asked companies to design a system to meet these requirements. Now the defense agency has also included specifications on the system itself.

Japanese government also specified that the Japanese partner of the American company winning the competition will be expected to sign a contract with a firm price for the system installed at the radar sites and operating. Firm price is expected to prevent cost escalation similar to those experienced during the F-104 program, when original agreements were estimates rather than firm prices.

Defense agency has greatly accelerated its over-all timetable. Prior plans called for a systems design contract, to be followed by a production contract. Present plans call for award of systems design and production contracts simultaneously.

Funds have hitherto been a major stumbling block for the program. About $83 million has been planned for the system under Japan's second five year defense build-up program (1962-66). There was disagreement within the defense agency whether this money should be used to equip only one of the three areas into which the nation's air defense system is divided, or to equip all three. The Japanese now have decided to develop the system for the whole country.

Britain Will Pay 'Normal Costs' Plus 5% for U.S. Polaris Missiles

Washington—Great Britain will pay "normal costs" for U.S. Polaris missiles and related equipment, plus 5% to cover part of the research and development costs incurred after Jan. 1, 1963.

A technical agreement signed by the two countries on Apr. 6 contains details of the basic agreement reached by President John F. Kennedy and British Prime Minister Harold Macmillan last Dec. 21 at Nassau (AW Dec. 24, p. 20).

Britain will receive the 2,500-naut. mi. range Lockheed-developed A-3 model Polaris, minus the warhead.

British Plans

Britain plans to build four nuclear-powered submarines, each armed with 16 missiles. It will purchase 64 missiles, plus an undisclosed number of spares from the U.S.

Total cost to Great Britain of the Polaris submarine and missile program was not announced, but one official estimated that one third of the sum will be spent in the U.S. Development cost of the A-3, which is not yet operational, will be an estimated $1.75 million per missile, minus the warhead.

"Normal costs" are defined as including charges for materials, work performed, use of capital facilities and overhead costs. The 5% fee is partial reimbursement for current research and development, not for what was spent prior to Jan. 1 (AW Feb. 4, p. 37). Replacement items from current stocks will be furnished at the most recent procurement costs.

The agreement specifies that these items will be furnished:

• **Polaris missiles,** less warheads but including guidance capsules; missile launching and handling systems; missile fire control systems; ships navigation systems; personnel training; research design, development, production, test or other engineering services required.

• **Additional associated support,** test and training equipment and services. These include test and checkout equipment, specialized power supplies, power distribution systems, construction spares and spare parts and technical documentation including specifications, blueprints and manuals. Use of training and missile range facilities will also be furnished.

Information about the hull, auxiliary machinery and equipment of U.S. Polaris submarines will be furnished, but the agreement specifically excludes information about the nuclear propulsion plants of U.S. submarines.

Navy's Role

Missiles and equipment will be fabricated to the same documentation and quality standards as in the U.S. Polaris program. Production schedules will be integrated with the U.S. program.

The Navy, acting for the Defense Dept., will be executive agent for the U.S. government in the joint program. The Admiralty will represent the British government.

The U.S. project officer probably will be Rear Adm. I. J. Galantin, director of the Polaris special projects office. Rear Adm. H. S. Mackenzie, chief Polaris executive for the Admiralty, is expected to be named project officer for Britain.

A joint steering task group will also be formed, composed of project officers and liaison representatives. It also may include scientists, industrialists and government executives from both countries.

The agreement protects patent and proprietary rights, and holds the U.S. not responsible for unusual hazards. Security measures are also detailed.

According to present plans, Great Britain expects to have its first Polaris submarine operating in 1968. The A-3 missile is now being test-fired and will go into production early next year. The first U.S. submarine carrying the A-3 type missile will be deployed in mid-1964.

Military Space Studies

Series of studies designed to explore various military aspects of space is being prepared by Air Force's Space Systems Div. for industry competition. As many as 18 separate studies are contemplated, with proposal requests for the first studies expected shortly.

One of the first in the series will be to determine the military potential and usefulness of space. Another one will be a theoretical investigation of critical parameters for orbital vehicles in space. The latter will not be tied to any specific vehicles or concepts.

Contractor Evaluation Comments Asked

Washington—Details of the Defense Dept.'s new contractor evaluation program, in which companies' past performances on major development projects are scored to provide criteria for selecting contractors for new programs, have been sent to the individual military departments and to the 21-man Defense Industry Advisory Council for comments (AW Feb. 4, p. 95).

Defense Dept. hopes to introduce the new contractor performance evaluation plan by July 1. National Aeronautics and Space Administration, which participated in preparation of the evaluation system, currently is getting reactions to the plan from its centers before introducing the system into NASA programs.

The proposed procedure avoids the use of numerical or comparative ratings of individual contractors, and no blacklist of "undesirable" contractors is planned.

The system will provide a collection of factual summaries of each contractor's performance in meeting his contractual commitments on each major program in terms of technical performance, cost and schedule.

Development contracts amounting to over $1 million are expected to receive contractor performance audits at the conclusion of the project. In addition, contracts whose annual funding exceeds $5 million or where the total program figure exceeds $20 million, will also receive audits at six-month intervals, according to present plans.

Initial Performance

The military project manager will prepare the initial performance evaluation, which will be sent to a central evaluation group of the military department involved. If the report is a six-month audit, the evaluation group will have the option of making an independent field investigation with its own team of technical, procurement and legal experts.

If the program is completed, an independent field audit is mandatory under present plans.

The evaluation report then goes to the contractor involved for his review and comments, if he disagrees with its contents.

These comments become a permanent part of the record.

The report next is returned to the project manager for his review and comments on views reported by the contractor and central evaluation group. The report then returns to the central evaluation group a second time, and the group has the option of making another field investigation in the event that there is a sharp divergence of opinion.

The procedure is aimed at creating a system of checks and balances which minimizes the possibility of an unfair appraisal.

The complete report, including all project manager and contractor comments, will then be filed, and will be available for use in evaluating bidders in subsequent competitions. For example, if companies "X" and "Y" are finalists in a subsequent competition, with proposals comparable in all respects but price, and if company "X" quotes a cost which is 20% less than company "Y," the past performance records of both companies will be withdrawn from the files and analyzed.

If both companies have a consistent record of achieving contractual performance requirements, reasonably on schedule, but company "X" consistently overruns its contract cost estimates by 40% while company "Y" normally meets its cost estimates, this might provide the basis for awarding the contract to company "Y."

Major Programs

For major development programs, many of which are contracted on a cost-plus-fixed-fee basis, there has been a strong temptation for bidders to be overly optimistic in quoting cost, time and performance in their eagerness to get the job. Even with cost-plus-incentive-fee type contracts, there is a tendency to "promise the moon" to get the job.

The new evaluation system is expected to provide a much-needed counterbalance to this situation, according to Robert Tucker, assistant director for engineering management, office of the director of defense research and engineering. Tucker's office is responsible for preparation of the plan.

The plan proposed is a "fact-oriented rating system," Tucker said, intended to minimize as much as possible the differences between individuals involved in evaluating different programs. Fundamentally, it seeks to answer the question: How well did the contractor perform what he agreed to do, in terms of technical performance, cost and schedule?

The evaluation records will show the original contract terms as well as any modifications introduced by subsequent change orders.

The records will show also whether these change orders were requested by the government or the contractor to ease his commitment.

For contractors who are uneasy about the new Defense Dept. evaluation system Tucker offers the following advice: "Don't promise more than you honestly think you can do and if you get the contract, accomplish what you promised.

The proposed performance evaluation system will not, Tucker emphasized, require any additional paperwork or reporting by contractors beyond what now is required. Nor should there be a significant increase in the workload on a military project manager, providing he is doing a good job now of managing his program.

Performance Data

The data on performance, schedule and cost required for the six-month progress reports on large programs is the same kind of information a project manager should already be obtaining and analyzing, Tucker said.

Because the new plan will apply sharp pressure on contractors to make more realistic commitments, it will also require military project managers to draw up more realistic and well-defined work statements of what is required prior to selecting the contractor. This is another useful byproduct of the plan, according to Tucker.

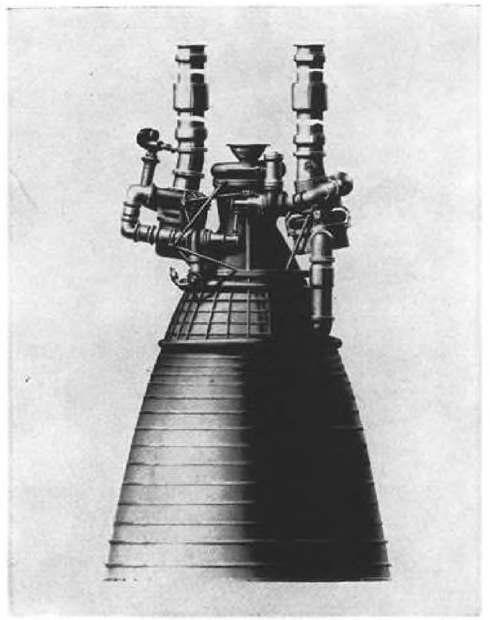
For large contractors who have several major divisions involved in defense business, performance evaluation reports will be filed by individual divisions, so that each is judged largely on its own performance. However, Tucker speculated that a certain amount of "corporate rub-off" may occur with adverse performance of a sister division. Perhaps it should be this way, he said, since corporate management must assume responsibility for all of its defense divisions.

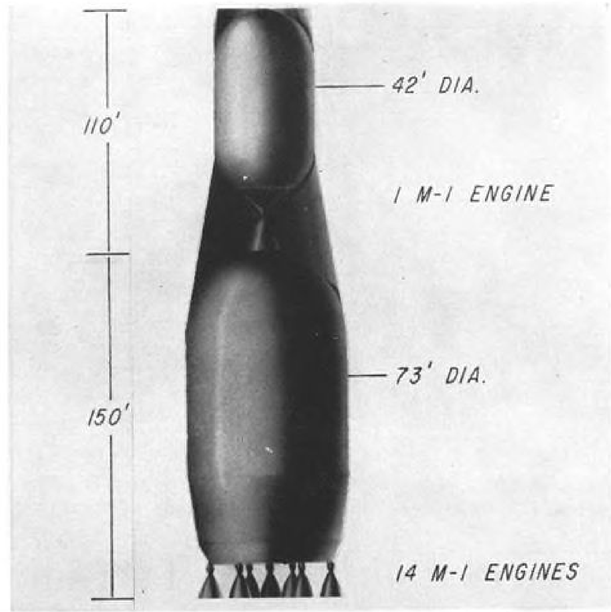
Evaluation Plan Tests

The contractor evaluation plan submitted to the services and industry for comment was developed by a special working group, which was headed by Army Lt. Col. Stewart P. Blake.

The working group also included representatives from all the military departments and the National Aeronautics and Space Administration.

The initial rating format prepared was field-tested by the working group on three existing development programs. Improvements suggested by this experience were incorporated, and the revised plan was then given to 10 military program managers for them to use in a trial rating of their program contractors. Suggestions developed by this second field trial were then incorporated into the procedure manual currently proposed for system use.





M-1 flight configuration, left, is 25 ft. high, 15 ft. across nozzle base. Two-stage-to-orbit launch vehicle design, right, based entirely on M-1, would weigh 13.6 million lb., generate 17-million lb. thrust, and is expected to place 1-million lb. payload into 140-mi. orbit.

Higher Thrust Potential Planned for Aerojet M-1 Engine

Aerojet-General's M-1 hydrogen-oxygen engine, designated as the upper-stage propulsion system for the Nova launch vehicle, is being designed for a greater thrust potential than its current uprated value of 1.5 million lb., according to J. C. Moise, assistant M-1 program manager.

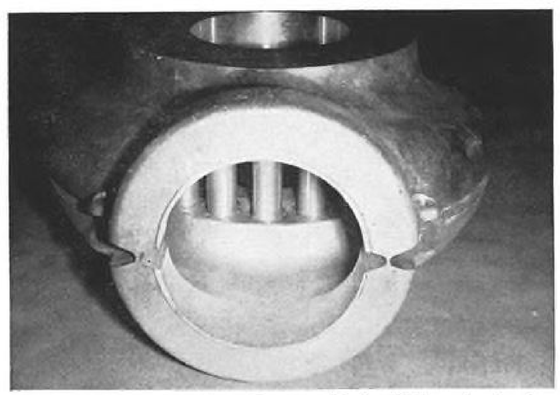
Aerojet also envisions possible use of the engine as a booster (see drawing, upper right). As a booster, the engine would have a smaller nozzle expansion ratio than that used in the upper-stage application, the company says.

M-1 will be ignited electrically and shut down by venting the gas generator valve and thrust chamber valve actuators, which close the propellant valves by spring action. Turbopump assemblies will deliver more than 100,000 shp.

M-1 components will undergo tests beginning this fall. Preliminary flight rating tests are planned for 1967, engine qualification flights in 1969.

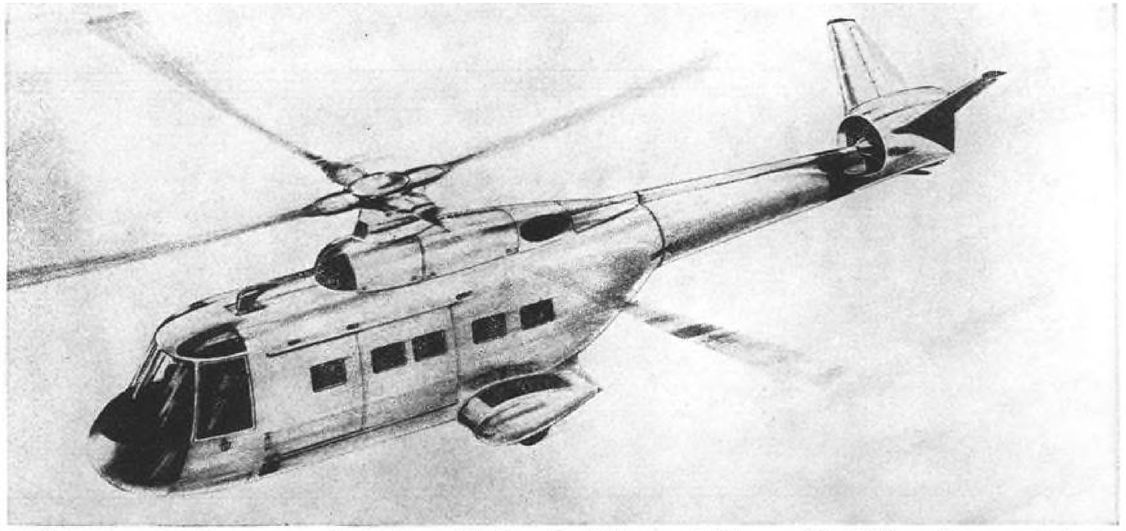


M-1 hydrogen engine gas generator injection assembly is shown.





Completed thrust chamber valve assembly for M-1 engine is shown at left. At right, an M-1 turbopump housing has been marked for testing. Test facilities include hydrogen storage vessels with 2.5-million lb. capacity, seven days' maximum production of all U. S. plants.



SUD SA-330, assault helicopter now under development, is shown in artist's concept with proposed ducted fan anti-torque control system at the tail. Helicopter would have a crew of two and carry 12 soldiers.

Sud Planning Twin-Turbine Assault Helicopter; Ducted Fans Possible

Marignane, France – Sud Aviation's helicopter division is developing a twin-turbine, assault-type helicopter, designated SA-330, which is scheduled to fly in 1965.

French army has indicated strong interest in the SA-330, originally designated the Alouette 4, but no firm orders have been placed.

SA-330 will be designed to carry 12 troops and two crewmen. Gross weight will be five to six tons. Single-rotor helicopter will be powered by two Turbomeca Bastan 7 engines, each delivering 1,300 shp. Cruising speed will be about 155 mph., maximum speed approximately 180 mph.

Sud engineers, at the request of the French army, are studying a ducted-fan system in an attempt to avoid an anti-torque tail rotor layout. This would permit faster flight and improved rough-field landing capability. Initial SA-330 prototype, however, is being built with a conventional five-bladed tail rotor. Single main rotor is fitted with four blades of 49.2-ft.-dia.

Sud plans to display a full-scale mockup of the SA-330 at the Paris air show in June. The SA-330 could become operational in 1967.

New helicopter is provided with two side doors and a rear drop-door for quick egress. Sud officials say the SA-330 will be an all-weather, highly maneuverable vehicle. Use of two 1,300-hp. turbines is expected to give the helicopter a power reserve of 88% at normal weight and 65% at maximum weight.

Sud engineers acknowledged that the proposed ducted-fan tail system would result in consumption of power in stationary flight of three times that required by a normal tail rotor system. However, they expected the Bastan twin-turbine layout to supply ample power for this flight regime, and that the tail fan system will afford a considerable gain in speed during flight.

French army is interested by the new tail system, as well as other features, including a retractable landing gear, designed to make the SA-330 fast and maneuverable.

Sud's new helicopter design marks a continued effort by the company's main helicopter plant here to hold its important position as a helicopter manufacturer. Helicopter sales account for 20% of Sud's total business. To date, Sud has sold 1,320 helicopters and delivered 1,236. These sales include:

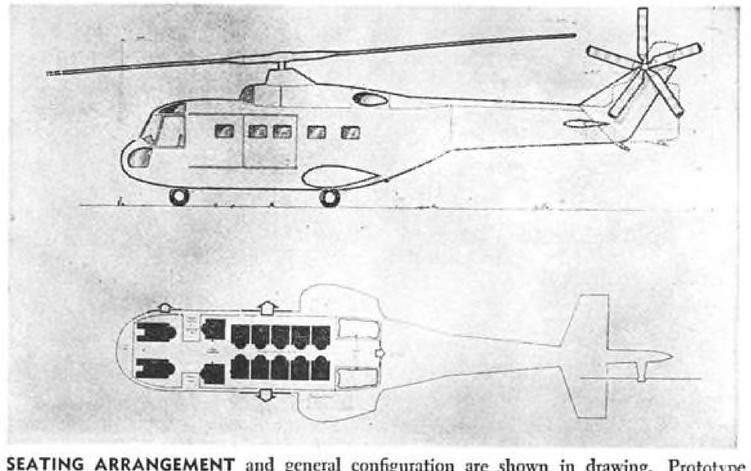
• **Djinn.** Sud built 150 of these two-place turbine helicopters including 100 for military customers.

• **Alouette 2.** As of Mar. 15, Sud had received 863 orders for this five-place, turbine-powered helicopter from 28 customers. A total of 816 Alouette 2s has been delivered.

• **Alouette 3.** As of Mar. 15, Sud reported orders for 122 of these seven-place helicopters and 85 deliveries. Production of 230 vehicles is programed to date. Of the 122 ordered, 33 are for French military. The remainder are civil and export orders.

Sud's other helicopter production includes license construction of 180 Sikorsky H-34s. The company also expects shortly to go into full-scale production of its 30-passenger Super Frelon three-turbine, transport helicopter.

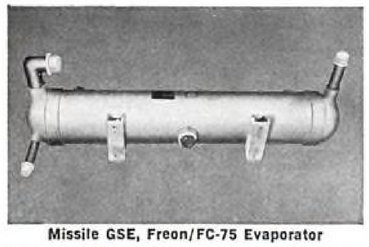
French military orders—army, navy and air force—should result in production of 150 to 200 Super Frelons.



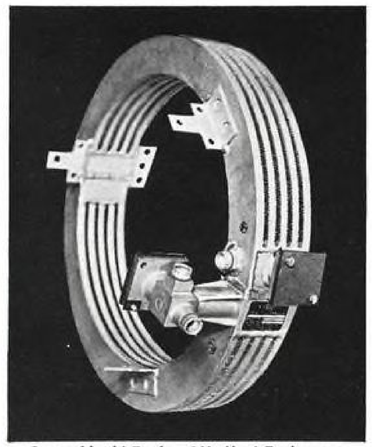
SEATING ARRANGEMENT and general configuration are shown in drawing. Prototype will be built with standard tail rotor. Note ducted fan outline in side view.



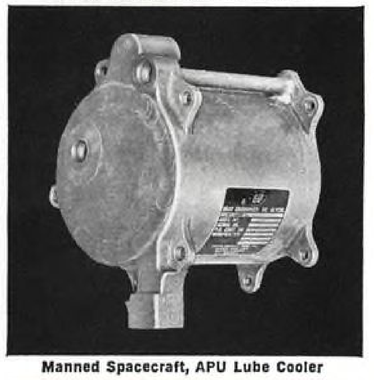
IRBM Guidance Cooler, FC-75/Air



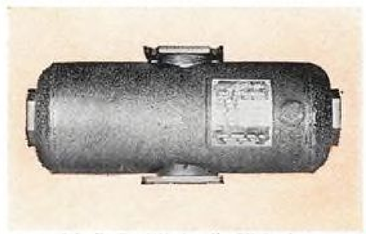
Missile GSE, Freon/FC-75 Evaporator



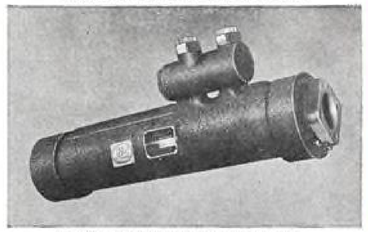
Space Liquid Engine, LH_2 Heat Exchanger



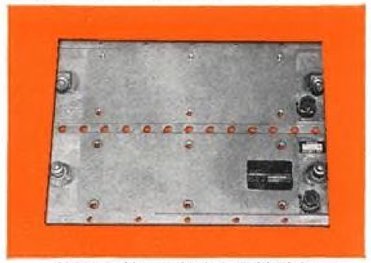
Manned Spacecraft, APU Lube Cooler



Missile Fuel/Hydraulic Oil Cooler



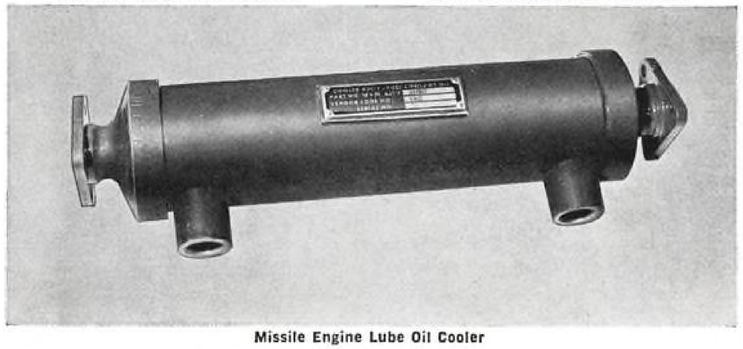
ICBM RP-1/Hydraulic Oil Cooler



ICBM Guidance System Cold Plate



Missile Guidance Cooler, FC-75/Air



Missile Engine Lube Oil Cooler

THE HEAT'S OFF

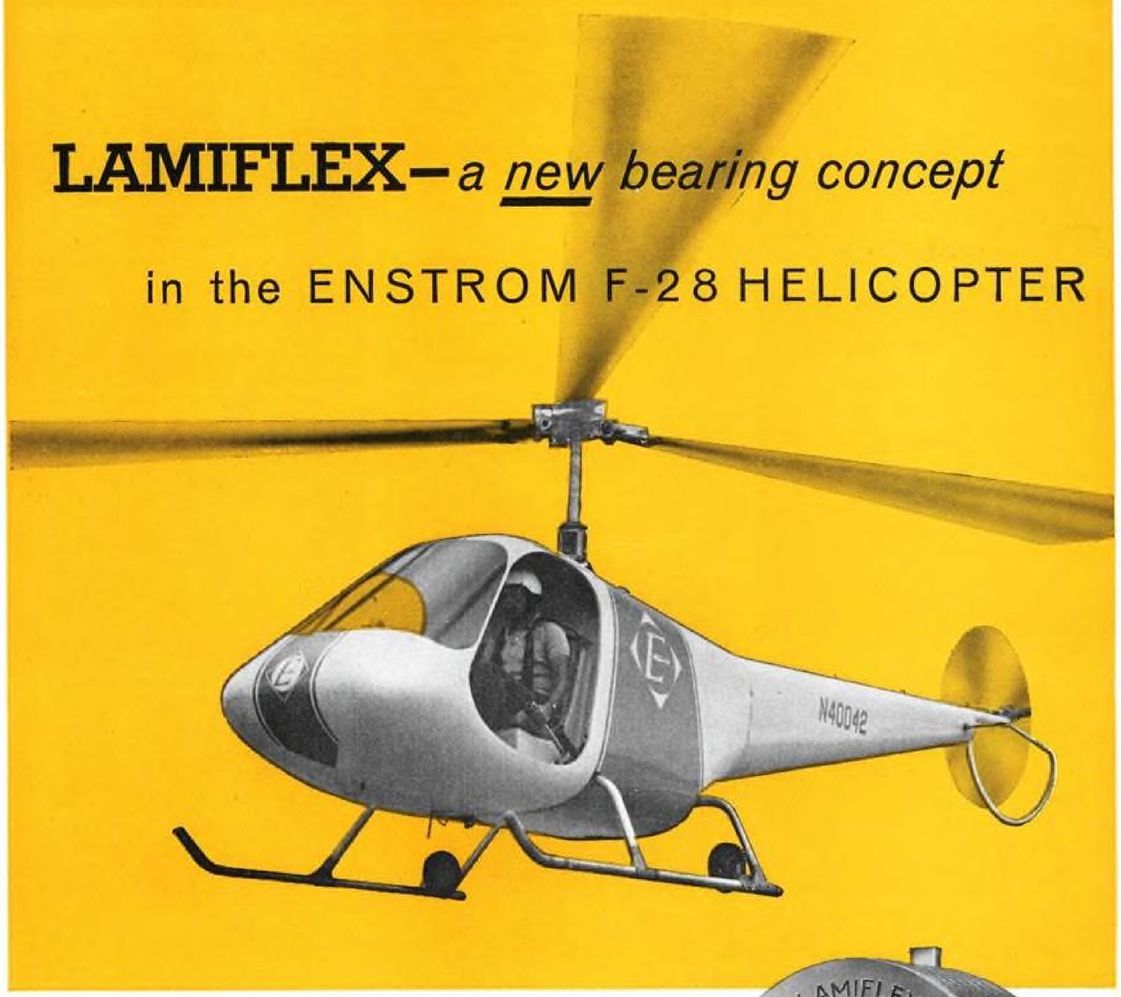
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McNamara Shifts Policy, Seeks Nuclear Power for Large Ships

Washington—Defense Secretary Robert S. McNamara, reversing his earlier stand, now wants all future U.S. aircraft carriers and other combat ships displacing 8,000 tons or more to be nuclear-powered.

His policy switch was passed to the Navy's sea-based strike forces study group, which has been making a detailed study of fleet air defense and anti-submarine warfare, in addition to strike forces (AW Feb. 11, p. 35).

The study group believes that a nuclear-powered carrier could be built for only 20% more than the cost of a conventionally-powered ship, by using four reactors instead of eight as in the USS Enterprise. In addition, reactors are now more efficient than when the Enterprise was designed.

McNamara is currently withholding funds appropriated by the last session of Congress for the conventionally powered CVA-67. Vice Adm. Hyman Rickover, the Navy's nuclear power expert, convinced McNamara that nuclear power was logical and economical if properly applied (AW Mar. 4, p. 21).

When the Navy was preparing its Fiscal 1963 budget requests in the summer of 1961, McNamara directed that the submission specify conventional power for the new ship. He believed it would be impossible to sell Congress on another $500-million carrier.

The Navy's policy now is to seek nuclear power for all combat ships displacing 8,000 tons or more. This would include carriers, cruisers and some frigates. Navy Secretary Fred Korth, in testimony before the Senate Armed Services Committee Mar. 4, said nuclear power is "being given much study and consideration."

"Such evaluations," he said, "weigh the increased cost of these ships against their operational advantages and seek to strike a reasonable balance between these more costly advantages and the over-all requirements of ships to fulfill the commitments of the Navy."

Existence of the study group was confirmed by Adm. George W. Anderson, chief of naval operations, before the same committee. "We have had a study going on for considerable time. This particular study arose because the Atomic Energy Commission asked the Secretary of Defense whether or not it would be feasible and desirable to incorporate nuclear propulsion into the CVA-67 which was authorized last year.

"As a result of this we have had this matter under review and under discussion with the people in the Dept. of Defense. In addition, we are studying the whole sea-based striking force system which we expect to have completed for the Secretary of Defense in the detail which is desired by April first."

The study now is expected to be completed by May 15.

Vice Adm. William A. Schoech, deputy chief of naval operations for air, is chairman of the study group. Guidance is furnished by a steering committee composed of Assistant Secretary of the Navy for Research and Development James H. Wakelin, Jr., Adm. Schoech, Vice Adm. Ulysses S. G. Sharp, Jr., Rear Adm. John B. Colwell, and Maj. Gen. Edward W. Snedeker, USMC. Dr. Alain Enthoven, deputy assistant secretary of defense for systems analysis or his representative, and Rear Adm. Turner E. Caldwell are ex-officio members of the committee.

Polaris A-3X Launches

Cape Canaveral—First launch of a Navy-Lockheed Polaris A-3X from a ship-borne platform Apr. 10 resulted in destruction of the missile by the range safety officer when it veered off course shortly after lift-off.

Missile was launched from the USS Observation Island, a surface vessel, offshore from the Cape.

Two days earlier, another A-3X made a successful 2,000-mi. flight down the Atlantic Missile Range after launch from a land pad here. That missile carried new lightweight glass-fiber rocket motor cases, a more compact second-stage thrust vector control system and a longer reentry vehicle than earlier versions.

IAM Prepares for Boeing Strike

Washington—International Assn. of Machinists last week was preparing to strike Boeing Co. facilities in 13 states from Cape Canaveral, Fla., to Seattle, Wash. Workers were to be released from the 80-day no-strike injunction of the Taft-Hartley Law Apr. 15.

The stage was set for IAM action when 37,457 Boeing workers, both union and non-union, voted on a final company proposal and rejected it by a 65% vote. Result of the election, conducted by the National Labor Relations Board, was 13,141 to accept and 24,316 to reject.

The Boeing case marked the first time in the aerospace industry that a dispute has reached the critical "last offer" stage of Taft-Hartley. This stage occurs during the 60th to 75th day of the 80-day injunction period. Within this 15-day period it is required that a final management settlement proposal be put to a vote of all workers. Earlier this year, an extended dispute between IAM and Lockheed Aircraft Corp. was settled on the 56th day of the 80-day injunction period.

The union position in the Boeing case has strong national and local government support (AW Apr. 1, p. 29).

National Conciliation and Mediation Service, in a final attempt to avert a strike, started all-day negotiations—including Sunday sessions—promptly after the NLRB announced the rejection.

A statement by Boeing management on the election commented that "it is significant that more than 35% voted for the company offer." It added: "In view of the union-claimed membership, the percentage vote for the offer indicates that many union members, along with non-members, want a settlement and do not look with favor on the possibility of a strike." IAM has roughly estimated a 70% membership among Boeing workers.

IAM President Al Hayes said: "Boeing employes, both union and non-union, have made it perfectly clear that the company's offer is unsatisfactory. The next move is now up to the company. We are often reminded that the defense posture of the entire free world depends on continuing production at Boeing. We are well aware of our responsibility. Not only have IAM members twice postponed strike action at the request of the federal government, but also we have agreed to settle this dispute along lines recommended by the aerospace board appointed by the President."

Laser Discovery

New technique for converting light output of a ruby laser into microwave frequencies by changes produced in the index of refraction of a quartz crystal has been discovered by scientists at International Business Machines Corp.

The reactive-mixing technique could be applied to communications by laser beams operating at longer wavelengths, where previously used photoconductive converters have relatively low sensitivity. It might also be used to generate energy in the millimeter and submillimeter wavelength region where present sources are extremely limited in power.

In IBM experiments, the output of a ruby laser was reflected back and forth through quartz crystal with reflectors placed so that adjacent Fabry-Perot modes were 423 mc. apart, causing quartz crystal to produce output at 2,964 mc.

Lunik 4 Believed to Have Failed in Mission

By Edward H. Kolcum

Washington—Soviet reaction to its Lunik 4 lunar probe mission has led to a belief that the probe failed its primary objective to soft-land a payload on the surface of the moon, or to take detailed photography of the lunar surface.

The vague generalities that characterized official Russian reports of Lunik 4 support a widespread feeling that the Soviet lunar exploration program is experiencing problems at least as severe as the U. S. Ranger lunar landing program.

Lunik 4 Launch

The 3,128-lb. Lunik 4 was launched from a parking earth orbit Apr. 2 (AW Apr. 8, p. 33). It flew past the moon Apr. 5 at 8:25 a.m. (EST) at a distance of 5,281 mi. Logical development program for lunar exploration, according to U. S. space officials, would dictate a soft lander, a lunar orbiter or a photographic payload for Lunik 4. Instead, the probe missed the moon by a greater distance than did Luniks 1 and 3, which Russia launched in 1959.

The fact that Lunik 4 took 3.5 days to reach the vicinity of the moon indicates that Russia shaped a flight path that sacrificed time for payload weight. Several U. S. officials believe Lunik 4 contained an ejectable package that was to have landed on the lunar surface. Normal flight duration from earth to moon is about 60 hr.

Lunik 4 is now in a highly-elliptical earth orbit ranging from 55,800 mi. to 434,000 mi. Russia said the probe gradually will go into a solar orbit, as did Luniks 1 and 3.

Adding to the mystery surrounding Lunik 4 was the fact that Russia did not ask Great Britain's Sir Bernard Lovell to help track the vehicle with the large Jodrell Bank radio telescope as it has done in the past.

Jodrell Bank taped signals for 6 hr. Apr. 4 after searching the frequency band since Apr. 2. The signals suddenly stopped, but were picked up again Apr. 5 for a period of 44 min., and were heard again for 2 min. on Apr. 6.

Lovell said that in his opinion, the signals stopped Apr. 4 because "some complicated maneuvers were being carried out." He said there were four possible missions for the probe: a close pass at the moon, which he considers unlikely; a lunar orbit; soft-landing an instrument package, which he feels was the intent, or a circum-lunar flight with the payload returned to earth. This last possibility he termed "the most fantastic of all."

Jodrell will attempt to analyze the signals, which Lovell said are far more complicated than those of Lunik 3.

Little Coverage

Moscow's reluctance to discuss Lunik 4 objectives and instruments was noted in the first announcement of the launch, and it increased throughout the flight. Radio Moscow virtually ignored the flight, and canceled a lecture program entitled, "Hitting the Moon" scheduled at 7:45 p.m. Apr. 5 Moscow time. It substituted a poetry program and an interlude of piano music for the scheduled program.

Soviet news agency Tass carried a number of interviews with Russian scientists who speculated on the significance of Lunik 4, but these comments also were vague.

These were some of the interviews carried by Tass:

- **M. V. Viktorov,** an astronomer, said results will be obtained in the fields of launch from orbit, long-range communications, and new information about the moon.
- **A man identified** only as "chief designer," presumably of Lunik 4, said experiments and observations being conducted by the payload "will be of great importance for future flights toward the moon . . . Soviet scientific program of studies of the moon is being successfully fulfilled."

Tass Reports

Official daily Tass reports were unusually terse, and said simply that the instrumentation was working normally, and radio communications were good. In a general story on the moon Apr. 7, only a brief reference was made to Lunik 4 in the Soviet newspaper Pravda, and no further references to the moon shot were made Apr. 8.

Lunik 4 was photographed by Russia's 2.6-meter reflector early in its flight and appeared as a star of the 14th magnitude.

The 2.6-meter reflector also photographed the Mars 1 probe.

There were reports in France and Italy that Lunik 4 transmitted television pictures of the lunar surface. Two Italian astronomers in Turin said Apr. 8 that they monitored television signals from the probe, and screened six slightly blurred pictures of what, they said, appeared to be the surface of the moon.

Eight-Day Soviet Manned Flight Forecast

Washington—Soviet Russia may attempt an eight-day manned orbital flight and at least one rendezvous mission this year, according to Dr. Edward C. Welsh, executive secretary of the National Space Council.

In a memorandum titled "Space Race with USSR," written to Vice President Johnson, Dr. Welsh said the U. S. program is in the building stage this year and few spectaculars can be expected from it. But he said Russia may attempt:

- Manned orbital mission of eight days. Dr. Welsh told Aviation Week & Space Technology this would be done to proof-test components and systems for a lunar mission, and to demonstrate that Russia has the capability for a mission of this duration.
- Manned orbital rendezvous mission, also as a step toward manned lunar landing. Russia has frequently indicated it prefers the earth-orbit rendezvous technique for landing men on the moon.
- Closeup pictures of the planet Mars, if the Mars 1 probe continues to function.
- Several unmanned lunar soft-landing probes. Dr. Welsh's memorandum was written before Lunik 4 was launched. There has been wide-spread speculation in the West that Lunik 4 was intended to make a soft landing on the moon (see story).

One other possible Russian shot is the launch into earth orbit of a two-man capsule, Dr. Welsh said, although evidence that Russia has the capability for such a mission is not as clear as for the other probabilities.

Major U. S. accomplishment in 1963 is expected to be the launch of Saturn SA-5 in an attempt to orbit a spent S-4 hydrogen-oxygen upper stage weighing about 33,000 lb. (AW Apr. 1, p. 32). This would be more weight than either the U. S. or Russia has ever placed in orbit.

In assessing the status of the space race at this time, Dr. Welsh said that the USSR is ahead in the total amount of knowledge and experience in manned space flight, and has more powerful rockets in operation. U. S. is developing more powerful vehicles than any known to be under Soviet development.

U. S. has placed four times as many payloads into orbit as Russia, but Russia has put substantially more weight into orbit. Although Russia has a potential in the fields of weather, communications and navigation applications, it has no accomplishments to compare with the U. S. achievements in these fields. Both nations, Dr. Welsh said, have obtained remarkable amounts of scientific data.

Soviet Space Failures

Washington—Soviet Union's failure to honor an agreement to register space launchings with the United Nations has increased the conviction here that Russia is experiencing fundamental difficulties in its space program. This is exemplified by the widespread belief that the Lunik 4 moon probe failed its mission (see p. 38).

UN General Assembly unanimously resolved early last year to register earth satellites and space probes. Although the U. S. has updated the registry every two weeks, Russia has not submitted a report since last Dec. 28. It covered launches through last Nov. 1. Since that time, Russia has publicly announced the launchings of Cosmos 12 and 13 and Lunik 4.

The fact that the U. S. designated its first 1963 satellite—an Air Force shot fired on Jan. 7—as 1963-2 is a clear indication that Russia launched 1963-1. Early January was an opportune time to launch a lunar probe, and there is speculation that Russia failed in an attempt at this mission.

Because there have been few recent reports on Russia's Mars 1 probe (AW Mar. 25, p. 26), there is a belief that the payload is no longer transmitting. It is also believed that Mars 1 failed to respond to a midcourse maneuver correction necessary to bring it close enough to Mars to make meaningful observations.

Of the 33 reports submitted for UN registry, the U. S. furnished 25. U. S. summaries include USAF and National Aeronautics and Space Administration. The last submitted by the U. S., on Apr. 5, contains launches through February.

Sequential Arabic numeral designations, which the UN began urging this year, have reached 1963-10. U. S. uses the expedient of skipping a number when its surveillance network tracks a foreign satellite, even though Russia does not admit making the launch. Through Apr. 10, the launches were: 1—unannounced Soviet vehicle; 2—USAF Thor Agena D on Jan. 7; 3—USAF Thor Agena D on Jan. 16; 4—NASA Syncom, Feb. 13; 5—USAF Blue Scout, Feb. 19; 6—designation skipped for Cosmos 13, launched Feb. 21; 7—either an Air Force Blue Scout, launched Mar. 13, or a Thor Agena D, launched Apr. 1; 8—designation skipped for Lunik 4 launched Apr. 2; 9—NASA Explorer 17, Apr. 2; 10—USAF Blue Scout, Apr. 5.

NASA Speeds Planetary Program

Washington—Pace of the U. S. planetary exploration program has been increased by the National Aeronautics and Space Administration with the award of $100,000 Voyager study contracts to Avco's Research and Advanced Development Div. and General Electric's Missile and Space Div., and the selection of 10 experimenters for the Mars Mariner flyby mission in 1964.

Voyager is a probe designed to orbit Venus or Mars and to eject an instrument package on the surface of the planets. Both Avco and GE have made extensive planetary entry studies, based largely on nose cone and re-entry body work they have done for Defense Dept. and NASA. Avco has made in-house studies of Voyager design concepts in a program which began last May.

GE, which previously studied Mars entry, Venus/Mars entry capsules and Venus/Mars atmosphere under Jet Propulsion Lab contracts, has named C. A. Taylor study project manager.

There has been considerable industry speculation that Goddard Space Flight Center will be assigned management of the planetary landing capsule project, because of its experience in developing and managing most of NASA's earth satellites. Goddard and JPL have both conducted studies of instrumented planetary entry capsules. NASA said a decision has not been made.

Experimenters for the 1964 Mars flyby spacecraft are California Institute of Technology—television, cosmic ray ionization and infrared spectrometer; JPL—magnetometer and ultraviolet photometers; State University of Iowa—low energy cosmic rays; University of Chicago—cosmic ray spectrum; MIT—plasma probe; Goddard—cosmic dust; Stanford University, radio propagation. Other experiments will measure interplanetary magnetic fields, charged particle flux and cosmic dust density.

Voyager spacecraft, which will be the next generation of the Mariner project, is expected to be developed in time to take advantage of launch opportunities to Mars in December, 1966 and March, 1969, and to Venus in June, 1967 and January, 1969.

Space Objects Study

Techniques to determine by passive means the range and range rate between two non-cooperating objects in space will be investigated by USAF's Space Systems Div. in a six-month study.

Aim will be to determine range and range rate in real time over distances on the order of 500 to 1,000 mi. Target vehicles assumed include ballistic missile before burnout, missile and components after burnout, missile in sunlight and satellite in shadow, with surface emissivity of 0.5.

News Digest

American and Eastern airlines have agreed to revise the stock exchange ratio of their proposed merger if the plan is approved by the Civil Aeronautics Board. Since the merger agreement, Jan. 22, 1962, Eastern's common stock market price has declined and American's has risen to the point where both are selling at $20-21. Book value of Eastern's stock dropped from $30.96 at the end of 1961 to $26.83 while American's dropped slightly, from $18.66 to $18.49.

Charles W. Frick, who resigned as manager of NASA's Apollo project two weeks ago (AW Apr. 8, p. 32), has rejoined General Dynamics/Convair as vice president-engineering.

Dassault Balzac VTOL testbed made its first public transition flight before top French military officials Apr. 8 at Villaroche. The modified Mirage fighter, prototype of the Mach 2 Mirage 3V supersonic VTOL fighter planned for operational use beginning in 1966, demonstrated vertical takeoff, transition to forward flight, aerobatics and high-speed performance prior to making a VTOL landing.

Bell 204B, turbine-powered commercial helicopter version of the military UH-1B, has received its Federal Aviation Agency type certificate. Bell Helicopter Corp. announced the first three orders for the helicopter—one to Mitsui & Co., Ltd., of Japan, which will make a version of the 204B under license and two to the Indonesian government (AW Mar. 18, p. 39).

USAF Project Forecast

Project Forecast, USAF accelerated planning effort (AW Apr. 8, p. 25), will involve 200 key personnel from Air Force, industry, universities, and government agencies, as required, at the peak of the expected four-month task at Space Systems Div.

Directed by USAF Chief of Staff Curtis LeMay in conjunction with Air Force Secretary Zuckert, the intensive planning studies will be initiated this week (Apr. 16) and will project the structure of the Air Force in the 1970 decade. The studies also will be conducted to assure integration of available scientific knowledge with Air Force requirements for new systems for national security.

Gen. Bernard A. Schriever, commander, USAF Systems Command, has responsibility for conducting Project Forecast. Maj. Gen. Charles H. Terhune, Jr., is project manager.

Douglas to Build DC-9 Despite Order Lack

Airline reluctance to assure sales forces firm to initiate cost-sharing plan with program subcontractors.

Reluctance of airline industry to place orders for aircraft still in the design stage has forced Douglas Aircraft Co. to begin production of its short-haul DC-9 twin turbofan transport in order to capture sales, and to underwrite some development costs through an unusual cost-sharing plan with subcontractors.

The plan calls for subcontractors to carry a portion of development expense, with profits and return on costs being geared to the number of airplanes sold. It is the first of this type of contract to appear in aircraft manufacturing.

These are the basic features:

• **Subcontractor will not** receive payment for his product until aircraft are accepted by airline customers or within 30 days afterwards. Standard procedure now is to make payment within the ordinary billing time after equipment is shipped from the plant.

• **Subcontractors must pay Douglas** 5% of their expected return to help cover flight-test expense. This is payable in two increments: one-half within 12 months of the contract and the other half within 24 months. Contract is renegotiable after the sale of 200 airplanes.

• **Contract termination proceedings** are designed to provide the subcontractor with a guarantee if fewer than 125 airplanes are sold. Reimbursement by Douglas for subcontractor units not sold would be made in this manner: nonrecurring or fixed overhead costs would be divided by 200—the number of aircraft sales on which the rate of return is based—to yield the unit non-recurring cost. This figure would be multiplied by the difference between the number of planes sold and 125 aircraft. This figure would be the amount reimbursed to the subcontractor for unsold items.

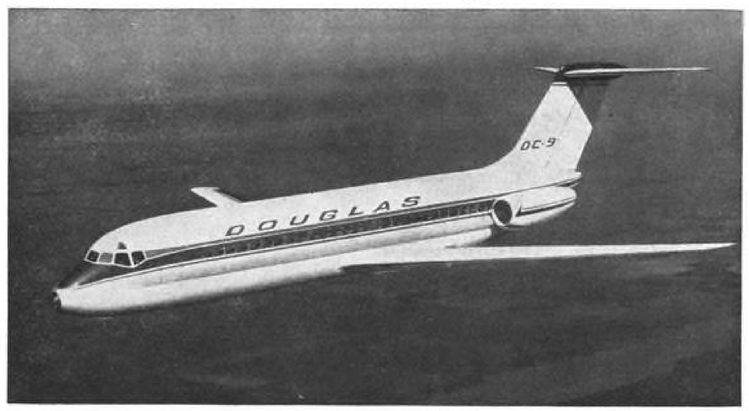
• **Extra costs, such as interest** on the subcontractor's investment between the awarding of the contract and final payment by Douglas, as well as the 5% contribution, will be included in the bidder's contract price.

The cost-sharing plan is basically a partnership transaction to share development costs, according to Douglas. It is based on market forecast studies of the number of units expected to be sold.

Subcontractors' bids have been received, and contracts have been negotiated with most of the winners. Actual signing of the contracts is expected within 30 days.

Preliminary design work on the DC-9, which is quite similar to the BAC 111 in operating performance, configuration and specifications, will be accelerated immediately. First flight is scheduled for the spring of 1965, with certification expected later that year and first deliveries beginning early in 1966. BAC 111 deliveries will begin in 1964.

British Aircraft Corp. has sold 41 BAC 111s. At one time, Douglas had received indications of confidence from airlines that pointed to the sale of 125 aircraft, but this figure reportedly has now dropped to about 100.



DOUGLAS AIRCRAFT'S proposed DC-9 transport is pictured above in artist's conception.

In general, most airlines are being noncommittal toward the DC-9, although cost studies conducted by several carriers point to a need for a short-haul plane such as the DC-9 or BAC 111. United Air Lines is studying both aircraft, but since it has ordered 40 Boeing 727 transports, it feels that its interest in them lies in the far distant future. American Airlines has also ordered the 727, but is looking at both the DC-9 and BAC 111 carefully, with the idea of placing an early order for one of the models. American President C. R. Smith, accompanied by W. J. Hogan, executive vice president and chairman of the finance committee, talked with BAC officials during a recent trip to England.

TWA is interested in the DC-9, BAC 111 and the Sud Caravelle, but may turn to more 727s for its medium-haul requirements. Eastern feels the DC-9 is too large and one official termed it a Lockheed Electra replacement rather than a Convair 340 or 440 replacement. National Airlines echoed this view by saying that if it did purchase the DC-9, it would use the plane to replace its Electras. It is not committing itself at this time.

Delta is showing enthusiasm for the DC-9, and noted that "there is definitely a place in today's air transport industry for an airplane with the capabilities of the DC-9." Delta said it will continue to "watch the development of the DC-9 very closely." Alaska Airlines is also showing strong interest.

Bonanza Airlines, recently turned down by the Civil Aeronautics Board in its bid to purchase a fleet of BAC 111s (AW Mar. 18, p. 50), does not believe the Board will allow it to buy the DC-9 at the present time. If the Board's opposition to small jet planes for local service carriers continues, it will have a dire effect on the sales of both the DC-9 and the BAC 111.

Hawaiian Airlines is definitely interested in a short-range jet transport and has requested CAB to approve the purchase of three BAC 111 transports (AW Jan. 18, p. 37). Mohawk Airlines has ordered the BAC 111, but the contract drew a sharp rebuke from the CAB (AW Mar. 4, p. 34).

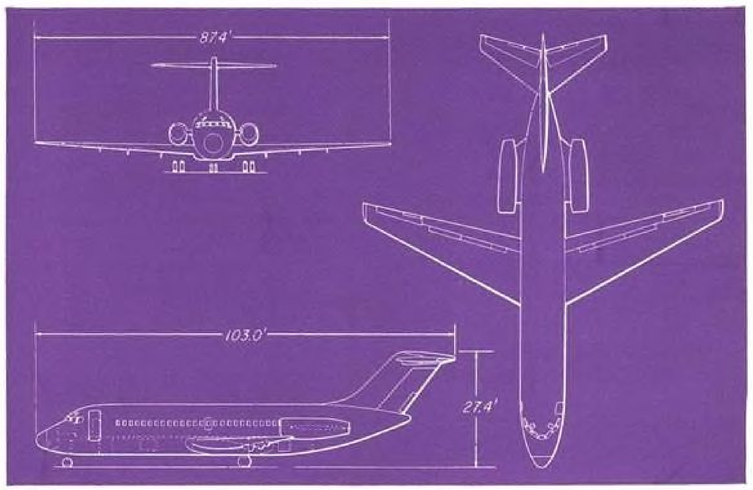
Meanwhile, reaction to the Douglas cost-sharing plan has been good, although some subcontractors are dubious over the termination provisions and feel that if the program fails, their losses will be substantial. However, one major subcontractor said that only one company that had an opportunity to bid decided against participation because of the cost-sharing program.

Subcontractors who feel they have a good chance of winning a place in the DC-9 project agree that the prime requisites of the program are quality products and the ability to obtain the financial backing necessary to participate in the sharing of initial development costs.

One subcontractor described its role as "sharing the design responsibility and carrying a portion of the development cost which would be amortized over the number of airplanes sold." Another bidder said the program represented a joint development effort with Douglas, taking the same corporate risks, but at the same time receiving the same profit as Douglas if the project is successful.

In its official announcement of the DC-9 program, which was originally termed the Model 2086, Douglas took notice of its British competitor. "While our decision to build the DC-9 had to be, and is, based on our best business calculations, we are also conscious of the benefit to our national interests of this project," Douglas said. "American-built aircraft have been pre-eminent in world air commerce for almost 30 years. We shall be pleased to help, once again, in maintaining that position of leadership."

Douglas plans a longer-range, 83,000-lb. version of the present model, which has a gross weight of 77,000 lb., that it will build for customers with longer routes, such as Trans-Canada Air Lines.



DOUGLAS DC-9 DESIGN evolution has resulted in a longer, heavier airplane. Over-all length has grown from 95.3 ft. to 103 ft. (AW Jan. 22, 1962, p. 48) and the larger Pratt & Whitney JT8D-5 engines are mounted lower on the fuselage and the fuselage now extends farther behind the engine tailpipes. Earlier designs specified the 10,000-lb.-thrust Pratt & Whitney JTF-10A engine. Configuration of the fin has been modified so that the leading edge now extends ahead of the stabilizer. Wing sweep and area are essentially the same. Cabin door, located originally just ahead of the wing, had been moved to the cockpit area when Douglas unveiled a mockup last year (AW Apr. 16, 1962, p. 40).

Trans-Canada has shown strong interest in the airplane and will make its decision by late summer.

The DC-9 will be powered by two aft-mounted Pratt & Whitney JT8D-5 turbofan engines. The JT8D-5 is a version of the JT8D-1, which is the powerplant for the Boeing 727 and the planned powerplant for the Sud Caravelle Super B model. A reduction in maximum thrust rating from 14,000 to 12,000 lb. was attained by reducing both rpm. and engine operating temperature, which is expected to give the engine longer life and lower maintenance costs.

The basic BAC 111 will be powered by two Rolls-Royce Spey 163-2 bypass engines of 10,400-lb. thrust. However, British Aircraft Corp. and Pratt & Whitney are now negotiating for the use of the JT8D-5 on the BAC 111. Time between overhauls (TBO) on the JT8D-1 is estimated at 2,500 hr. at the time of its introduction, and the manufacturer plans to recommend a similar TBO for the JT8D-5 to the Federal Aviation Agency.

Lower temperature and stress level ratings for the JT8D-5 are expected to increase the life of most hot section parts by 50% and burner can life by 25%. The engine has steel and titanium compressor blades rather than aluminum blades.

The DC-9 will cruise at Mach 0.8 above 22,000 ft.-altitudes, while the BAC 111 has a maximum cruise speed of Mach 0.78 at 21,000 ft. Maximum takeoff weight of the DC-9 is 77,000 lb. and 73,500 lb. for the BAC 111. Maximum landing weight for the BAC 111 is 67,000 lb., compared with 73,350 for the DC-9.

Douglas has planned a high landing weight to permit landings on multi-stop routes with a full payload and sufficient fuel for both reserves and continued operation over route segments without refueling. The manufacturer says that the plane will carry 70 passengers 860

American Pilots Act to Form New Union

New York—American Airlines' 1,850 pilots may be formed into a new union called the Allied Pilots Assn. as a result of Air Line Pilots Assn. pressure to dissuade the pilots from negotiating a contract with American Airlines that would not require Americans' flight engineers to have commercial pilot and instrument rating (AW Mar. 18, p. 41).

Americans' contract provides for a reduction in jet crews from four to three men, with the flight engineers trained to assist the pilots in radio work and navigation. In return for eliminating the added training expense to American, the company has agreed to concessions for flight crews—primarily a reduction in monthly flight time from 85 hr. to 75 hr. ALPA has threatened leaders of the pilots negotiating committee with expulsion.

Americans' pilots' contract negotiating committee last week sent "authorization-to-act" cards to the pilots. Essentially, the cards would give the present pilots' negotiating committee power to consumate a contract with American regardless of ALPA's objections.

Temporary president of the new union would be Nicholas J. O'Connell, head of American pilots negotiating team. Cards are being sent only to Americans' pilots and not to any flight engineers. The pilots said they do not intend to solicit engineers membership in the new union but it will be opened to them should they want to join it. Provisions of the contract negotiated by the new union also would be open to the engineers.

Main purpose of the cards, according to the pilots, is to clarify that O'Connell and the negotiating team are the legitimate bargaining representatives of the pilots. If a majority of the pilots approve the authorization, the new Allied Pilots Assn. will schedule a meeting soon to draw up a constitution and bylaws and will make appropriate overtures to the National Mediation Board.

mi. Total range is reduced approximately 110 mi. for each stop. Three stops, for example, will give it a range of slightly over 600 mi. with full payload.

The DC-9 will carry 70 passengers in a single-class configuration, 65 passengers in a mixed class and 83 passengers in a total economy or tourist configuration. Passenger capacity of the BAC 111 is the same. Maximum seating capacity of the Caravelle Super B is 80 passengers.

Wing spans of the three aircraft compare this way: DC-9, 87 ft. 4 in.; BAC 111, 88 ft. 6 in.; Caravelle, 112 ft. 5 in. Over-all lengths of the planes are: DC-9, 103 ft.; BAC 111, 92 ft. 6 in.; Caravelle, 108 ft. 3 in. Heights are: DC-9, 27 ft. 4 in.; BAC 111, 23 ft. 9 in.; Caravelle, 29 ft. 5 in.

High Block Speed

Douglas says that high block speed will be attainable at all ranges of the DC-9. Assuming maneuver time to be 12 min., block time for a stage length of 200 mi. is 37 min. For a range of 800 mi., block time is 1 hr. and 43 min.

Placard speeds will permit high cruising speeds at short ranges and low altitudes. At 11,500 ft., for example, cruise speed is 468 mph.

Takeoff capability permits short-field operations. The DC-9 is being designed to take off from a 5,000-ft. runway on an 86F day at sea level with 70 passengers for a 475-mi. range segment. On a standard day, a DC-9 with the same payload can take off from a 5,000-ft. runway for a range of 600 mi.

Maximum landing weight of 73,350 lb. will require less than a 5,000-ft. field. Douglas estimates that normal landing weight will be about 65,000 lb., resulting in a corresponding reduction in landing field length requirements. The DC-9 landing approach speed is 130 mph. and corresponding stall speed is about 100 mph. It will be equipped with double-slotted flaps mounted on external hinges. No leading edge takeoff or landing devices will be incorporated into the configuration.

The DC-9 will be designed to operate at less than $1 per mile for all ranges in excess of 450 mi., based on the 1960 Air Transport Assn. cost equation. Direct operating costs per seat mile will be 1.34 cents with a 70-passenger arrangement, or 14,350 lb. payload, at ranges of about 800 mi. under high speed cruise. For shorter ranges, such costs are higher but slightly under two cents per seat mile.

The DC-9 electrical system incorporates a 400 cycle, three-phase a.c. electrical system. A 40-kva. brushless generator is mounted on each engine through a constant-speed drive unit. The system will also include two 50-amp. transformer-rectifiers to generate 28 v. d.c. power, and both systems will operate separately in a non-parallel configuration. In the event of failure of either the a.c. or d.c. system, power can be transferred by automatic controls from one to the other. The airplane will be equipped with batteries to provide 45 min. of emergency electrical power.

Standard navigation, communications and beacon systems will be installed in the aircraft, and additional space has been made for two HF systems, one Doppler and one tape recorder.

Both hydraulic systems will be equipped with an engine-driven pump and a backup electric motor-driven auxiliary pump. Fire-resistant Skydrol 500A fluid will be used at a pressure of 3,000 psi. During flight, rudder and spoiler subsystems operate at 1,500 psi. while brake, nose wheel steering, wing flap and gear retraction subsystems are completely depressurized after takeoff.

Main landing gear and nose gear are of conventional design.

Fuel Capacity

Fuel capacity of the DC-9 is 2,745 gal. Two integral wing tanks and two feed tanks under the center wing section will be installed. On the larger version of the aircraft, fuel capacity will be increased by the addition of another tank in the center wing section.

Two-spar construction will be used on the wing. Leading edge will have a wing box with three shear webs. Wing skins will be continuous across the load transfer area at the wing-fuselage juncture. Lower wing surface will be 2024-T4 aluminum alloy, and upper surface will be 7075-T6 aluminum alloy. Wing sweep is 24 deg., wing area is 925 sq. ft. and aspect ratio is 8.25.

Windows, 10 in. x 14 in., will be installed in every frame bay. Windows are machined panels with coined edges and coined attach holes.

Doors of the aircraft will have multi-locking devices.

Empennage is T-shaped with horizontal tail on the top of the vertical stabilizer.

The DC-9's horizontal tail is adjustable to provide a wider center of gravity range.

DC-9 Specifications

Crew	2 plus cabin attendants
Capacity	
Passengers	56-83
Cargo	600 cu. ft.
Dimensions	
Span	87.4 ft.
Length	103.0 ft.
Height	27.4 ft.
Wing area	925 sq. ft.
Sweepback at 25% chord	24 deg.
Tread of main wheels	17.6 ft.
Wheelbase (fore and aft)	42.5 ft.
Engines (2)	P&W JT8D-5 at 12,000 lb. takeoff thrust
Max. takeoff wt.	77,000 lb.
Max. landing wt.	73,350 lb.
Zero fuel wt.	64,000 lb.
Fuel capacity	2,745 gal.
Payload[1]	18,150 lb.
Level flight speed[2]	560 mph.
Rate of climb[3]	2,900 fpm.
FAA takeoff field length at max. takeoff wt.	5,320 ft.
FAA landing field length at max. landing wt.	4,980 ft.
Range[4]	1,100 mi.

[1]Space limited
[2]Max. cruise thrust at 25,000 ft.
[3]En route S. L. at takeoff wt.
[4]High speed cruise with 50 passengers.

Insurance Firm Investigation Is Asked

Washington—Civil Aeronautics Board enforcement attorneys last week recommended an immediate Board investigation of the possible influence exerted by major insurance and investment firms over Trans World Airlines and Pan American World Airways (AW Apr. 1, p. 41).

Acting on a complaint filed by Hughes Tool Co., the Bureau of Enforcement said there are "reasonable grounds" to believe that the airlines had violated provisions of the Federal Aviation Act in planning their merger proposals, as charged by Hughes Tool.

The company specifically contends that Metropolitan Life Insurance Co., Equitable Life Assurance Society, and Irving Trust Co. gained control of TWA without prior CAB approval. It further alleges that Dillon, Read and Co. and TWA officers conspired to obtain control of the airline for their own purpose, and that Pan American, through its president, Juan Trippe, and Metropolitan entered into merger negotiations with the express purpose of eliminating TWA as a competitor.

Noting that TWA and Hughes Tool Co. are now engaged in a series of legal actions, the Bureau advised CAB that it should first determine whether to exercise its own authority, since the issues are the same as those before the courts.

In addition, the Bureau also reminded CAB that it should re-examine its approval two years ago of a voting trust agreement under which control of Hughes Tool's 78% of TWA stock was placed in the hands of a voting trust, most of whom were selected by Metropolitan and Equitable.

OAS Studies Need for U.S. Aviation Aid

By Robert H. Cook

Washington—Latin America would receive more than half of all the aid money the U. S. plans to spend on aviation development throughout the world under proposals now being studied by the Organization of American States (AW Apr. 1, p. 38).

Under the current Alliance for Progress program, the long-range bill may climb even higher, as the estimates of four Latin American countries, which OAS declined to identify, indicate a need for U. S. grant and loan aid totaling $5.5 billion over the next 10 years. The sum includes highway, rail, maritime and air transportation projects.

Aviation continued to receive the lowest priority in the transportation field in this estimate, accounting for only 4% of the total, but the sum allotted—$218 million—is an indication of increasing interest in this field.

The significance of this figure, particularly since it involves only four of more than 20 South and Central American countries eligible for foreign aid, is more apparent when compared with the total U. S. foreign aid distributed last year for this purpose. In the form of direct grants and loans, the Agency for International Development (AID) allotted only $10.6 million for aviation development throughout the entire world. Of this total, Latin America received $2.6 million.

Expressed in another manner, the average $21.8 million desired by the four Latin countries through the next decade is double the total Fiscal 1962 foreign aviation aid bill, and nearly 10 times the sum allotted to all of Latin America.

Cost of Aid

While it appears that Latin America's requests for aviation aid may multiply several times, the ultimate cost may be considerably less if the U. S. adopts recommendations of the Clay Report that call for greater emphasis on repayable loans rather than direct grants, and stress the necessity for governments to fully justify and document their aid requests.

Leaning heavily on the prospect of increased foreign aid, the OAS is making a comprehensive study of Latin America's present and future air transportation needs. During a meeting of government civil aviation experts last month, OAS said, "special emphasis was placed on the need for the study to include the possibilities of obtaining the financing needed to promote the expansion of air transportation, within the system of financial assistance established under the Alliance for Progress."

Initial findings of the study which may be available by the end of this year, are expected to encompass the following areas:

- **Detailed inventory** of all existing equipment, installations, services and personnel.
- **Projection of future** needs in these areas.
- **Total cost of necessary** expansion and methods of financing.
- **Possibility of lowering** airline costs through consortiums or joint use of facilities and services.

The study will cover both domestic and international air transportation, and will analyze the economic effect on the industry of different markets, types of service, user charges, taxes, navigation facilities and International Air Transport Assn. fare structures.

The study pointed out that Latin America has at least one carrier for each country and 10 international airlines—including U. S. flags—competing in domestic and international markets. In view of this, OAS has placed particular emphasis on obtaining complete, accurate traffic statistics, "including true origin and destination data on passengers."

Ending Chaos

There is considerable doubt within the aviation industry that OAS can end the chaos that has characterized past attempts at an exchange of traffic data between the U. S. and Latin American governments, or among individual Latin American governments and airlines. Desire for national prestige has also thwarted several proposed mergers or pooling agreements, such as suggested recently by Aerolineas Argentina, Aeronaves de Mexico, Avianca of Colombia, Varig of Brazil and Viasa of Venezuela (AW Jan. 14, p. 45).

Domestically, there are strong indications that the OAS study will generate sufficient evidence to justify a substantial increase in U. S. aid for this purpose.

Federal Aviation Agency, which serves as technical agent for AID in aviation development projects, has long held that AID has failed to give proper recognition to the role of aviation in the economic growth of foreign countries.

A strong supporter of the OAS study, FAA contends that much of the Latin American air transport system is outmoded and needs to be overhauled. Particular emphasis should be placed on development of the countries' domestic airports and airways facilities as the most practical and economic means of improving their over-all transportation networks, the agency contends.

AID has no specific plans to expand the amount of aviation aid for Latin America, since most of the larger projects are nearly completed, but it agrees that if more funds are available, they should be channeled into improving domestic operations. The agency pointed out, however, that the individual governments concerned must first decide the importance of air transportation in their long-range economic development plans, and then justify this need in any application for AID funds.

Careful Evaluation

Against this background, many observers feel that the first, and greatest hurdle faced by the OAS will be convincing member governments to evaluate more carefully the cost of building and maintaining expensive highway, rail and maritime facilities as opposed to domestic airline services that may do the job at a fraction of the over-all cost.

The $5.5-billion estimate made by the four Latin countries for transportation development is an example of this problem, since 56% of the sum is earmarked for highways and 32.6% for railroads. Much of the highway construction planned would be in mountainous country where it might be far more economical and efficient to substitute air travel, these observers have contended.

"In other words, in most of the areas where large sums of Alliance for Progress funds are being used to subsidize highway facility construction, air transportation is more economical. Large investments of natural resources are now being made to finance extensive highway construction in areas where volumes of available traffic are so low that conclusive economic justification is precluded," OAS contends.

Highway transportation and development can be economically justified in well-populated areas over level and rolling terrain for distances of several hundred miles.

It is conversely impractical in mountainous country because of the circuitous routes, steep, twisting grades and daily cargo volumes too low to justify expensive construction and maintenance costs, the organization feels.

Domestic airline development projects that should be pursued include additional landing strips, communications, pilot and mechanic training, meteorology and weather forecasting stations, emergency lighting for strategically-located landing strips and other general aides to air navigation, OAS believes.

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Cargo capacity for this aircraft is 95,282 pounds over intercontinental ranges. An extremely large cargo door allows loading oversize containers. And a built-in, lightweight cargo handling system speeds on or off loading.

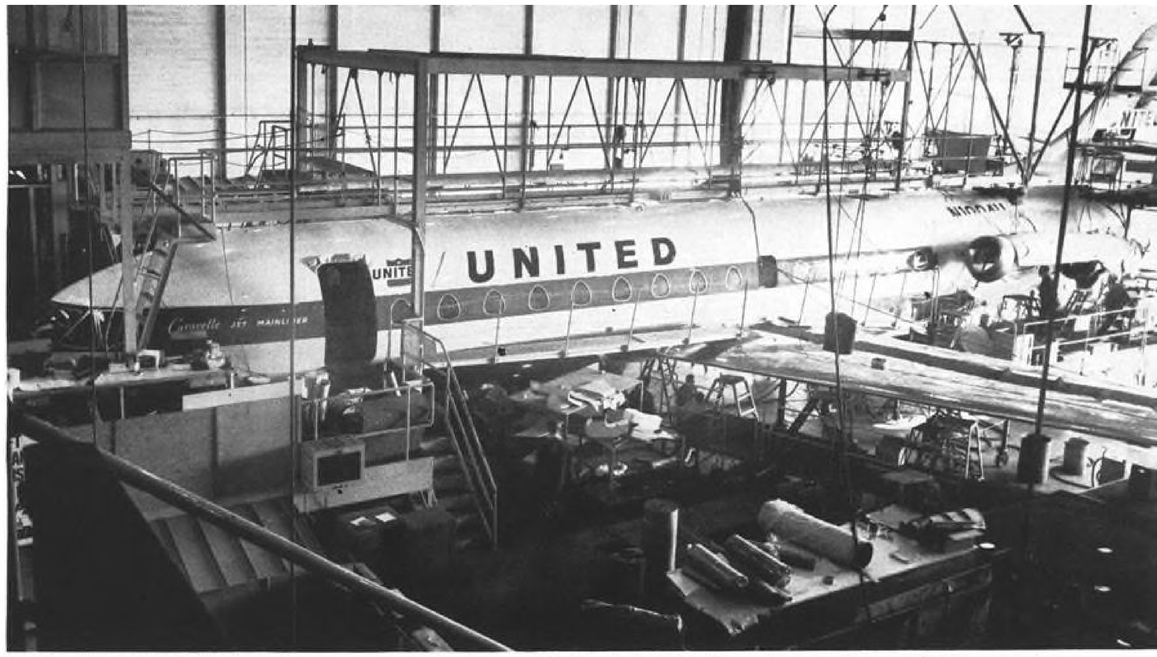
As an all-passenger aircraft, up to 189 persons can be accommodated.

There are 12 basic passenger/cargo combinations. Any of these can be arranged in less than 2 hours. Provisions are made for both bulk cargo and pallet cargo. Seats are track mounted for quick rearrangement. When cargo is transported, fold-down baggage racks protect the cabin windows.

The "Jet Trader" is available now for early delivery. It has been flying since November, 1962; has already been ordered by 6 airlines.

For detailed specifications, route studies, and performance information please address Mr. J. O. Moxness, Vice President Commercial Sales, Douglas Aircraft Company, Long Beach, California, U.S.A.

DOUGLAS AIRCRAFT DIVISION



UNITED AIR LINES CARAVELLES are currently undergoing modification in San Francisco prior to service introduction on medium-range routes in conjunction with Boeing 727s. Caravelle 1962 load factor was 57%, compared with United's 51.2% system-wide average.

United Plans Caravelle-727 Integration

By James R. Ashlock

San Francisco—Caravelle aircraft of United Air Lines are being programed to operate on medium-range routes in conjunction with all-first-class Boeing 727s, a plan which the carrier feels will reduce the French jet's operating costs through expanded utilization.

The Caravelles, which United officials acknowledge have been operating at direct operating costs (DOC) considered high for a twin-engine jet, are currently passing through their first major overhaul here. Twelve of the 20 aircraft have been overhauled, and the last will be completed about mid-July.

"The DOC on the Caravelles was $772 per aircraft hour in 1962," a United spokesman told AVIATION WEEK & SPACE TECHNOLOGY. "We originally thought it would be about $650 an hour, but that proved unrealistic."

He attributed the higher costs to short route segments, unexpectedly frequent engine changes and the special maintenance schedule drawn up for the Caravelles.

United feels the Caravelle will be a good partner for the 727s it now has on order. Like the Caravelle, the 727 will be an all-first-class airplane, which can be backed up by the Caravelle to ensure schedule reliability. The Caravelle is expected to receive enough extra work in this role to improve its daily utilization.

Average stage length of the Caravelle is currently 434 mi. Its average trip time has been 1 hr. 12 min., with a daily utilization of 5 hr. 6 min. on an average of 4.3 trips per day. Daily utilization has reached 8 hr. in peak periods. Hourly pay for the three-man cockpit crew has been $8 less than on United Boeing 720s and Douglas DC-8s in consideration of the Caravelle's lower gross weight.

"The DOC will probably come down to around $750 an hour with extensions of engine and airframe time-between-overhaul [TBO] and improvement of in-service reliability," Tom J. Richert, assistant to the vice president of engineering and maintenance, said. "But it isn't expected to go any lower so long as we operate the Caravelle as we are presently."

Despite its special problems, United feels the Caravelles have accomplished the purpose desired when the first one was delivered in February, 1960. Although they are operated as all-first-class, which reduces loads on weekends, the Caravelles' load factor in 1962 was 57%, well above United's system-wide average of 51.2%. Their revenue procural was the best of any United aircraft, off-setting somewhat their having the highest DOC in the fleet.

Caravelles have also enabled United to capture a good portion of the market in the competitive market between Chicago and New York. With them, United has a heavy schedule frequency into which the 727s can be integrated.

"The full potential of the airplane probably won't be realized until it goes to work with the 727," Richert said. "There should be plenty of occasions when it can be used for back-up or special-section support."

Caravelles will continue to operate on their present routes after the 727s are delivered, but United expects to gain some extra utilization of the airplane by using it for a backup or extra section airplane to the 727, in addition to its regular chores.

Caravelles have had to carry their own weight with United, often operating without benefit of jets to fill in for them when problems arise. Much of the on-line interruptions have originated with the Rolls-Royce Mk. 532R Avon engines.

In June-July of last year, the Avons were averaging 13 premature removals a month, or about 20 per 10,000 hr. of operation. Since then the average has dropped to nine removals a month. But this is still well below the reliability factor of United's Pratt & Whitney JT4A-3 and JT3D-1 powerplants, which average less than five premature removals each month.

P. A. Fruehauf, director of engineering operations, explained that many premature engine removals were the

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result of a peculiar "rotating stall" in the compressor section. Certain blades in the 17-stage compressor would stall, with the stall then rotating around the section and affecting other blades. This touched off a vibration in the tail section and necessitated engine removal.

Speculation exists that some of this problem arose from United's special specifications for the engine, which called for the addition of the 17th compressor stage to bring the thrust rating up to 12,080 lb.

To correct the problem, United initiated a 24-item modification of the engines, about half of which have been reworked. Carrier also asked pilots to minimize engine operation in the 5,000-6,000 rpm. range—the area where blade stall occurred most frequently. The modification involved primarily the alteration of clearance and tension tolerances in the compressor section and changes to the variable inlet guide vanes.

Vibration Frequency

United is also checking each compressor blade for individual vibration frequency, assuring that each is within prescribed tolerances. This check alone has caused a rise in costs attributable to the engine, United officials said.

The Mk. 532R on United's Caravelles is also the first of this series to be equipped with a thrust reverser, another of the carrier's specifications. Although the reverser has worked well except for some minor metal cracking, the maintenance of it has boosted costs above those reported by foreign users of the same engine.

United also experienced an unsatisfactory frequency of engine shutdowns initially due to false fire warnings. They were averaging one or two a week—a high rate for only 20 airplanes.

Caravelles came equipped with a Gravinier fire-warning system of European manufacture. United officials said the unit was overly sensitive to moisture variations, which touched off false warnings. Using components manufactured by Fenwall, United redesigned a custom system that included a repositioning of sensors. The modification cost approximately $3,000 per airplane, but false warnings have been reduced to tolerable ratios.

Engine vibration also necessitated a major strengthening of the tail assembly attachment during overhaul. Attachment bolts were found to have a limited fatigue life, and have been replaced by larger ones with no fatigue restrictions. Internal structure of the tail assembly has also been beefed up.

This was United's second round of concern with the Caravelle's vertical and horizontal stabilizers. Even before the aircraft were received from Sud Aviation, United insisted that the tail surfaces be strengthened against skin cracking due to sonic vibration. The surfaces were given an X-ray examination each 500 hr. during early operation, but this has been discontinued, since no damage became evident.

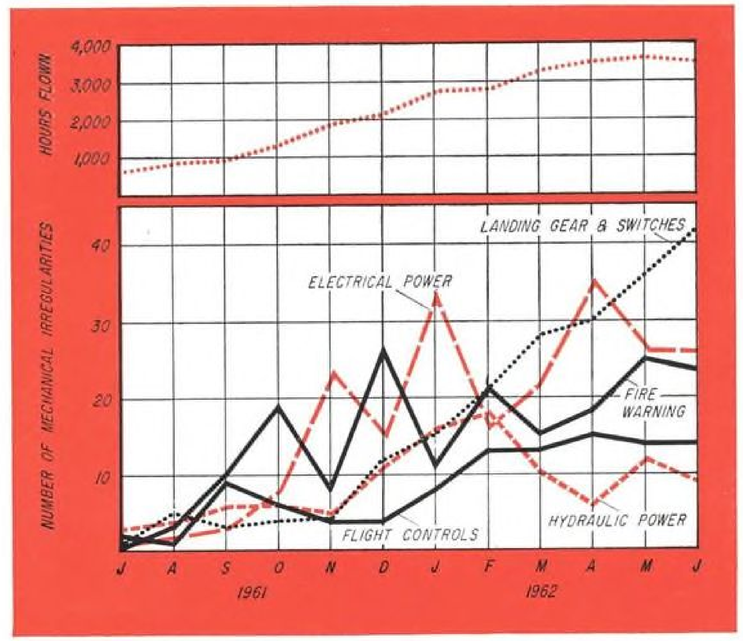


CHART REFLECTS five major areas of mechanical irregularities on United Air Lines Caravelles and frequency of occurrence during Fiscal 1962.

Two areas in which United anticipated difficulties, but which held up better than expected, were in the Caravelle's mechanical control system and in the area around the enlarged cockpit windscreen. Fruehauf said the fully powered control arrangement, which features four individual hydraulic systems, had performed flawlessly. Nor had there been any failures around the windscreen, where the fuselage structure was altered to give the crew 50% more visibility.

Some galling of shock and strut cylinders on the landing gear created problems, but none that affected reliable action of the gear. Because of the Caravelle's gross weight of 110,231 lb., the gear did not require the exotic, heat-treated metals that need special treatment on larger jets.

"The gear works beautifully," Fruehauf said. "We haven't had anything like the problems we experienced with our larger jets' landing gears."

United pilots have voiced general satisfaction with the Caravelle's handling characteristics, although some feel the engines are slow in coming up to full power, causing apprehension on minimum-visibility landings.

Preparation for the Caravelle overhaul program was the most intensive ever undertaken by United for a specific aircraft. Teams were sent to Europe to study the maintenance procedures of foreign Caravelle users. In classroom orientation, each man assigned to Caravelle maintenance was supplied with a pocket-size quick-reference device, designed by United, for converting metric units to English units. Some maintenance personnel were brought in from line points because they could speak French.

"In negotiations with the Federal Aviation Agency, we took advantage of other carriers' experience and gained a 3,000-hr. TBO on the airframe," Fruehauf said. "This was a precedent in the U. S., where 2,500 hr. is the usual starting point." TBO on the Avon engines started at 1,400 hr., but will go shortly to 1,600, Fruehauf said.

Parts Stockpiling

In stockpiling more than 14,000 separate parts and materials, United made widespread use of computers in determining frequency of parts use, proper delivery timing, advance ordering requirements and lead time needed by suppliers. Douglas Aircraft was the initial stockpiler of Caravelle components, but the role has been assumed by Pacific Airmotive since Douglas canceled out as Sud's U. S. representative.

"We actually over-supplied ourselves on Caravelle parts," Freuhauf said, "but we couldn't take any chances with supply lines extending all the way to France."

Sud's practice of supplying subcontractors with master jigs from the Toulouse plant has resulted in United's



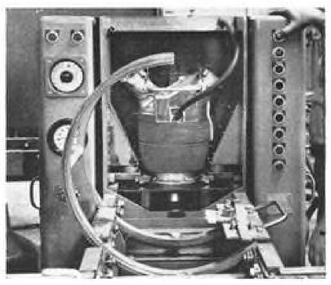
WHY A *SEMI-AUTOMATED* CYLINDER OVERHAUL LINE?

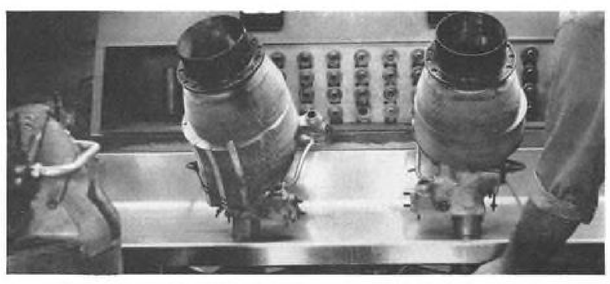
Because we still haven't found a mechanical substitute for the skill and judgement required for a high quality overhaul. There are too many variations to compensate for; almost every cylinder requires a different treatment. Airwork installed enough cylinder overhaul automation to sharply reduce the cost per cylinder . . . but retained all the stations where human judgement preserves the quality of individual cylinder overhaul methods.

For example, Airwork replaces all valve guides at overhaul. The new valve guides are reamed to exactly fit (within .0015") their mating valve stem. The valves are measured, then put in a special board that shows exactly which one goes with the cylinder being reamed. The operator mikes the valve stem, then selects the right size reamer from the more than 200 stored in the cabinet in the background.

To maintain accuracy, the normal .006" taper in the valve stem has been reduced to not more than .002" on a special honing machine before it reaches this station. The combination of a less barrel shaped valve stem and a more accurately fitted valve guide provides maximum protection against oil leaks.

Airwork uses automation to reduce the physical effort involved in handling 28-pound cylinders . . . but keeps all the skills a quality overhaul demands. This is progress —without loss of craftsmanship—one more reason an Airwork overhauled engine will provide a long, trouble-free operating life.





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receiving parts that are exact in every detail. This policy differs from that of many aircraft manufacturers, who merely give out specifications and let the subcontractor choose his own means of production.

"It's a real comfort to know the components you receive are ready to go right on the aircraft, and that they will fit," Freuhauf said. "This has saved us quite a bit of money."

Supply Coordinator

United also stationed a parts supply coordinator in France, but delivery proceeded so smoothly that he was recalled in March.

Sud still has two technicians at the United base here, and Rolls-Royce has eight technicians.

United wanted to keep the same team on Caravelle overhaul to gain maximum use of the group's learning curve. Thus it was decided to run the Caravelle's through overhaul one after the other, rather than stagger them, as are the DC-8s and 720s.

Drawing up the routing chart that would bring the Caravelles here in succession, United had to cut 700 hr. off the first aircraft allowable TBO so that the twentieth would come in when its airframe had logged 3,000 hr. Thus, only 83.2% of the authorized TBO time on the 20 Caravelles was used up before the overhaul cycle began. In comparison, United is able to use 91% of the time on its DC-8s through staggering their overhauls.

"But after this first overhaul, we'll schedule the Caravelles for overhaul on a pattern similar to that for the DC-8s, and we won't have so much throw-away time," Richert said. "The next overhaul cycle for them should come about September, 1964.

Since no Caravelles are scheduled west of Omaha, United used them as special-section aircraft on the Chicago-San Francisco route to minimize ferry expense. About six of the 12 that have come in for overhaul have flown here with passengers aboard.

All in-service line maintenance and periodic checks on the aircraft are performed at Chicago.

First aircraft spent 21 work days at San Francisco, where 18,500 manhours were consumed in the initial overhaul. United alloted an especially long period for the first overhaul to give the 160-man work team adequate time for familiarization.

Subsequent aircraft are coming in on Tuesday mornings and remaining for 11 days of overhaul and flight testing. Manhour requirements have been reduced to 8,500-9,000. Overhaul costs per airplane, including engines, are averaging $125,000.

"Any delays we've encountered in overhaul have usually come from irregularities revealed in post-overhaul flight tests," Richert said. "We've been slightly late on about half the airplanes worked on so far."

40 Modifications

About 40 separate modifications are being made during the overhaul program, ranging from minor items, such as fasteners and fittings, up to the strengthening of the tail assembly. Only noticeable change has been relocation of the rotating beacon, which was moved from atop the vertical fin to a point on the fuselage after the tail-area vibration was analyzed.

United officials said the carrier has no plans to dispose of the Caravelle, even though it is still considered an "interim airplane." Spokesmen said United needed the Caravelles to establish markets while awaiting delivery of the Boeing 727.

However, United left Caravelle depreciation on a 10-year basis when it advanced depreciation on its DC-8s and Boeing 720s to 14 years. Thus the Caravelle's hourly depreciation is $182 compared with hourly depreciation of $105 on the 720.

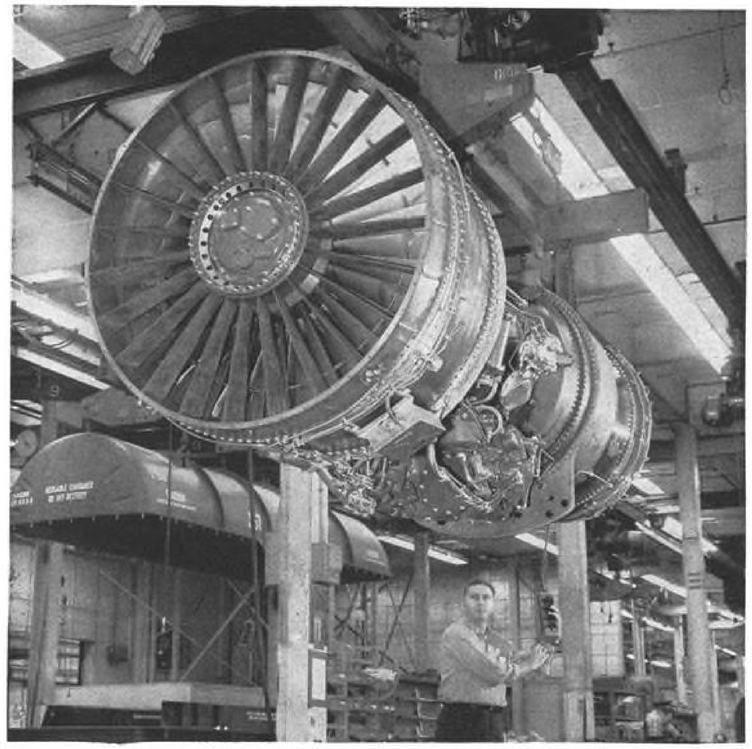
TWA Orders 320Cs

New York—Three Boeing 707-320C jet freighters have been ordered by Trans World Airlines, a move predicted earlier by Aviation Week & Space Technology (AW Apr. 1, p. 49).

Cost of the aircraft, including their American Machine & Foundry cargo handling systems, is $24,500,000. Of this sum, approximately $15 million may be supplied by lending institutions and the rest will come from the carrier's equipment budget.

A lease arrangement is also being considered by TWA.

Delivery is scheduled for April, May and June of 1964. Although they will be convertible to passenger use, the aircraft will enter service on transcontinental and transatlantic routes in all-cargo configuration.



USAF, FAA Approve TF33-P-7

Pratt & Whitney Aircraft's TF33-P-7, 21,000-lb. thrust turbofan engine which will power the Lockheed C-141 transport, has been approved by both USAF and the Federal Aviation Agency. First production engine already has been shipped to Lockheed-Georgia Co.

Soviet Hydrofoil Traffic

Moscow—Soviet Union expects to carry more than 2 million passengers on hydrofoil vehicles this year, a 50% gain over 1962.

Hydrofoils are being operated on the Volga, Dnieper, Ob, Irtysh and Amur rivers and other water ways in the USSR.



WITH THE SHORT HAUL JET

The BAC One-Eleven is on final assembly. It has already been ordered by: BRITISH UNITED AIRWAYS, BRANIFF INTERNATIONAL AIRWAYS, MOHAWK AIRLINES, KUWAIT AIRWAYS and CENTRAL AFRICAN AIRWAYS. Passenger appeal and low break-even factors make the BAC One-Eleven the first choice for all short haul operators. The BAC One-Eleven is the jet successor to the Viscount with even better than Viscount economics.

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BAS 33

AIRLINE OBSERVER

► United Air Lines has decided not to convert its entire Douglas DC-8 fleet to Pratt & Whitney JT3D-3 turbofan engines, after discovering it was more practical to retain the P&W JT4A-3 and -9 and P&W JT3C-6 turbojets for the bulk of its DC-8s. United has found a buyers market where it can purchase surplus JT4As, which have a thrust rating only 1,200 lb. below the JT3D-3 turbofan's 18,000 lb. Time-between-overhaul (TBO) on the JT4A will reach 4,000 hr. by Apr. 26, whereas TBO on the JT3D-3 is 2,200 hr. United feels the lower purchase price and maintenance cost will more than make up for the JT3D-3's fuel economy. When United's three Douglas DC-8F freighters are delivered with the JT3D-3s, the carrier's DC-8 fleet will consist of 11 aircraft with turbofans, 20 with JT4A turbojets and 10 with the JT3C-6 turbojet which, with 13,500 lb. thrust, is suitable on shorter DC-8 routes.

► Defense Dept. will continue to use private carriers for transport even after the current buildup of military airlift is completed, Defense Secretary Robert S. McNamara recently told the Senate Armed Services Committee, "because we feel the need for maintaining a reserve in the private air carriers' capability." Lack of long-range airlift "is probably the most important shortage today, the one we are seeking to correct by the airlift procurement program," he said.

► Trans World Airlines is faced with the return of $3,110,000 that a Civil Aeronautics Board examiner recently found had been overpaid to the airline for subsidy between Feb. 5, 1946 and Dec. 31, 1953. The 10-year-old dispute between the Board and TWA began in April, 1956, when the CAB held that TWA should have received only $42,942,000 in subsidy instead of the $51,095,000 it was granted. TWA has no reserve for the payment and may have to draw on general corporate funds if the repayment is required.

► Eastern Air Lines has begun a major effort to strengthen its passenger services, improve appearance of flight equipment and terminal facilities, streamline reservations procedures and improve flight operating efficiency. The campaign will cover 12 specific problem areas, each supervised by a top company official.

► Provision has been made in India's third five-year plan for the purchase of 30 medium-size turboprop transports—presumably the Avro 748 being built by license in India—to replace Indian Airlines Corp.'s Douglas DC-3 fleet. Purchase of four Sud Caravelle turbojet transports is still under consideration.

► United Air Lines will retire its 30 Douglas DC-7 aircraft this year. Three of them will be taken by Douglas aircraft when United receives the DC-8F freighters now on order. Carrier will continue operating the DC-6 fleet, including freight versions, which will supplement the jet freighters.

► Frontier Airlines is attempting to introduce a no reservation-type service under the title of "Go Show." The service, now being investigated by the CAB, would be provided between Denver, Phoenix and Tucson. Fares would be $30 to Phoenix and $40 to Tucson, for a $2.70 saving between Denver and Tucson. A seat would be guaranteed only when the passenger purchases a ticket at the airport at least two hours before flight departure. The airline estimates "Go Show" will earn an additional annual net profit of $41,518, based upon carriage of 2,721 passengers.

► American Airlines has proposed granting reduced fares to United Nations delegates and members of the U.N. Secretariat on a local standby basis similar to the reductions currently offered U.S. military personnel. National Airlines, in opposing the plan, argued that the same reasoning could be used to offer the fare reduction to "foreign embassies in Washington, D.C., the Organization of American States, American veterans organizations and/or the Daughters of the American Revolution."

SHORTLINES

► **Air Congo** has joined the International Air Transport Assn. as an active member.

► **Airport Operators Council** told Congress that supersonic transports must be able to operate from existing airports. The group said that aircraft must "be designed to fit the airport system, not vice versa."

► **Braniff International Airways** has completed installation of AiResearch integral auxiliary gas turbine starters on its fleet of Lockheed Electra turboprop aircraft.

► **Civil Aeronautics Board** has granted Pan American World Airways temporary exemption authority to serve Rabat, Morocco, and Conakry, Guinea.

► **Continental Air Lines** flew approximately 250 million revenue passenger miles during the first quarter of 1963, a 15% increase over the first three months of 1962.

► **Japan Air Lines** has introduced new four-day excursion tariffs on its domestic routes which will reduce fares as much as 20% on trips within Japan.

► **Martin Co.** saved $1,066,714 in travel expenses during 1962 as a result of its policy requiring employes to fly tourist class on company business trips.

► **National Airlines** reported a 15% increase in the number of passengers carried in March and a 20% increase in revenue passenger miles compared with the same month last year.

► **Pan American World Airways** will provide 104 nonstop flights per week between San Juan, Puerto Rico, and New York—a monthly capacity of 70,000 seats. Schedule calls for a concentration of flights on weekends when traffic is heaviest.

► **Pacific Southwest Airlines** has decided to take these steps in its modernization program: construct an electronic reservations control center, build a $500,000 facility for the overhaul of its turboprop engines and adopt a new ticketing system called Instant Ticket and a program of packaged California tours.

► **Scandinavian Airlines System** has purchased one Caravelle Mark 3 transport to bring the carrier's Caravelle fleet total to 19, four of which are leased to Swissair under the terms of a cooperation agreement. Terms of the purchase include trade-in of an SAS Douglas DC-7 transport to Sud.

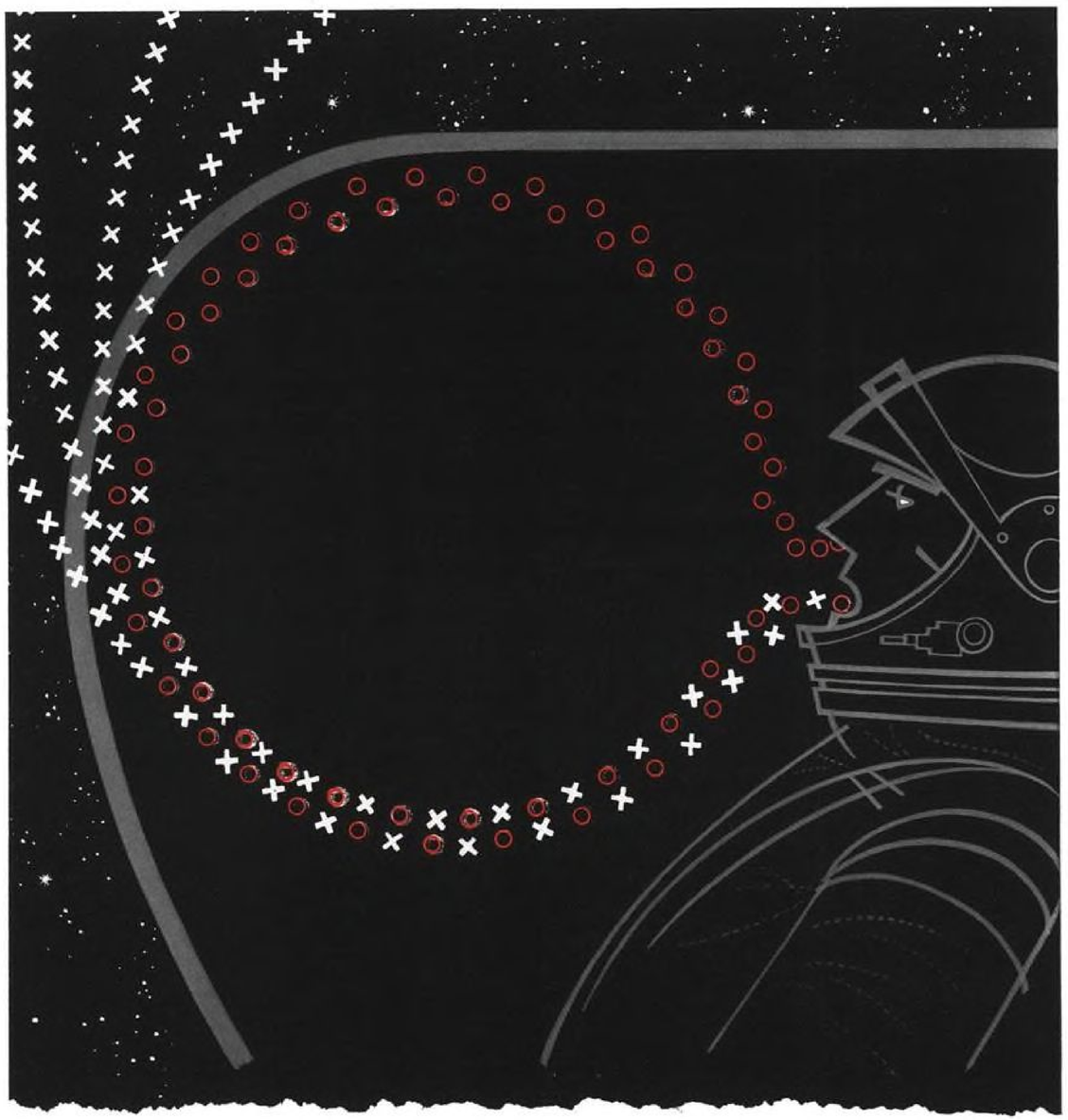


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Mars Mission Study Proposals Evaluated

Los Angeles—Competing industry proposals for a study of system concepts for a manned Mars landing-and-return mission are being evaluated at NASA's Ames Research Center, Moffett Field, Calif. Two parallel, fixed-price, nine-month contracts, not exceeding $100,000 each, are contemplated.

The projected analyses are part of the programed continuity for manned planetary exploration beyond the Apollo mission and anticipate these basic requirements:

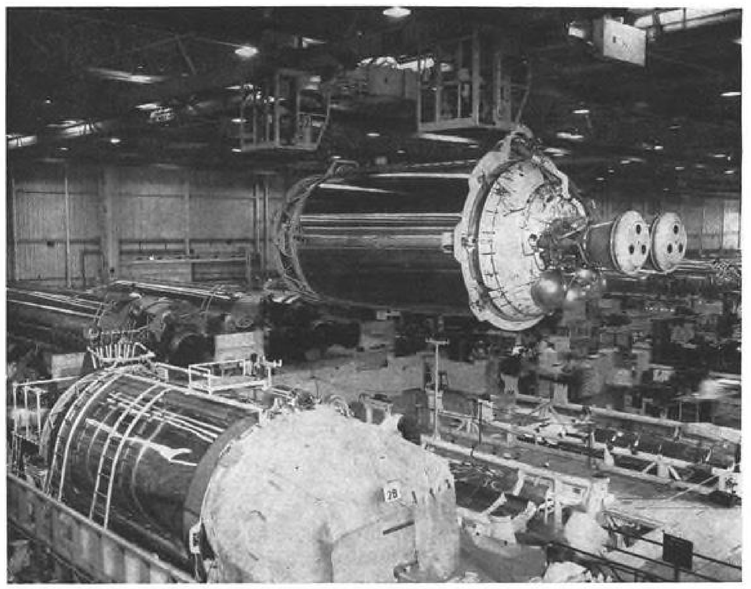
- **Round-trip,** simple-profile missions up to one year duration through cycle of oppositions from August, 1971, to July, 1986.
- **Crew of three** to six astronauts.
- **Stay on Mars** of about 3 to 20 days.
- **Exploration of Mars surface** for accumulation of scientific data in the immediate vicinity of the landing site, with possibility of excursions to other landing locations before return to earth.

Chief aim of the study will be a preliminary analysis to establish the technical feasibility and scope of the manned Mars mission. Relative evaluation of different system concepts will be performed and characteristics of the more promising procedures established to accomplish the goals will be studied. Technical problem areas, in which solutions will contribute significantly to probability of mission success, will be explored.

These various aims will include the following technical tasks:

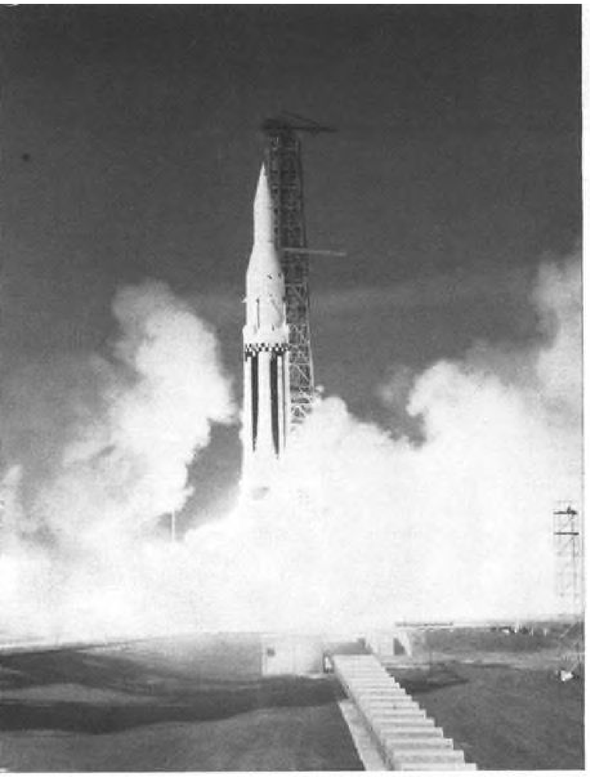
- **Exact trajectories** will be developed within limits of current knowledge of planetary positions and constants and computing techniques. This will include realistic analyses of effects of launch-time variations, injection errors, midcourse corrections, planetary orbital injections, rendezvous operations, atmosphere entry, landing and takeoff procedures, and plane changes for the return trip.
- **Trade-off studies** will be performed for the Mars orbital rendezvous mission mode, with or without an excursion vehicle, as compared with the direct-mission mode. This will include analysis of orbital plane change and rendezvous requirements for the various shapes, payload weights, and volumes involved.
- **Possible use of the atmosphere** and/or gravitational field of Venus will be studied to reduce total round-trip time and energy requirements for the Mars mission.
- **Use of a lunar base** will be considered to determine if assembly and fueling of propellant tankers, to be used for midcourse rendezvous with the manned payload from earth, will offer significant reduction of energy requirement for the Mars mission.
- **Varying the degree of closure** of the ecological cycle will be examined to determine effect on mission reliability, thermal control and power requirements, radiation shielding, and other necessary requirements. Use of a back-up system also will be investigated in the studies.
- **Natural environment,** with particular regard to meteoroids and solar protons, will be studied to determine protection requirements. Prediction processes will be ascertained to simplify or reduce protection requirements. For example, communication may be possible with artificial solar satellites monitoring the surface of the sun, or with unmanned probes preceding the Mars expedition by a short time to measure the meteoroid flux. Considerable amount of on-board material used for environmental protection may be available for the earth return trip, NASA suggests.
- **Task of maintaining** the crew's morale and physical condition will be examined. Display requirements and communications, guidance and navigation tasks will be analyzed to give minimum degradation in human performance.
- **Emergency return,** crew safety, fail-safe features, and backup modes will be considered.
- **Weight requirements** from earth-orbital speed will be computed for chemical propulsion systems for the 1971 opposition, for chemical propulsion supplemented possibly with RIFT-type graphite-core nuclear upper stages for the 1973 opposition, and for chemical propulsion with tungsten carbide-core nuclear upper stages for the 1975 opposition.

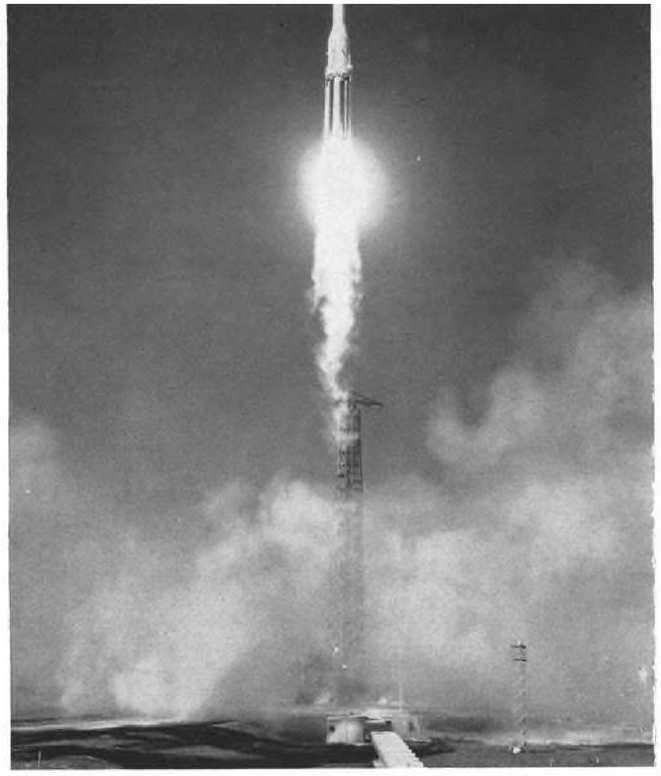
Concurrently with the manned Mars landing-and-return mission study, NASA is supporting a study of an unmanned spacecraft (Voyager) to perform orbiter-lander missions to Mars and Venus during 1967 through 1975 (AW Mar. 11, p. 302).



Centaur Shipped to Cape Canaveral

Flight-equipped Centaur space vehicle is lifted from the General Dynamics/Astronautics production line in San Diego prior to shipment to Cape Canaveral. Vehicle being lifted will be used for extensive ground tests with the Atlas launch vehicle. Neither the Centaur nor the Atlas currently is scheduled to fly, although both are flight-equipped. Next flight vehicle is 2B, shown in foreground. Shroud over aft section keeps interior clean while work is being performed on the vehicle.





SATURN SA-4 is shown lifting off Pad 34 at Cape Canaveral, Fla. Flight demonstrated vehicle's successful one-engine-out ability.

SA-5 to Fly First Live S-4 Upper Stage

By George Alexander

Huntsville, Ala.—Marshall Space Flight Center, with four successful Saturn booster flights to its credit, is turning its attention to the flight this August of the first hydrogen-fueled upper stage.

S-4 second stage will be flown atop Saturn SA-5. There is a strong possibility that this flight might occur before the second Centaur upper stage can be flown aboard an Atlas. Centaur also is scheduled for August.

S-4 stage, built by Douglas Aircraft Co. and powered by six Pratt & Whitney RL-10 engines rated at 15,000-lb.-thrust each, will carry a full propellant load of 100,000 lb. The stage will burn for 460 sec. and inject itself, a guidance and instrumentation module and a ballasted dummy payload into an elliptical earth orbit ranging between 125 and 250 naut. mi.

Saturn Payload

Entire weight in orbit will be 33,000 to 35,000 lb., the heaviest yet orbited by the U. S. (AW Apr. 1, p. 32).

Payload also will carry one, or possibly several, tape recorders with voice messages. There is considerable speculation that one of the voices will be that of President Kennedy, repeating a similar experiment done with former President Eisenhower's voice in Project Score in late 1958.

SA-5 booster will be the first of the Block-2 Saturn S-1 stages to be flown. Block-2 vehicles (AW July 2, p. 117) feature the uprated H-1 engine at 188,000 lb. thrust—compared with the 165,000-lb.-thrust H-1s in Block-1 vehicles, increased propellant capacity and stabilizing fins. The booster will carry a full propellant load of 850,000 lb. and will be programed to burn for 140-150 sec.

Flight also will be the first staged from Complex 37, the second Saturn launch complex built at Cape Canaveral to date by the National Aeronautics and Space Administration.

Preliminary data analysis of the fourth Saturn (SA-4) flight (AW Apr. 1, p. 32) indicates that it was one of the most successful launches to date in the test program. Launched Mar. 28 from Stand 34 at Cape Canaveral, SA-4 reached a peak altitude of 80 stat. mi., a velocity at burnout of 3,662 mph., and a distance of 232 mi. down the Atlantic Missile Range.

Velocity was about 33 fps. higher than anticipated, giving added credence to Marshall's growing belief that the propulsion system of eight H-1 engines is developing more than the calculated 1.32-million-lb. thrust. Greater thrust is believed to average out to 1% over the course of the flight trajectory.

Higher-than-expected thrust would also explain shut-down of the four inboard engines at 112.9 sec., rather than the anticipated 114 sec. With all eight engines burning normally and supplied with 625,000 lb. of propellant, cut-off of the four engines would have occurred at T + 112 sec.

Engine Shut Down

However, an engine was deliberately shut down at T + 100 sec. to test the S-1 stage's engine-out capability. Marshall engineers expected the burning time of the other seven engines to be extended an additional two seconds, or until T + 114 sec.

Outboard engines shut down after 120.5 sec. of flight, when all liquid oxygen was depleted. This was the same shut-down sequence used on SA-3 (AW Nov. 26, p. 32). Oxidizer depletion probably will not be employed again until SA-7, because of the importance attached to testing of the S-4 stage.

Possibility exists that this method of shutting down the S-1 might induce oscillations in the S-4 during separation.

Engine-out experiment was described by one Marshall engineer as "remarkably uneventful." No. 5 engine, an inboard, was shut down at T+100 sec. by a timer, and the propellants that normally would have been consumed by this engine cross-manifolded to the other seven engines.

There were no indications of any disturbances in SA-4's trajectory caused by the sudden loss of one engine, nor were there any significant movements by the outboard control engines to compensate for its loss.

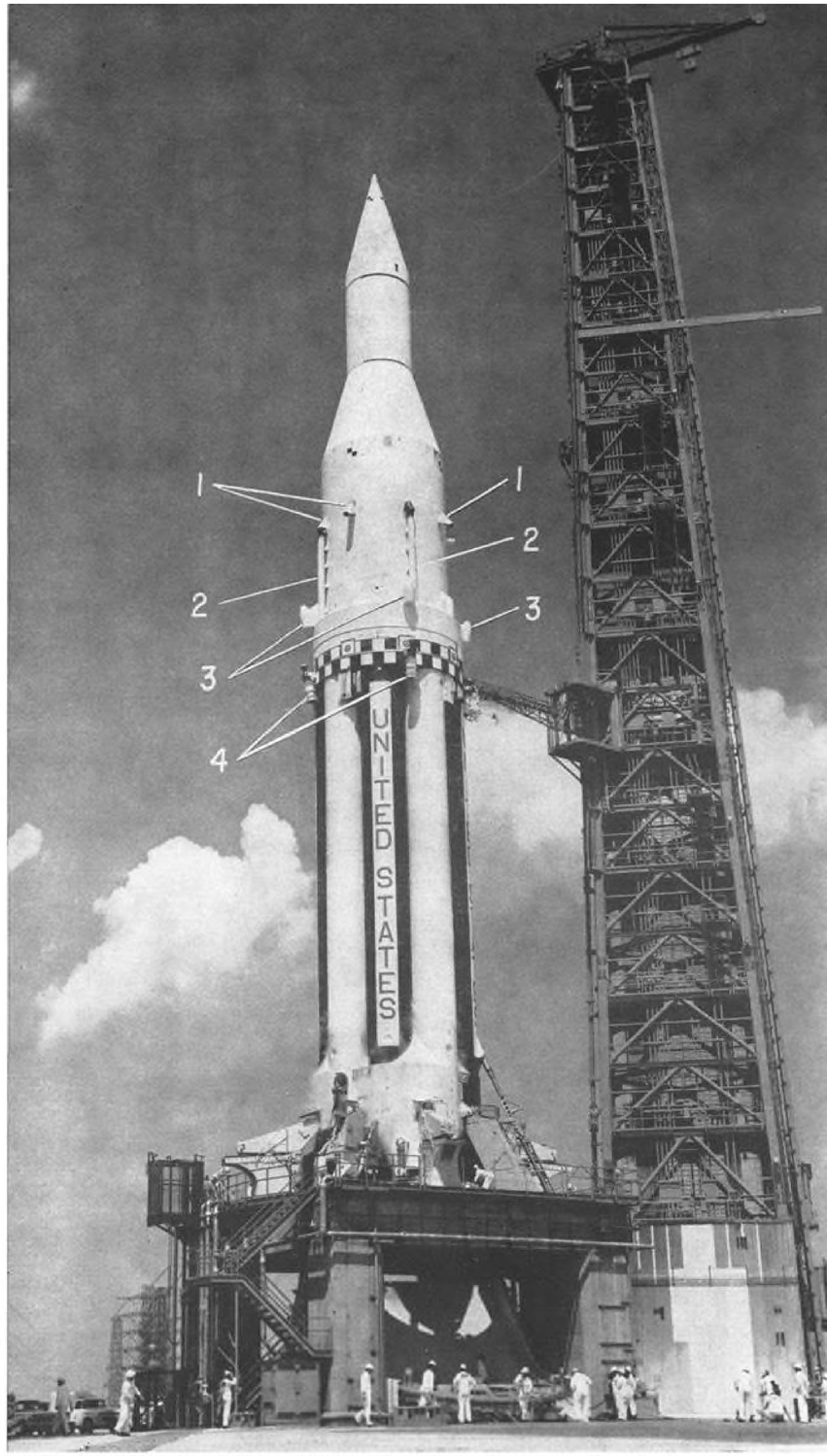
SA-4 also upheld the good instrumentation record established by the three previous Saturn flights (AW Dec. 3, p. 23). Otto Hoberg, chief of the Instrumentation Development Branch of Marshall's Astrionics Div., said that of 612 in-flight measurements carried by SA-4, only four were total losses. Eleven other measurements were not clean, but are believed to be statistically recoverable through interpretation with other data.

Hoberg said that the Ampex Corp. MR-100 airborne tape recorder also operated satisfactorily. The recorder was started at liftoff and ran until T + 155 sec., or about 30 sec. after burnout of the S-1 stage. Only that part of the flight between T + 98.3 sec. and T + 152.4 sec., covering the engine-out experiment through burnout of the retrorockets, was played back. Playback was initiated at T + 164.4 sec.

Tape showed that radiation effects from the retrorockets' exhaust lasted about 5 sec. after the 2-sec. burning of the small solid-propellant motors. Recorder performance was considered of equal importance to the playback of data.

All 10 telemetry links, the General Electric Co. Mistram transponder and the Ryan Aeronautical Co. L-band radar altimeter also worked perfectly, according to Hoberg. The radar altimeter provided about 20 sec. of data which can be compared for accuracy against that furnished by the Azusa and Mistram systems.

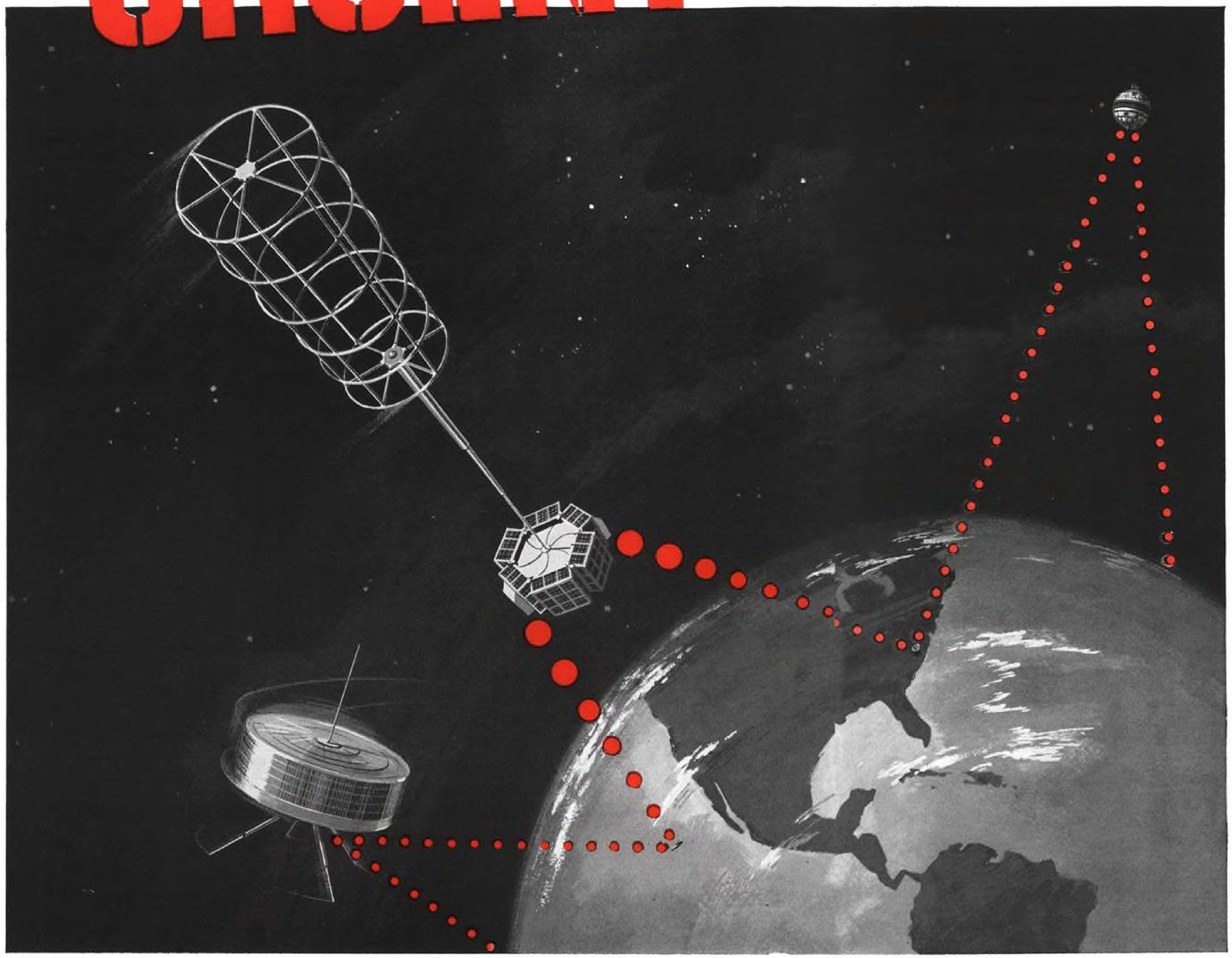
Two control accelerometers, which replaced the angle-of-attack sensors used on earlier Saturn flights, also operated satisfactorily. These are conventional spring-mass accelerometers; they will be used on operational Saturn 1 vehicles in pitch and yaw axes to detect lateral loads greater than 1g. There analog outputs will be mixed in the control computer, as they were on SA-4, with signals from the stabilized guidance platform to turn the vehicle into strong winds and thus alleviate broadside forces.



POISED AT COMPLEX 34, Saturn SA-4 is shown during final preparations for launch. Detailed in photo are (1) ullage rockets, (2) cable tunnels, (3) S-4 retrorockets, (4) S-1 retrorockets. SA-4 was launched at 3:11 p.m. EST on Mar. 28. Engine No. 5, one of four inboard powerplants, was shut down by a preset timer after 100 sec. of flight. SA-4 carried dummy, water-filled S-4 and S-5 stages and a dummy nose cone. Having achieved four successful Saturn booster flights, Marshall Space Flight Center is focusing its attention to SA-5 which will contain the first hydrogen-fueled upper stage in the series.

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NASA Favors Deployable Stations For First-Generation Space Study

Dallas, Tex.—Space station which will be capable of accommodating 15-18 men, in an orbit 200-300 mi. from the earth for a duration of from 3-5 years, is in the current state-of-the-art and could be launched from Cape Canaveral by a Saturn 5 in the late 1960s, according to Manned Spacecraft Center space station program manager Edward H. Olling.

Olling described numerous configurations under study by MSC, Langley Research Center, USAF and industry, and stated that there had been sufficient study to indicate the feasibility of such a station as a space laboratory.

He indicated that earlier concepts, such as inflatable structures (AW Aug. 20, p. 99), do not look very promising because of the problems associated with fitting the necessary crew support and laboratory equipment and packaging the deflated structure as well as the attendant complexity of inflating such a structure in space.

Three-spoked MSC configuration described by Olling would be faired into the top of a Saturn 5 and be compatible with this launch vehicle. Three-man crew would ride in a command module atop the station, which would consist of three wing-like spokes folded downward. Once positioned in orbit, the station would be deployed by the crew. Equipment then would be checked out and the station would be ready to accept additional personnel. These might be ferried to the station in groups of six in modified "bus" configuration Apollo command modules having two rows of three-abreast high-density seating.

Rendezvous and personnel transfer would be via a centrally located hangar capable of housing four Apollo buses simultaneously and configured so that the buses could be checked out inside the hangar in a shirtsleeve environment. Buses would be designed to be reusable for as many as a half-dozen ferry missions.

Three-spoke configuration would have a radius of approximately 75 ft. deployed and could incorporate rotation capability of approximately 4 rpm. to provide varying degrees of artificially induced gravity along the lengths of the spokes. Spokes would be modularized to provide separate laboratories, rest, nutrition and waste areas. Centrally located hangar and command and control module could be designed to remain stationary while the spokes rotated.

Olling indicated that the personnel complement for the first six months might comprise six men, 12 men after this period and 18 men after a year in orbit—rotating personnel every 90 days when the full complement is aboard the station.

Space station of this capacity would be capable of handling detailed long-term experiments on human, animal and plant life subjects in an environment of varying degrees of weightlessness. On human and animal subjects this would include clinical studies of metabolism, cardiovascular effects, bone demineralization, muscle atrophy, semi-circular canal phenomena, and cell nutrition. In the case of animals and plants, experiments could be continued over periods of time permitting breeding and heredity studies of these and other space-environment associated experiments, which would be extremely valuable in future long-duration planetary missions, Olling noted.

Station of this size also would be useful as a landing point for returning manned spacecraft where astronauts and their vehicles could be checked out and if necessary, quarantined, prior to their return to earth.

Olling considered that design and operation of such a facility, which would have an estimated 40,000 cu. ft. volume, would be a less stringent problem technically than Apollo, considering that it need not incorporate that program's complex navigation and guidance, lunar landing module and re-entry requirements.

He also considered that first-generation space stations would be of the deployment type, rather than "tinker-toy" configuration requiring boosting prefabricated assemblies in space separately and assembling these in orbit, due to lack of experience and knowledge of latter procedures and requirements. Such space-assembled configurations probably would be utilized in second or later generation stations and where structures of considerably larger size would be considered necessary.

Fibrillation Unit

Washington—Unit designed to stop "ventricular fibrillation," the condition that took Astronaut Donald K. Slayton out of the U. S. manned space flight program, has been added to its medical products line, the Westinghouse Electric Corp. announced recently.

Westinghouse said the 31-lb. unit uses an electric shock to restore the heart to a rhythmic beat. Ventricular fibrillation is uncoordinated quivering of the heart's muscle fibers.



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DENVILLE, NEW JERSEY

Apollo, Gemini Simulator Variety Planned

By Erwin J. Bulban

Houston, Tex.—Gemini and Apollo training and simulation facilities planned by National Aeronautics and Space Administration will comprise approximately 24 types of devices ranging from comparatively simple mockups to complex computer-driven equipment.

Missions will provide astronauts with practice in entering and escaping from spacecraft, experience in working out real-time lunar mid-course navigation problems, and will assist in developing an acclimation to extra-vehicular activity.

Some devices are already available—such as the high-speed jet fighters used for providing brief zero-g familiarization. Others are in the proposal stage or are being evaluated from industry prior to announcing a contractor, and some are still undergoing study.

Gemini and Apollo flight trainers will be designed to acquaint astronauts with the following:

- **Appearance and modes** of operation of all instrument displays, switches and control systems.
- **Out-of-the-window displays** which can be reasonably anticipated and simulated.
- **Detection and correction** of as many anticipated systems failures as can be calculated.
- **Dynamic response characteristics** of the spacecraft as shown by flight instruments and out-of-the-window displays for spacecraft motions caused by either automatic or manual control systems.
- **Over-all mission timing** and practice of specific tasks contained in particular mission flight plans.

Flight trainers are considered the most important, and probably will be the most costly, of all the training items to be used in the Gemini and Apollo projects, according to Howard I. Johnson, technical assistant to the chief of flight operations, NASA Manned Spacecraft Center, Houston.

Costs can be kept down, he believes, in that actual physical translational and rotational spacecraft motions will not be simulated. This omission is based on comments by Mercury astronauts that display motions alone in fixed-base simulators are a surprisingly good approximation of combined instrument and body motions under weightlessness in space. Launch and re-entry linear accelerations can be reproduced satisfactorily as a part-task on a centrifuge.

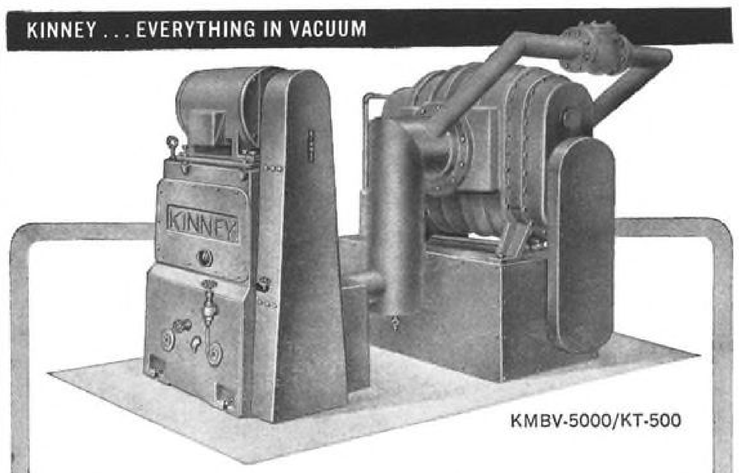
Flight trainers will have active interior displays operating as an analog of actual spacecraft equipment. Hybrid analog and digital computers will simulate onboard systems and spacecraft response characteristics. Long-term navigation calculations, requiring low or no computer drift will be handled by the digital computer as will most simulation of onboard systems for which discrete actions or failures require certain discrete responses.

Analog computers will be used for short-term high-response applications and for analog instrument readouts where small errors are not particularly important, or where the analog readout can be periodically corrected either by the digital computer or by an instructor.

Out-of-the-window displays have not yet been fully decided, Johnson states. The Gemini trainer will probably have a fairly accurate visual display of the celestial sphere, a display of the rendezvous vehicle and a display of earth partially covered by clouds.

The Apollo trainer will probably have, in addition, a display of earth and the moon from a wide range of distances and a detailed display of the moon from close orbits. The Lunar Excursion Module (LEM) trainer will probably have a celestial presentation and a lunar dis-

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The tiny Beckman Sensor shown here weighs a scant 2 grams, but withstands 50 g's as well as severe vibration. Working on an electrochemical process, response is rapid. In less than one second it detects a change in the oxygen partial pressure. The electrolytic cell that does the work lasts up to three months. Easily calibrated in air, it can be replaced in seconds.

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play ranging from close orbits to certain selected landing sites.

One of the more difficult tasks now appears to be providing good out-of-the-window displays. Under study are new methods of producing these images electronically.

Two each of the Gemini and Apollo flight trainers are expected to be procured, according to Johnson. One of these, for early generalized training will be located at the Manned Spacecraft Center, and the other, for specific flight training, will be located at Cape Canaveral.

Gemini part-task trainer is a modification of the MSC-based Mercury procedures trainer, the plan being to reprogram the computer to represent Gemini dynamics and set up a rendezvous task based on a new out-of-the-window display which may develop into a complete display system applicable to both Gemini and Apollo flight trainers.

Apollo part-task trainer system will possibly include three static units: the earth launch and re-entry trainer, the navigation and trajectory control trainer and the orbital and rendezvous trainer. A study is now being made to determine whether costs can be pared by combining these functions into two or even possibly one trainer.

Trainer Work Load

Part-task trainers will be included since their lesser complexity, compared with flight trainers, will permit earlier acquisition and use. They will eliminate some of flight trainers' work load. They can provide more accurate simulation in some particular mission phases than the flight trainers, and crew operational problems can be studied involving variation in simulation parameters that cannot be handled in the flight trainers because of their design features or unavailability.

Gemini and Apollo centrifuge programs will utilize the Navy's Air Development Center equipment at Johnsville in a pattern developed in the Mercury program. A human centrifuge is also planned for MSC at Houston, which will be approximately the same size as the Navy's unit, but will have lower design maximum acceleration level of not more than 30g. MSC's centrifuge will also feature an increase in maximum payload and the volume of the gondola will be approximately three times greater, so that at least three men and necessary equipment can be tested simultaneously.

Egress trainers will normally be boilerplate mockups of the Gemini and Apollo spacecraft having accurate reproductions of recovery equipment and escape paths. They will be accurately scaled in center-of-gravity and total weight so that their hydrodynamic behavior will match that of the actual spacecraft. Later in the programs, it may be possible that actual spacecraft that have flown may be used for this training, Johnson notes.

The Gemini paraglider trainer, consisting of a boilerplate spacecraft attached to a prototype paraglider, providing landing practice after release from a helicopter, is scheduled to be delivered to MSC from Edwards AFB. Practice will be carried out at Ellington AFB, Houston.

LEM Trainer

The LEM trainer, to be developed on the basis of research and development with Bell Aerosystems' research vehicle (AW Feb. 25, p. 78) will include an accurately scaled mockup of the Grumman crew module with simulated braking and control rockets and a jet engine that will produce lift equal to $\frac{5}{6}$ths of the LEM's weight to simulate a lunar gravity environment. The astronauts will utilize the trainer in free-flight from the ground to various altitudes and practice attitude control, translational control and spot landings. Prior to this they will receive primary training in the large lunar landing facility, employing a tethered spacecraft suspended from an A-frame being procured by Langley Research Center.

The Gemini docking trainer is a large six-degrees-of-freedom moving base simulator having a full-scale Gemini spacecraft mockup with four of the six degrees of freedom: ±45-deg. rotation in pitch, yaw, and roll and 24-ft. in lateral translation. The Agena vehicle will also be simulated accurately and have the remaining two degrees of freedom: ±16.5-ft. of vertical translation and 102-ft. of range translation. Initially this simulator will be utilized by McDonnell, prime contractor on Gemini, to solve actual hardware problems associated with docking and latching phases of the rendezvous mission and it will then be released for Gemini astronaut training.

Later it probably will be converted to an Apollo docking simulator, Johnson reports.

Gemini Trainers

Gemini systems trainers, built by Burtek, Inc., Tulsa, Okla., are animated breadboards of some of the actual spacecraft onboard systems, using flow-path indicating techniques to show which components are activated when any particular input control is actuated. These are designed to provide the astronauts with speedy familiarization of spacecraft systems. Simulators will include electrical system, including sequencer and pyrotechnics circuits, environmental system, ejection seat system and attitude maneuver control systems.

Apollo simulators will also include a

need

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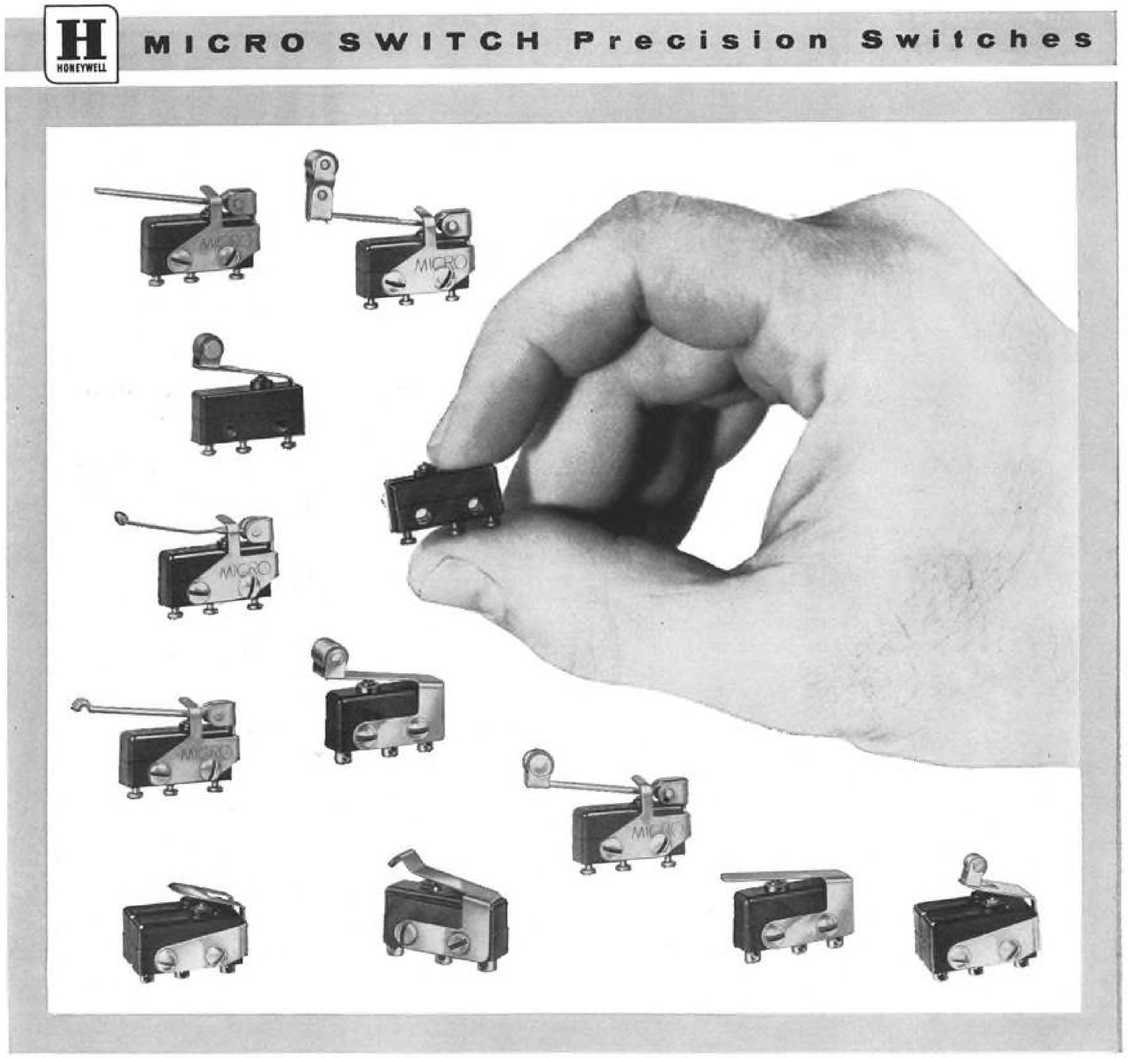
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three-dimensional lunar trajectory simulator—still in the early proposal stage—which will show in true scale except for spacecraft size, the relative dynamics of earth, the moon and the spacecraft system.

The earth model will be approximately 1-ft. dia., requiring a building approximately 70-ft. dia. to house the entire display. Earth will rotate about its own axis; the earth-moon system will rotate about its total center of gravity, which will be located at the center of the building. The lunar orbital plane will always be horizontal at eye-level.

Collimated light from the proper direction will fall on earth to represent the sun as seen from earth, with an internal light shining past a hemispherical movable shade to represent the sun's illumination of the moon. A model, in the form of a cone whose apex would represent the position of the spacecraft, probably will be used.

Television Presentation

The spacecraft will have three degrees of translational freedom to permit the trajectories of actual Apollo missions to be traced. Motions of the spacecraft would be in response to computer or taped commands. These commands could be speeded up by a factor of 1,000 to demonstrate a complete Apollo mission in approximately 10 min.

Because of the display's size, it could be viewed from an outside-in or inside-out position.

During actual Apollo missions, the display would be driven to keep pace with the mission permitting television presentations to be made to a worldwide audience.

The Apollo mid-course navigation simulator, still in the developmental stage by Ames Research Center, would consist of an Apollo command module mockup mounted on an air-bearing in a hemispherical domed room of about 50-ft. radius.

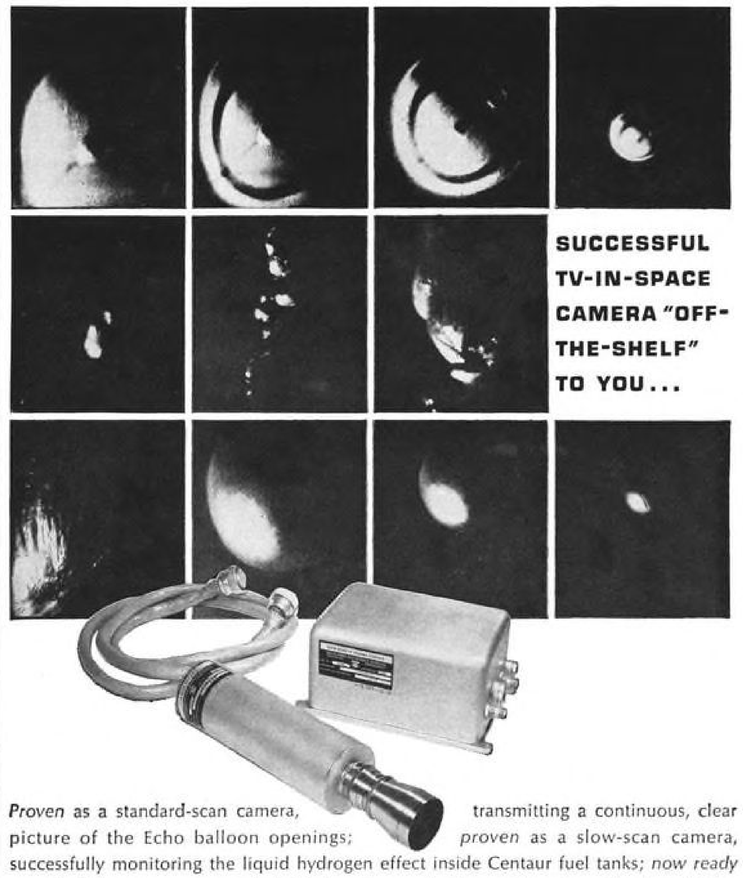
Simulated stars would be fixed on the dome's surface to provide the necessary high accuracy needed for practice of sextant operations during the mid-course navigation phase.

Future Facilities

Possible training facilities for future space flight projects include an extravehicular operations trainer on which NASA currently is doing studies. This equipment would permit simulation of the problems facing an astronaut away from his vehicle. This would include simulation of partial gravity tasks, such as walking on the surface of the moon and moving in space from or toward a spacecraft and performing repairs or assembly of components in space outside the vehicle. Such space activities would enable the astronaut to practice space motion using muscular power or strapped-on propulsion units.

As visualized in one study, the simulation complex would consist of a structure enclosing an area of approximately 100 ft. x 100 ft. x 200 ft., although smaller areas are also being considered. A dynamic support cradle will possess six steerable driven wheels. The wheels would operate against the inside surface of a hemisphere so that the dynamic cradle can have unlimited angular rotation about any axis without encountering gimbal locks.

The cradle would be shaped to provide a clear inner space so that it could accept spacecraft including an Apollo command module and would have onboard power in the form of a gas turbine engine driving a hydraulic pump—the wheels being driven and steered by hydraulic power. The spacecraft would be integrated with the cradle to the extent that thrust commands from any of the spacecraft control systems would be fed to the cradle computer, causing the cradle to rotate as it would in space. This would provide astronaut familiarization with the dynamic response characteristics of the spacecraft and acquaint the crew with any possible eccentricities of the spacecraft's attitude-indicating display systems.



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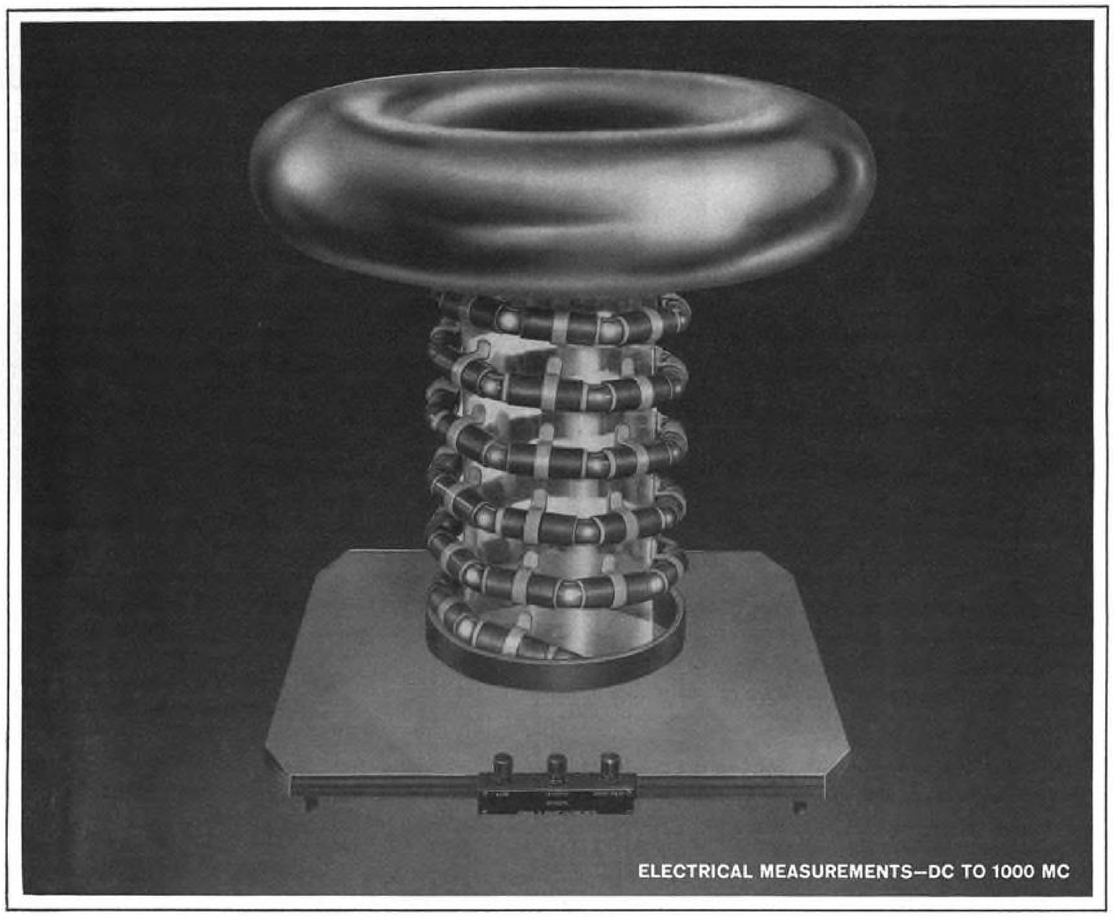
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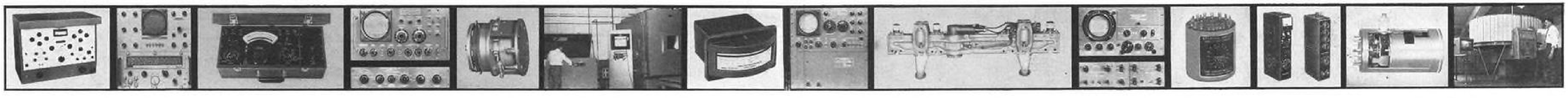


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Prospects Slim for Mach 3 Interceptor

By Philip J. Klass

Ent AFB, Colo.—Air Defense Command's hopes for Defense Dept. approval of a new Mach 3 improved manned interceptor (IMI) received scant support from Defense Secretary Robert McNamara in recent testimony before the House Defense Appropriations Subcommittee. McNamara called the program "questionable."

While McNamara's testimony revealed Defense Dept.'s intention to develop the capability to destroy bombardment satellites in case the Soviet Union should adopt such weapons, indications are that Army's Nike Zeus missile will form the backbone of this capability rather than Air Force's proposed manned satellite interceptors.

The Pentagon also takes a dim view of Air Force proposals for ICBM defense systems that would use large numbers of satellites for intercepting enemy ballistic missiles. Arguments that are used against the utilization of satellites are: extremely high cost, vulnerability to enemy countermeasures and the unreliability of complex spacecraft.

Nike X Emphasis

Instead, Defense Dept. is putting its ICBM defense emphasis on the new Nike X, for which the Army is the responsible agency.

There are mixed opinions here on the seriousness of the threat of hostile Soviet military action from space, but the recent sharp cutback of USAF's Satellite Inspector (Saint) program was still another blow to ADC's future role.

Add to this the current study of how to economize at ADC, ordered by Defense Dept., which is expected to trim the present force by at least 10%, and it is easy to understand why there is an atmosphere of uncertainty and frustration evident at ADC headquarters.

The command's current inventory of about 900 Convair F-106 and McDonnell F-101 interceptors would be no match for supersonic bombers, and even this capability is being cut by roughly 8% per year by accidents and other attrition.

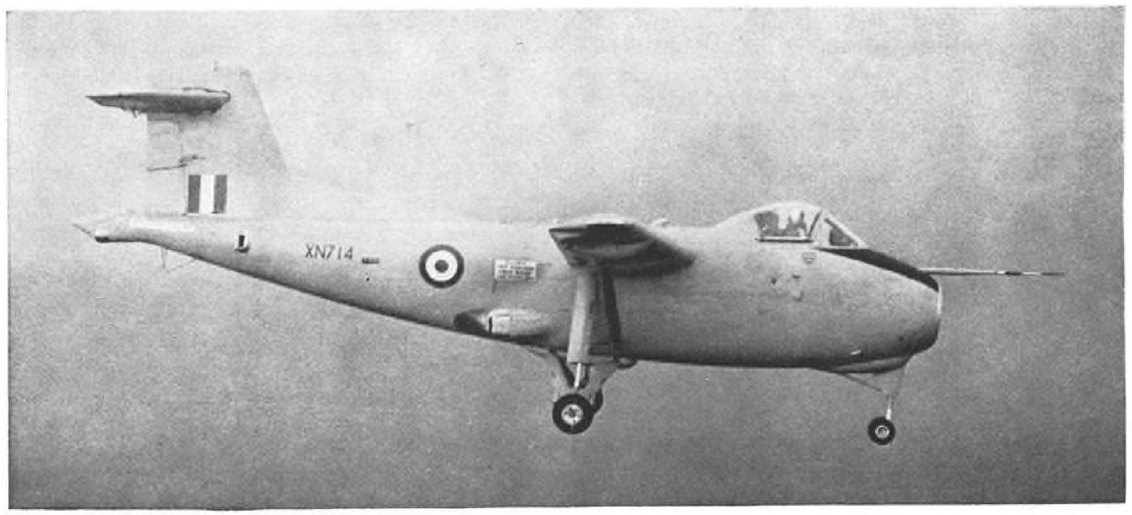
Both ADC and the North American Air Defense Command (Norad)—the U. S.-Canadian joint service command located here—have so far resisted the temptation to bolster their current capability with an interceptor version of the new McDonnell F-4C or the Navy's F-4B (formerly F4H) in the hope that a Mach 3 interceptor would be developed instead.

High Morale

In two sectors of ADC headquarters, morale is extremely high—ballistic missile early warning and space surveillance (AW Feb. 18, p. 89). Yet, where early warning once was only a means toward the end of destroying air-breathing targets, today it is an end in itself in the field of intercontinental ballistic missiles and satellites, since Air Defense Command has no way to destroy these targets now.

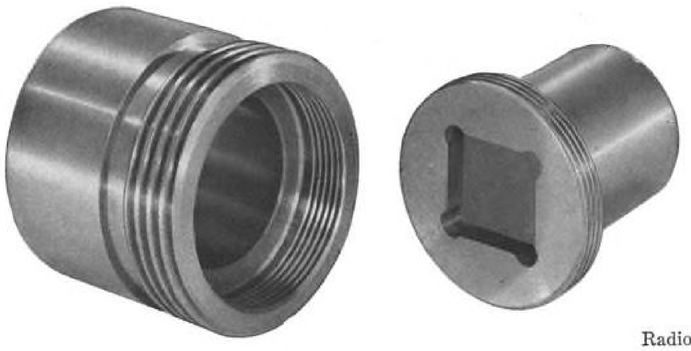
This is less than satisfying to former fighter-interceptor pilots who are long accustomed to being able to engage an intruder in combat.

There is general agreement among ADC and Norad officials that their two



First Photo Shows Hunting H.126 in Maiden Flight

First photo of Hunting H.126 jet-flap research aircraft on its recent maiden flight (AW Apr. 1, p. 37) shows the airplane in normal configuration during forward flight after takeoff from Royal Aircraft Establishment field at Bedford, England. H.126 was built by Hunting Aircraft under Ministry of Aviation specifications to investigate flight potential of jet flaps. Engine efflux from trailing edge in form of thin sheet across full wing span is used to produce lift and thrust. Powerplant is single Bristol Siddeley Orpheus turbojet, with additional thrust obtained from nozzles housed in fairing behind main landing gear (AW Sept. 3, p. 21).



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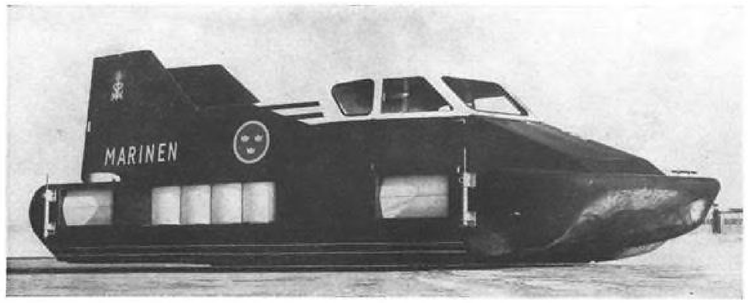
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Saab Air Cushion Vehicle Tested

First Saab 401 air cushion vehicle is undergoing flight tests for Swedish Naval Board in collaboration with Swedish air force and Defense Research Institute. Vehicle recently completed first hovering trials. Platform is based on full-scale test model. Powerplant is 180-hp., four-cylinder Lycoming O-360-A1A piston engine housed in aft end between fins. Body is made of light alloy, laminated plastic. Side ports contain guide vanes which can be opened simultaneously to form cascade by emitting propulsion jets from plenum chamber symmetrically on both sides. Jets can be used for braking by deflecting thrust backward. Vehicle has been under development since 1961.

most pressing needs are for an active defense against ICBMs and an interceptor capable of coping with supersonic bombers. But there is an understandable difference of viewpoint as to the best approach to ICBM defense which reflects the fact that Norad is a joint-service command with Army representatives.

Against air-breathing targets, the Army and its Nike Hercules are responsible for point defense, while USAF's interceptors and Bomarc missiles are assigned to longer-range area defense. But in the field of ICBM defense, Army currently holds a monopoly with its Nike Zeus and Nike X, both point-defense systems in the classical sense although their areas of coverage are relatively large.

ICBM Defense Role

If the Air Defense Command is to have a role in ICBM defense, aside from its responsibility for operating the Ballistic Missile Early Warning System, it is likely to come only if the Air Force can devise an area-defense system that could intercept ICBMs shortly after launch or during mid-trajectory.

It is not surprising, therefore, that ADC officials stress the many potential advantages of an area type of ICBM defense system. For example, the warheads could be destroyed before they had released any decoys, avoiding the problem of discriminating between warheads and decoys. There also would be less nuclear blast and radiation hazard to urban areas than with present point-defense systems (AW Feb. 11, p. 36).

Norad officials, including those wearing Air Force blue but mindful of their joint service responsibilities, say they would like to see early operational deployment of Nike Zeus or Nike X, with continuing efforts to devise an area-defense type system. This would give the nation a defense-in-depth comparable to what it now has against air-breathing threats.

Where several years ago the Army was pushing hard to obtain authorization for production of Nike Zeus, discussions with officials of the Army Air Defense Command (ARADCOM) here suggest that the service now is taking a more relaxed attitude.

Army Opinion

Army apparently expects that top government officials eventually will see an urgent need for an active ICBM defense, and when that time comes, the only system available for early deployment will be the Army's Nike Zeus and Nike X.

Some Norad and ADC officers express concern that military and Defense Dept. officials are taking a defeatist attitude on the feasibility of a truly effective defense against ICBMs, and that the nation is not devoting its best efforts to devising such countermeasures.

Officials here are reluctant to criticize decisions of their superiors, but an indication of their thinking is found in a recent article in the Air University Quarterly Review by USAF Lt. Gen. Robert M. Lee, ADC's commander.

"When we talk about absorbing the first blow and going on to win, we imply that we survive as a social entity. This may be entirely possible, if we provide the active and passive means of doing so. By passive defense I mean shelters, civil defense organizations and the means of rehabilitating the nation after attack," Gen. Lee wrote.

"By active defenses I mean simply that we must develop, as a matter of national urgency, a capability to counter nuclear weapons in whatever form and

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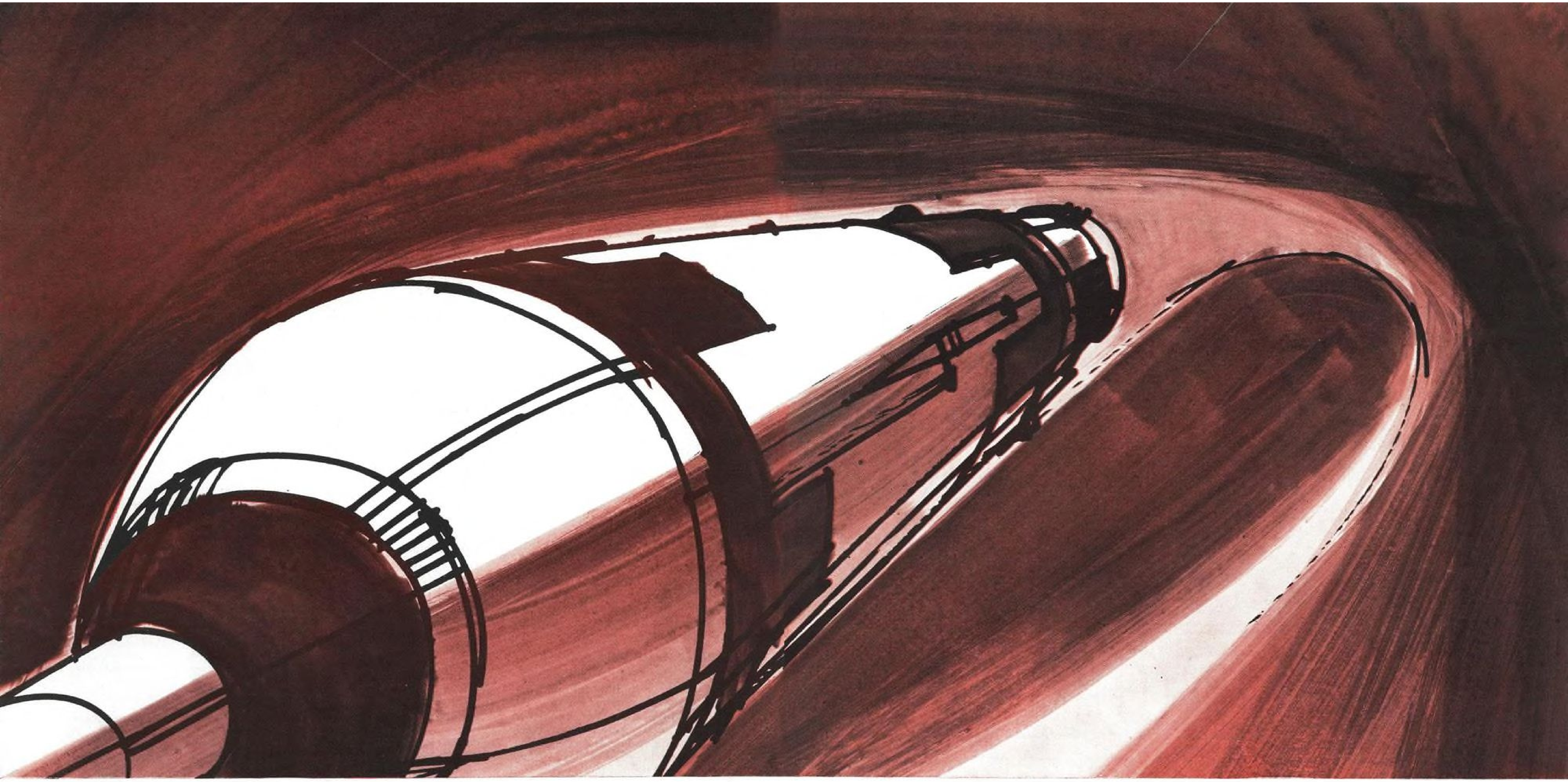
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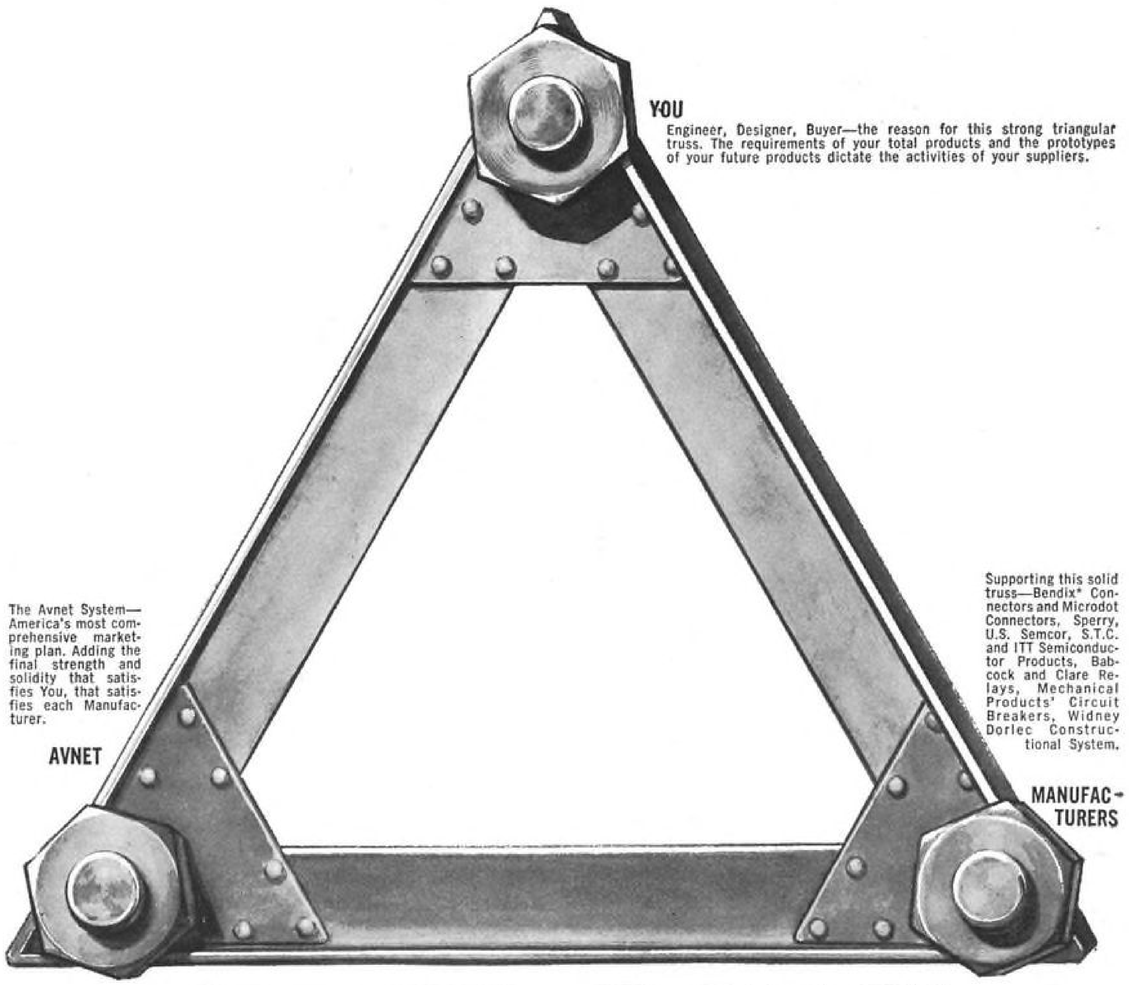


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however delivered. How this is done is not as important as selling the conviction that it must be done. Once we are convinced of that, then American ingenuity can attack the problem. . . . In my view, an ICBM defense would justify another Manhattan Project. . . when we talk about ballistic missile defenses we must include all means of delivery—aircraft, missile, satellite and submarine. . .," Gen. Lee said.

U.S. Vulnerability

"We have never previously been in a situation where the land and people who constitute our home base of operations have been vulnerable to immediate, devastating attack. If this base is destroyed, then subsequent military action loses meaning, for our people collectively represent the political and social institutions which we seek to defend," Gen. Lee concluded.

Defense Secretary McNamara appears to share many of these views, as evidenced by his statement to the House Armed Services Committee that ICBM defense is "the most urgent problem confronting us in the Continental Air and Missile Defense Forces. I believe that the matter of anti-missile defense is so important that we must make every effort to develop an effective system . . . accordingly, over $450 million is included in the 1964 budget to initiate Nike-X development and continue the Nike Zeus test program and related work under Project Defender," McNamara said.

But ADC officials would like to see more emphasis on area-type ICBM defense systems. They are inclined to the view that a defense using satellites is worth exploring in greater depth than is now authorized by the Defense Dept. One of the more promising systems of this type is known by the acronym of Sorti (satellite orbital track and intercept), proposed by General Electric's Missile and Space Div. (AW Feb. 4, p. 34).

Unlike Bambi, which required a large number of satellites orbiting over the Soviet Union where they would be vulnerable to countermeasures, Sorti proposes to place satellites in an inclined synchronous orbit at 22,300 mi. altitude, where they would trace out a figure-eight orbit over the Atlantic and Pacific oceans. Where Bambi proposed to use a satellite both for target detection and launch of interceptor missiles, Sorti proposes to use separate satellites for the two functions, with the killer satellites controlled from the ground.

Technical Problems

There is an understandable impatience here with the technical difficulties involved in such a defense, and with those who require a go-slow feasibility study first, because these are military men who never before have encountered a threat so far beyond their available weapons.

Norad and ADC officials believe the nation must face the threat of super-



F-104s Readied for Japanese Air Defense

Lockheed F-104DJ two-seat trainers, like No. 516 in center foreground, and F-104J single-seat interceptors are shown in hangar at Mitsubishi Heavy Industries' Komaki plant near Nagoya. Total of 200 aircraft—180 F-104Js and 20 F-104DJs—are programed for use by Japanese air defense force.

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SERIES D GAGES . . . are available in 7 models to measure force ranges from 0-20 lbs. up to 0-500 lbs. They are useful in measuring artificial forces built into boosted aircraft control systems to simulate air load on control surfaces. Here one is used to test the artificial "feel" of the rudder pedals.

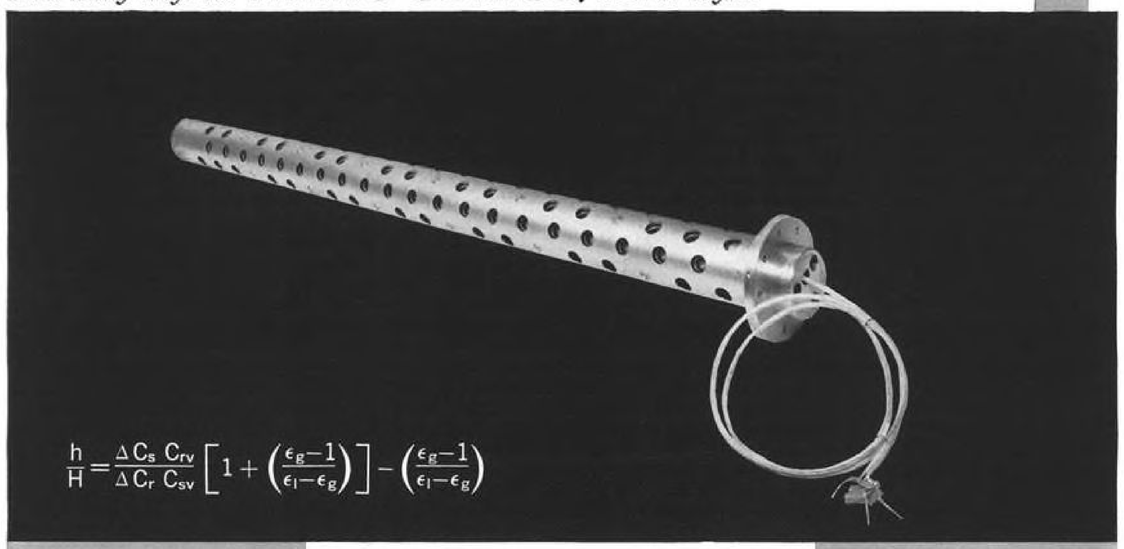
SERIES L GAGES . . . are lightweight units made in 14 models to measure load ranges from 0-500 grams up to 30 lbs. Gage shown is used to determine magnitude of forces which simulate the effect of air load transmitted to the control column from elevators and ailerons.



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Variable capacitance is only one of several techniques used by Trans-Sonics for the measurement of level. Differential pressure, piezo-electric effects, and mutual inductance are also used for systems having either analog or digital outputs. From liquid hydrogen to sea water, Trans-Sonics devices are providing accurate and reliable results in the most demanding situations — may we tell you more? Write, wire, or phone — !



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Army Troops Test Loading, Egress, Seating of CH-47A

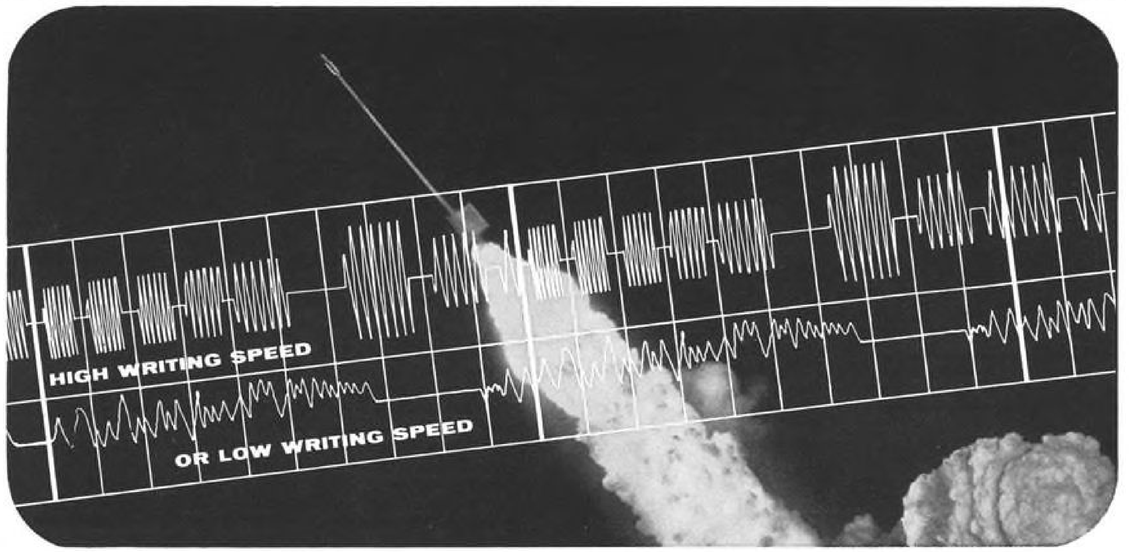
Troops at Army's Ft. Rucker, Ala., are shown during user familiarization checks of the Boeing-Vertol CH-47A Chinook assault helicopter. Seven Chinook production models were delivered to Ft. Rucker; three are undergoing user testing and four are in pilot training. First operational Chinook was recently delivered to Ft. Rucker, and is scheduled for delivery this spring to the 202nd Helicopter Squadron at that installation. This is the No. 16 aircraft in the series.

sonic Soviet bombers at least until 1970 —perhaps even longer if they are used as a second-strike force. If this appraisal is correct, the present inventory of interceptors will have dwindled to impotence in numbers and capability by later in this decade.

Norad and ADC, therefore, have submitted requirements for the improved manned interceptor, or IMI. The interceptor would have a speed of slightly better than Mach 3, an endurance of perhaps three hours, and would be equipped with a high-power airborne radar intended to make it less dependent on ground radar to locate its target.

Officials here acknowledge that in a surprise attack, the enemy's first blow is most likely to be struck with ICBMs and submarine-launched missiles, with enemy bombers coming in for the clean-up operations. They concede that under such conditions, much of the present SAGE air defense system would be destroyed, forcing an IMI to operate largely on its own.

McNamara told the House Armed Services Committee that the Pentagon intends "to make a thorough study of the entire problem of modernizing our manned interceptor force and we hope that next year we will be in a better position to make some definite recommendations on this subject." To expedite this study, USAF Maj. Gen. A. C. Agan, ADC's deputy chief of staff for plans, is on temporary assignment in the Pentagon. McNamara noted that if Russia deployed a new long-



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The mighty struggle for the sea

One phase of Hughes pioneering work in underwater visibility—where the effects of various conditions on closed circuit TV are gathered first hand.

How far can TV "see" underwater? How does sound behave in the sea? Are there unexploited new techniques which could be useful in this hostile environment? These are questions which are being answered by Hughes engineers and scientists aboard oceanographic ships and at land facilities.

Each answer is a vital link in a massive struggle — to know the sea is to control it. And while we know a great deal about the atmosphere and space beyond — we know less about the sea even though it holds much greater potential usefulness.

One of Hughes most important activities is in Sonar — Sound Navigation and Ranging — presently man's most effective tool in undersea defense and exploration.

For example, as submarines have become more capable — diving deeper, running farther and faster — we are obliged to develop more effective means of detection, classification and localization. Working with the U. S. Navy, Hughes scientists and engineers are engaged in all aspects of research, development, production and installation of sonar systems. They are being developed for surface vessels, submarines, aircraft and for the ocean's floor.

Some specific programs include submarine-radiation measurements, analytical and acoustical testing, classification and methodology studies, and the development of transducers, acoustic array systems, high gain receivers, sonobuoy systems, helicopter sonar and advanced data processing and display systems.

Other Hughes programs, undertaken in cooperation with major oil companies and other groups, include the remote-controlled MOBOT* systems and new varieties of dynamic ship positioning devices. MOBOT* is today working the ocean's depths—developing oil fields and other permanent sea floor installations.

These activities, and others, owe their usefulness to a Hughes belief that the only way to understand the sea is to work with it. That new ideas and new equipment can prove their mettle only when subjected realistically to the rigors of the ocean environment.

Engineers and scientists with abilities and interest related to these or other Hughes programs in advanced electronics and space are invited to inquire. Hughes is an equal opportunity employer. Please address Mr. S. L. Gillespie, Manager Employment and Manpower, Hughes Aircraft Company, Culver City 31, California.





The 100-foot Tilman J oceanographic vessel is one of two research ships docked near Hughes plants — just minutes from deep water. Fully instrumented for military and commercial work, it has a 5,000-mile range.

MOBOT* is lowered into one of the two test tanks maintained by Hughes for underwater research. This 105,000-gallon tank is one of the largest facilities for acoustic transducer tests and noise field measurement studies.

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Trident Cockpit Undergoes Bird Impact Tests

Flight cabin panels of de Havilland Trident three-jet transport remained intact after 13 bird impact tests conducted at British War Office Proof and Experimental Establishment. Canopy was placed on catapult and accelerated to 426 mph., normal climb speed of the Trident. Halfway down track, canopy collided with chicken carcass weighing 4 lb. and suspended by wires in flight position. Windshield, including gold-film heating element, is 1¼ in. thick.

range bomber, "we would have to reconsider the size and character of our interceptor force and particularly the need for modernization."

Norad and ADC officials decline to disclose their estimates of the cost and time schedule for the IMI. But Pentagon officials told AVIATION WEEK & SPACE TECHNOLOGY that ADC estimates a Mach 3 interceptor could be developed and placed in service within four years on a crash-program basis, at a cost of approximately $2 to $3 billion. Some Pentagon officials believe these figures are somewhat overly optimistic, however.

While the IMI could become airborne upon first warning of an enemy ICBM attack, they would soon run out of fuel unless enemy bombers quickly followed the missile attack. ADC believes that it can count on using dispersed air fields to assure that some survive the initial attack to serve as refueling points. However, this assumption is expected to come under hard scrutiny in the Pentagon study, particularly since a Mach 3 interceptor may not be able to operate out of many existing air fields.

Pentagon officials point out that there are several alternatives to the IMI which may appear more attractive under Defense Dept. cost-effectiveness studies. One of these would be to develop an improved, longer-range, air-to-air missile for use with a Mach 2-plus IMI or the F-4C.

Another possibility is use of the F-111 (TFX), which is intended to be suitable both for tactical and air defense missions.

F-4B Intercept

Ent AFB, Colo.—While Air Defense Command has so far resisted efforts to interest it in the McDonnell F-4B/F-4C interceptor because it prefers Pentagon approval for development of a new Mach 3 interceptor, the F-4B is reported to have scored highly with Air Marshal C. Roy Slemon, RCAF, deputy commander of the North American Air Defense Command, in a demonstration at Colorado Springs.

As Slemon was waiting on the runway to take off in a Navy F-4B, he was challenged to intercept a USAF Strategic Air Command B-52 flying overhead at 41,000 ft. In less than 10 min. Slemon was making a simulated attack on the bomber.



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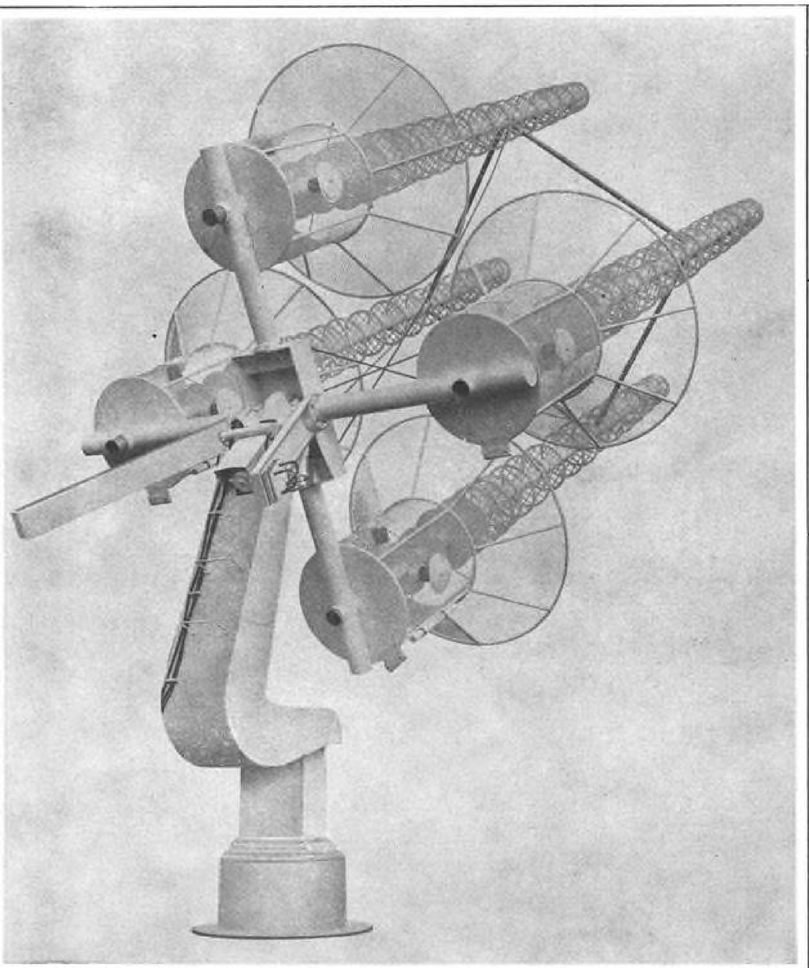
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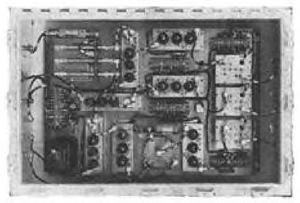
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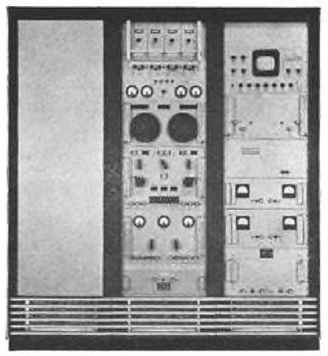
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ALL-METAL MOCKUP OF SIKORSKY CH-53A Marine Corps heavy assault helicopter shows fuselage configuration and engine placement.

Sikorsky CH-53A Passes Mockup Review

By Donald E. Fink

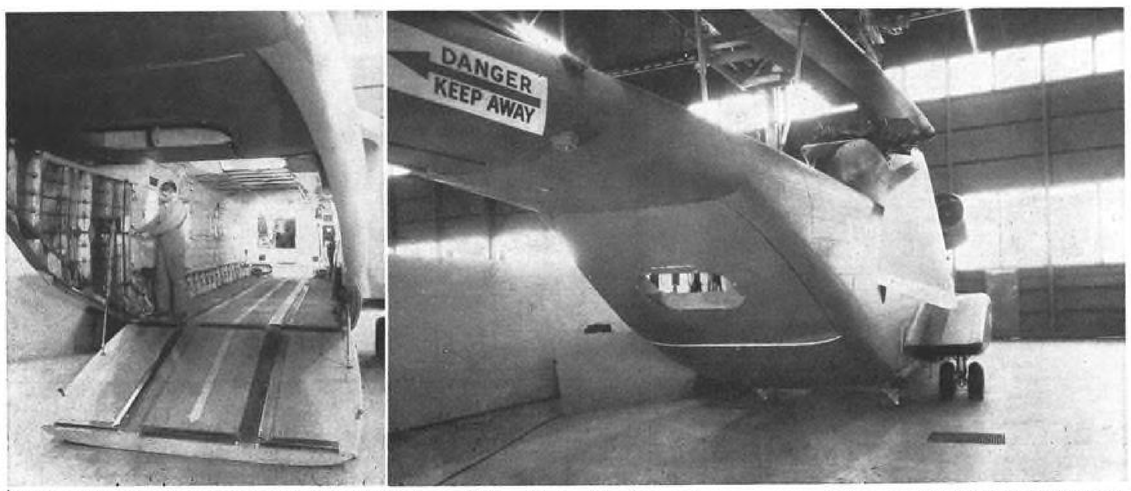
Stratford, Conn.—All-metal mockup of Sikorsky Aircraft's CH-53A Marine Corps heavy assault helicopter passed its preliminary review recently with few changes recommended by the Navy Bu-Weps review team.

Production of two flying prototypes has entered the metal-cutting stage and first flight is scheduled for June, 1964. The four-ton capacity helicopter, which will be powered by two General Electric T64-GE-6 turboshaft engines rated at maximum power of 2,850-shp. each, is scheduled for fleet delivery in 1965.

The two prototypes, a static test airframe and the mockup were ordered in a $9,752,502 Navy research and development contract awarded to Sikorsky last fall (AW Sept. 3, p. 24).

Production contract currently is being negotiated with the Navy, but Sikorsky already is tooling and purchasing materials in preparation for continuous production. The first two production helicopters will follow the prototypes down the assembly line. Announcement of the size of the production contract is not expected until July or August.

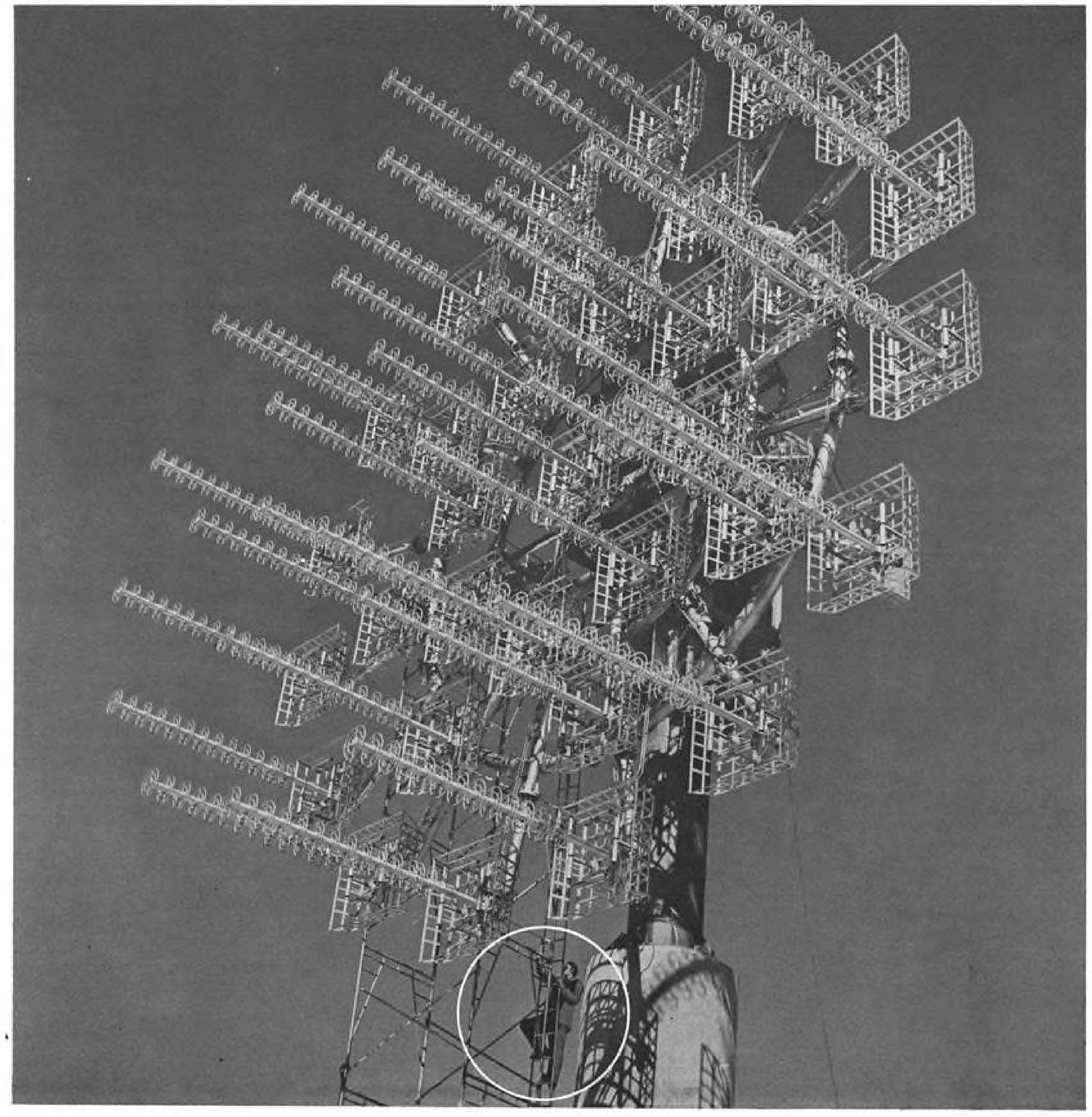
Metal construction was chosen for the mockup because it permitted faster and cheaper construction and also enabled Sikorsky engineers to resolve manufacturing techniques which will be used to improve the CH-53A's produci-

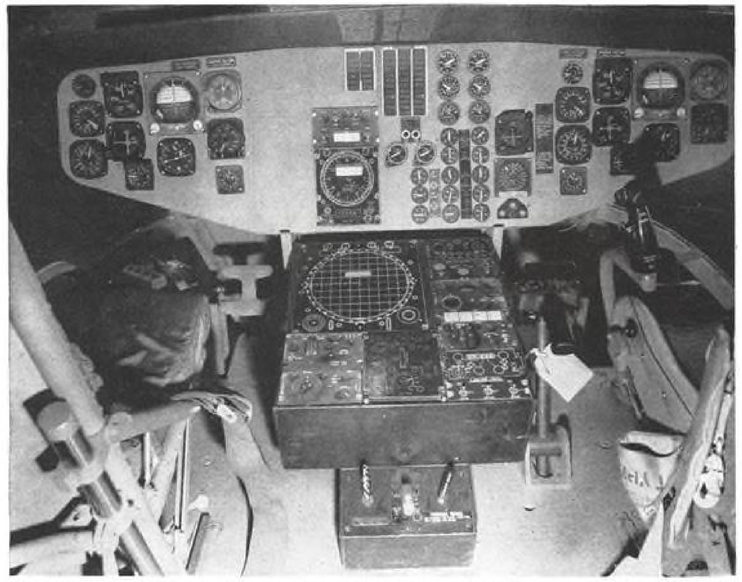


REAR VIEWS SHOW CABIN COMPARTMENT layout (left) with combined cargo door-ramp open. Ramp supports 3,000 lb. horizontally. Escape hatch is shown (right) in upper door panel. Folded blades will be stored on top of fuselage in production aircraft.

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CH-53A COCKPIT PANEL is split, with pilot's engine and flight instrument group at right and copilot's navigation instrument and communication control group at left. Console between seats contains tactical display plotting board (upper left) and radios. Note engine power trim console atop the collective stick.

bility, according to Charles M. Echeverria, CH-53A program manager.

Echeverria said a simple "tinker toy" principle was followed in developing dies to stamp out aluminum parts which could be used interchangeably on either side of the mockup's semi-monocoque fuselage. Fuselage frames were formed by welding stamped ribs together. Frames were then joined with rib braces and skin panels were riveted onto them. Floor is of conventional box construction.

Stamped parts also will be used in production models, but aluminum forgings probably will be used as the main fuselage structural members in place of the welded frames, Echeverria said. Skin on the forward one-third of the fuselage and leading edge of the tail pylon will be flush-riveted for improved streamlining.

The CH-53A, designated S-65 by Sikorsky, is the third stage of the company's large helicopter development program and draws on dynamic component technology developed for the twin-piston engine S-56—military designation CH-37—and the S-64 Flying Crane (AW May 14, p. 37). The design stems more directly from engineering experience gained in the S-64 program, but the CH-53A essentially is a new aircraft. The S-64, which is powered by two 4,050 shp. Pratt & Whitney JFTD-12A gas turbines, has its engines mounted together on top of the fuselage and ahead of the main rotor transmission. The engines drive rear-mounted gear boxes which are coupled with the main transmission.

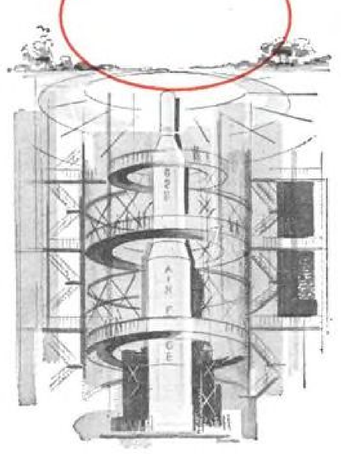
The CH-53A's two T64-GE-6 engines, which have front-drive gear boxes, are mounted in stream-lined nacelles which protrude at 45 deg. angles from the upper corners on each side of the forward fuselage section. The engine gear boxes, imbedded in the front of the nacelles, are driven by output shafts extending from the forward end of each engine. Power is transmitted to the rotor shaft via input shafts which extend back to the main transmission at 40 deg. angles.

The main transmission box and the six-bladed rotor head, which has conventional Sikorsky extruded aluminum spar blades, are direct outgrowths of the S-64 program. The extruded spar forms the main structural member of the blade. Rubber-covered steel counterweights extend along the leading edge of the blade spar to give chordwise static balancing. Trailing edge of the blade is an aluminum skin section with rib supports and a main channel support member which attaches to the rear of the main spar. Skin extension forms a sleeve which is attached to the spar by an adhesive bond.

Main gearbox is a truncated cone design developed for the S-64. It employs double planetary reduction gears to reduce the engine input shaft component of 6,023 rpm. to a main rotor shaft output of 185 rpm. Engine gearboxes effect a primary reduction of about 2:1 from the 13,000 rpm. output of each engine.

Transmission system, which uses steel gears manufactured by Indiana Gear Works, is designed for a maximum

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single-engine power of 3,200 shp. or a combined-engine component of 6,400 shp. This will enable the CH-53A to use growth versions of the T-64 engine without major design change.

Development of the CH-53A design, the first to be committed to Navy's new Integrated Maintenance Management Program, from its inception (AW Feb. 4, p. 92) stresses reliability and maintainability. These two considerations dictated to some degree the placement and design of such components as the engines, fuel cells, auxiliary powerplant and the engine accessories units.

Position of the engines, for example, reduces the chance of both simultaneously sustaining damage from gound fire, since the fuselage and the main transmission fairing shield each engine from opposite side fire. Streamlined sponsons, which extend from each side of the fuselage at floor level, also provide some shielding from below.

Fuel Cell Location

The aircraft's two fuel cells are located in the forward section of each sponson, which also house the main landing gear assemblies, and are supported by glass fiber liners and nylon lacing. The lower one-third of each cell is self-sealing and their location on opposite sides of the fuselage reduces the chance of both being hit simultaneously.

Fuel cells are interchangeable and can be quickly removed by opening access panels on the top of the sponsons. The fuel system, which is a negative pressure suction system, can operate efficiently from either or both cells. Low fuel line pressure, which will remain below 50 psig., permits use of flexible plastic fuel lines.

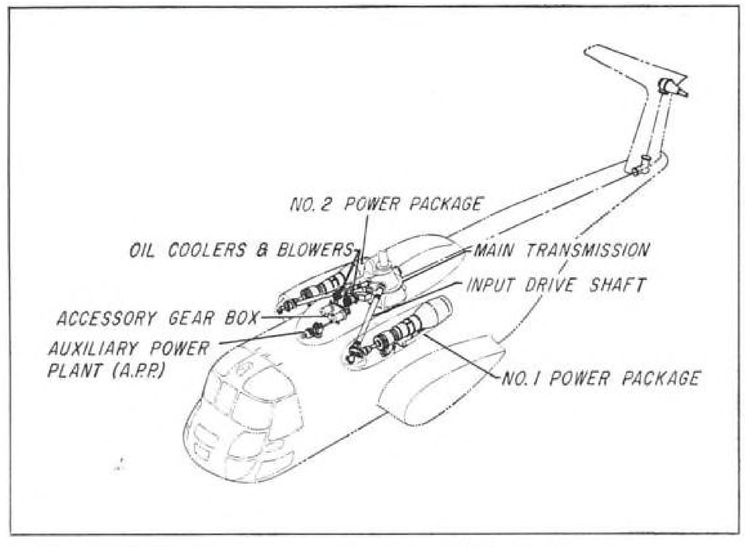
Fuel system employs two engine-driven pumps which evacuate the fuel lines. Fuel is forced through the system by atmospheric pressure. Main advantage of the system is the lack of fuel pumps in the tanks or sumps, which makes the system less vulnerable and easier to maintain, Echeverria said. Low-pressure lines also would not burst and spray fuel around the aircraft if punctured.

Built-in auxiliary powerplant, which consists of a Solar T62T-12 gas turbine engine with a hydraulic starting system, is located on top of the fuselage ahead of the main transmission. It is covered by the forward extension of the transmission fairing. In this location, the unit, which provides power for main engine starting as well as ground operation and checkout of all of the aircraft's hydraulic, electrical and electronic systems, is shielded by the fuselage below and the engine nacelles on each side.

Hydraulic, pneumatic and electrical accessory units, which are located directly behind the auxiliary powerplant, also are protected by the fuselage and the engine nacelles.

Typical of the accessibility considerations in the CH-53 design are the nacelles, which consist of a series of hinged panels that act as structural members when closed. The panels, easily reached from a work platform which folds out of the front sponson fairing, give 360 deg. accessibility to the engines.

Engine accessories, such as the fuel pumps, that require periodic maintenance have all been located on the underside of the engines. These are at chest level on an average size man standing on the work platform. Hand clearance around all engine service items



CH-53A POWER TRAIN and auxiliary powerplant installation are shown.



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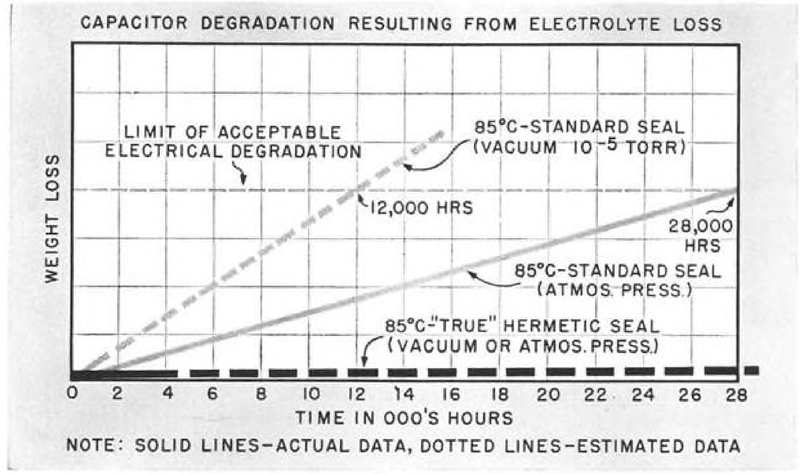
Acradrive/22 Motor
(exploded view)
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Outstanding advantage of the glass seal over a seal of organic material is that glass will not out-gas when exposed to vacuum or radiation. Glass is more stable to the chemical action of electrolyte, too. Both features reduce the possibility of contaminating vapors entering surrounding equipments, and improve capacitor reliability.

In developing the hermetic seal, General Electric has had the support of North American Aviation's Autonetics Division as a part of the program to develop High Reliability capacitors for the Air Force Minuteman. More recently, U.S. Army Electronics R&D Laboratory awarded G.E. a contract to support development of a hermetic seal for standard foil capacitors.

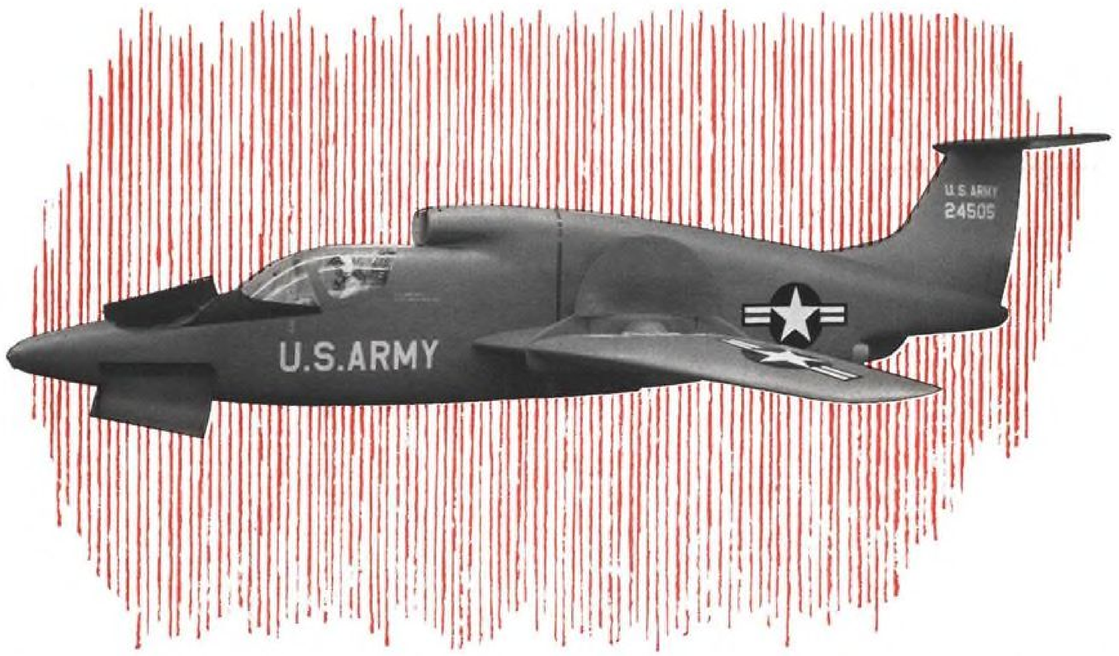
Ratings of the new hermetically sealed capacitors are 85 C and 125 C, 15 to 150 volts, and 75 to 610 microfarads. They come in 3 case sizes, of polar and non-polar construction.

Ask your General Electric Sales Engineer about the units now available from stock for prototype work. He'll be happy to assist you with application, too. For more information, write for Bulletin GEA-7614, to Section 430-16, General Electric Co., Schenectady, N. Y. *Electronic Specialty Capacitor Product Section, Irmo, S. C.*

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Army XV-5A* provides maximum range/payload

Scheduled to fly in mid-1963, the Army XV-5A* lift fan research aircraft will provide greater payload/range capability than any other high performance V/STOL system.

Now being designed and built by Ryan Aeronautical Company, under contract to General Electric, the XV-5A* aircraft will be powered by two J85 jet engines which drive submerged wing fans for vertical flight. This unique concept provides two to three times more lift, for a given amount of installed engine thrust, than any other high speed V/STOL design.

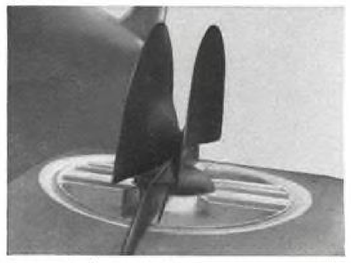
Result: Greater payload/range capability — less fuel consumption and need for logistic support. Because the lift fan system multiplies engine thrust by 300 percent, for vertical flight, XV-5A* engines can be sized for most efficient hovering and cruise conditions and do not have to be oversized to meet V/STOL flight requirements. These inherent and designed advantages give the XV-5A* performance which meets anticipated requirements for military missions.

* FORMERLY VZ-11

RYAN AERONAUTICAL COMPANY, SAN DIEGO, CALIFORNIA



Conventional XV-5A* cockpit permits pilots to fly through transitions without moving hand or foot control positions.



Low velocity and low temperature of lift fan efflux provide major advantages for operation from unprepared sites.

RYAN AEROSPACE

RYAN'S SPECTRUM OF CAPABILITIES



CH-53A Specifications

Dimensions:
- Over-all length with rotors operating ..... 88.1 ft.
- Over-all height at main rotor hub 16.6 ft.
- Over-all width with blades folded 15.5 ft.
- Main rotor diameter ..... 72.0 ft.
- Tail rotor diameter ..... 16.0 ft.
- Wheelbase ..... 27.0 ft.
- Wheel tread ..... 13.0 ft.
- Ground clearance ..... 1.5 ft.

Weights:
- Gross weight ..... 33,484 lb.
- Useful load ..... 12,534 lb.
- Internal or external cargo load .. 8,000 lb.

Performance:
- Max. speed at sea level with military-rated power and max. gross weight ..... 170 kt.
- Cruise speed at sea level with normal-rated power and max. gross weight ..... 150 kt.
- Hover ceiling with max. gross weight, military-rated power and out of ground effect ..... 7,200 ft.
- Combat radius, which includes cruise at sea level with 8,000 lb. cargo, hover over remote base for 10 min. out of ground effect, landing for troop or cargo discharge and return with 4,000 lb. cargo load ..... 100 naut. mi.
- Single-engine rate of climb on a standard hot day and with military-rated power on the remaining engine ..... 200 fpm.

ranges from five to eight inches and all drains and vent lines have quick disconnect attachments. Engine control lines are arranged for one-point hookup.

Engine air intake ducts on the nacelles are kidney-shaped and conduct the engine air flow around the engine drive gear boxes and torque tubes to the front face of each engine. Horsepower loss computed for the ducts is less than one-half of 1%. Inlets are about 10 ft. above the ground, minimizing the possibility of foreign object ingestion.

Cooling System

The nacelles also have been designed with a cooling system to maintain compartment temperatures at about 300F during hover and forward flight and to prevent "hot soak" temperature buildup after engine shutdown.

System uses air inlet louvers, located on the lower forward section of each nacelle, which act in conjunction with an exhaust ejector at the aft end to maintain a flow of cooling air through the nacelle. Reflective-finish layer on the inner cowling surfaces also helps to prevent compartment heat buildup through absorption. Small louvers on the upper rear nacelle panels permit free convective cooling after engine shutdown.

Walkways are provided along both sponsons and along the top of the fuselage, to give clear access to all units enclosed in the main transmission fairing. The front section, which covers the auxiliary powerplant, slides forward exposing the entire unit.

The aircraft's accessory units are located directly behind the auxiliary powerplant and derive their power from a gear box driven by the auxiliary unit. Fairing section covering the accessory units also slides forward for improved accessibility.

Located in the rear section of the fairing is a 600,000 btu. heater for cabin heating and an engine oil cooler. Large access panels also have been provided for these units.

Rotor Head

Transmission and main rotor shaft are reached via access panels on each side of the transmission fairing. The rotor head, which has an automatic blade-folding system and a blade positioner that sets the rotor head in the correct position for the folding sequence, can be reached from the fuselage walkways. All six blades fold back on top of the fuselage.

Tail rotor is a four-bladed, semi-rigid configuration. It is driven by a shaft which runs from the main transmission along the top of the fuselage to an intermediate gear box at the base of the upswept portion of the pylon. A secondary shaft runs from the intermediate gear box to the rotor gear box atop the pylon tip.

Carrier Stowage

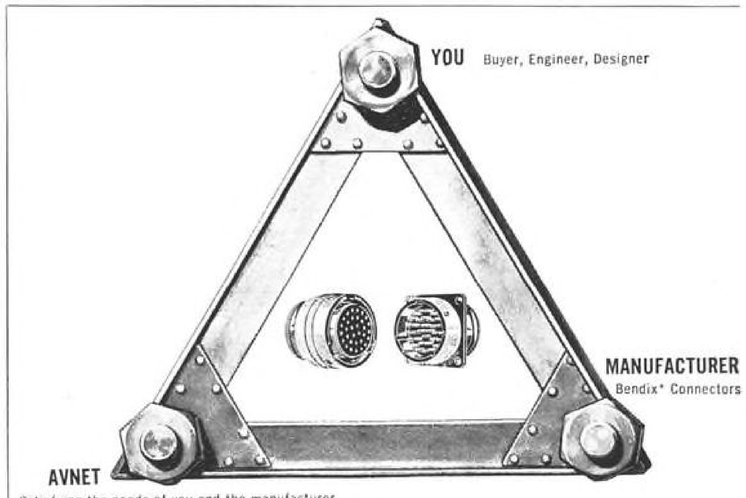
Tail pylon is hinged about 3 ft. forward of the upswept portion and folds automatically as part of the blade folding sequence. The pylon also can be folded separately with a hydraulic wobble pump, to lower the tail rotor assembly for inspection or minor maintenance.

Rotor blade and tail pylon folding reduces the helicopter's length to 56.5 ft. for stowage aboard an aircraft carrier. Maximum width is reduced from the main rotor diameter of 72.0 ft. to maximum fuselage width of 15.5 ft.

The CH-53A's semi-monocoque fuselage is divided into five main sections: the cockpit, forward cabin section, aft cabin section, tail pylon and the sponsons.

Over-all fuselage length from nose to tail pylon tip is 67.2 ft. The cabin is a constant section 30 ft. long, 6.5 ft. high and 7.5 ft. wide.

The cabin floor, which will support 300 psf. contains 5,000, 10,000 and 20,000-lb. capacity tiedown fittings



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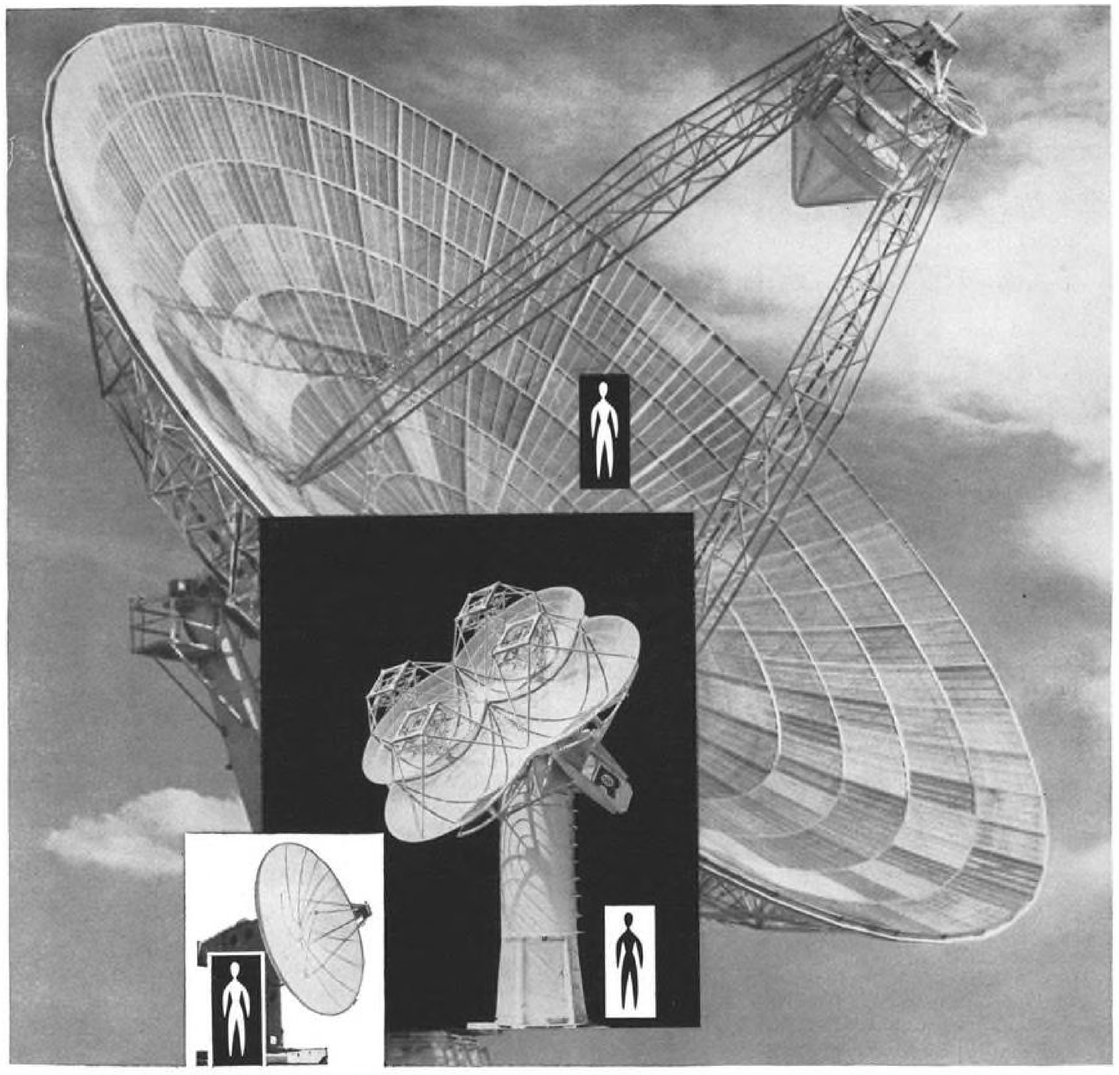
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Example: Antennas of diversified design

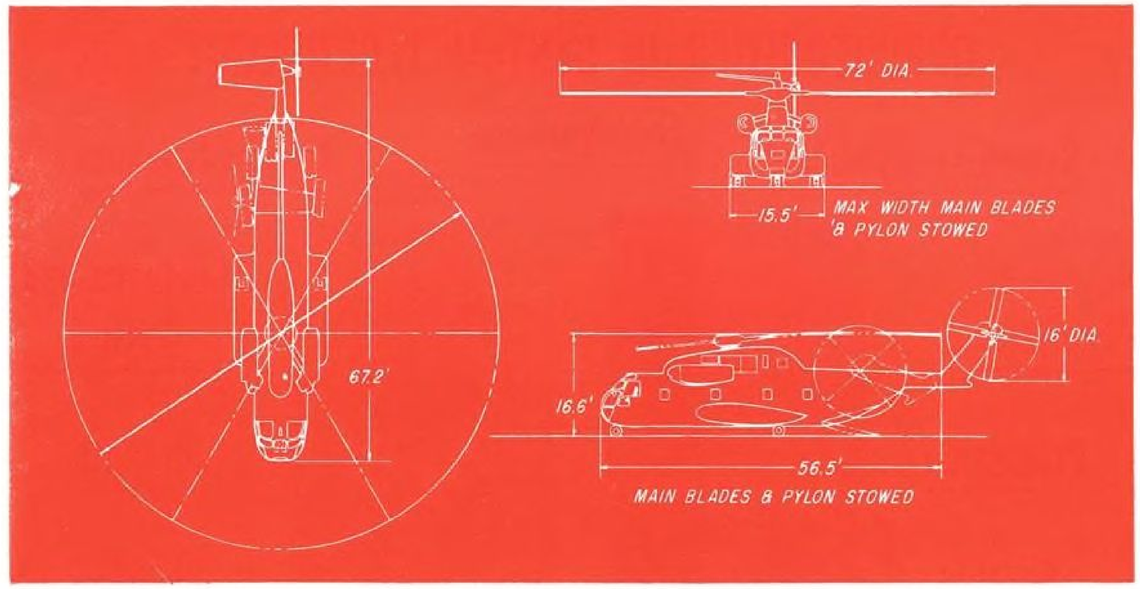
An effective antenna must provide far more than a sum of its parts. For maximum efficiency, it must be considered an integral part of an entire system rather than an individual component. That's why Radiation engineers *experienced* in complete systems development consistently base final design parameters on *ultimate* application. The success of this system oriented approach is evidenced by scores of Radiation antennas sweeping the skies from the Pacific to the Atlantic Missile Ranges.

Thus, Radiation has developed more experience in automatic tracking antenna design and application of telemetry techniques than any other company. A 12-foot dish antenna, featuring new all solid-state tracking servo system and mode switching logic, is now under development for the X-20 (Dyna Soar) program. Two high-gain, wideband 85-foot antenna systems will soon be put into service on the Atlantic and Pacific Missile Ranges. Radiation quad-helix array antennas with phase monopulse tracking have been delivered for Bell's Telstar Project. And now, Radiation's broad-band "Telscom" antenna is available. Telscom *combines* acquisition and tracking operations for telemetry, surveillance and communications and operates from 200 to 2,300 Mc.

These examples illustrate Radiation's unique contributions through advanced research and production techniques. If *your* interest lies in this field, you'll find a challenging and rewarding future at Radiation. Write for more information or send your resume to: Personnel Director, Dept. AW-4, Radiation Incorporated, Melbourne, Florida. *Radiation is an equal opportunity employer.*

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THREE VIEW DRAWING shows CH-53A general arrangement. Dotted lines in top and side views are main blade and tail pylon positions after folding. Note kidney-shaped engine intakes on front view. Main rotor is tilted forward 5 deg.

spaced 20 in. apart on the fuselage frames.

Seating arrangements for 28 combat-equipped troops, a crew chief and a troop commander originally were called for in the specifications, but one of the changes proposed by the mockup review team was to increase this to a total of 38 passengers. Cabin section also will be capable of holding 24 military litters and four medical attendant seats for transportation of wounded.

The primary mission of the CH-53A will be cargo hauling, however. The main cabin-access door, under the upswept tail pylon, and the integrated cargo-handling system were designed especially for this mission.

The rear cargo door consists of two horizontal panels, the upper of which swings in and up to give overhead clearance. The other swings downward to form a loading ramp. The hydraulically operated ramp can support 3,000 lb. when extended horizontally at the fuselage floor level. This permits loading cargo directly into the fuselage from truck bed level.

Cargo Handling System

Twin tracks, divided into 10-ft. sections, are set in floor channels to support wheeled vehicles. The track sections have rollers on the underside and can be flipped over to form a double roller track for loading boxes or palletized cargo.

Since Marine Corps specification call for all operations with a three-man crew —pilot, copilot and crew chief—a twin-winch integrated cargo handling system with a remote-control cable was built into the fuselage. The system consists of two 2,000-lb. capacity winches set in the forward corners of the cargo compartment. The winches can be operated singly or in unison and can be used to both load and unload cargo. The remote control cable is stored on an overhead, spring-wound reel near the rear door. This enables the crew chief to run cables out to boxes or pallets behind the fuselage and still maintain control of the winches.

Specific items the CH-53A is designed to carry include:

- **One 1½ ton truck and trailer.**
- **Hawk missile system.**
- **Honest John missile** on its trailer.
- **105 mm. howitzer** or one ½-ton jeep with a ½-ton two-wheeled trailer.

Guaranteed performance of the CH-53A at maximum takeoff gross weight of 33,484 lb. is 170 kt. at sea level. Normal cruise speed is 150 kt. Hover ceiling out of ground effect is 7,200 ft. and combat radius is 100 naut. mi. Rate of climb on one engine is 200 fpm. on a standard hot day.

Aircraft's landing gear consists of three identical double-wheel units, one in the nose and one in the aft section of each sponson. Tires are 8.50x10 tubeless.

Nose gear, which can rotate 360 deg. on the ground, retracts rearward into a wheel well in the bottom of the fuselage nose. The main gear assemblies retract forward into compartments in the sponsons. A tail skid, which extends from the bottom of the tail pylon when the gear is lowered, provides protection for the tail rotor during the landing flare. The skid automatically retracts when full landing pressure is exerted on the main landing gear, leaving the area under the pylon clear for loading and unloading operations.

CH-53A also has emergency water-landing capabilities. The entire bottom of the fuselage is watertight and the sponsons provide an additional 7,700 lb. of buoyancy. Sponsons also provide roll stability, enabling the helicopter to remain afloat for a minimum of two hours with its power off.

CH-53A's flight control system is composed of mechanical linkage units connected to three banks of hydraulic servos: a primary and a backup to handle flight loads and a third set to operate the automatic flight control system. Primary system controls roll, pitch, yaw and altitude. Back-up system controls roll and pitch only. System permits hands-off attitude stabilization and automatic cruise flight by maintaining dynamic stability.

Control System Operation

The system employs aircraft attitude and rate sensing, cyclic stick position sensing, electronic shaping and amplification and hydraulic boost for control surface movements. The system can be engaged prior to takeoff and left engaged during flight. It has limited authority, which permits stability corrections and allows the pilot to assume control of the helicopter through normal use of the manual controls at any time during flight.

Aircraft's electrical power system consists of two isolated circuits, each providing 115-200 v. a.c. or 28 v. d.c. power. The generators are mounted on

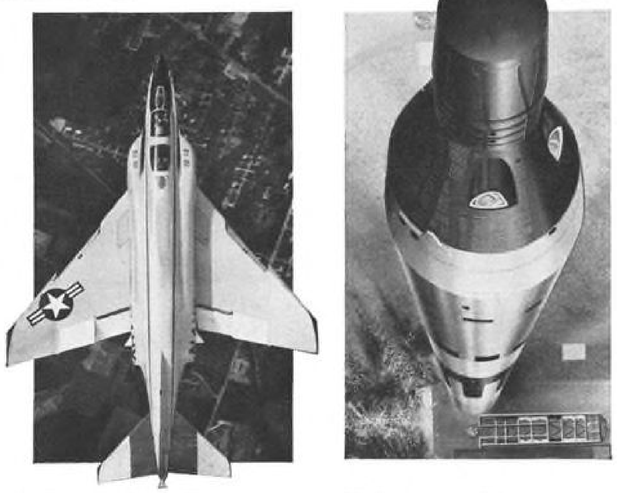
OPPORTUNITIES IN SYSTEM TECHNOLOGY

Structural Dynamics

Aerodynamics

Thermodynamics

Operations Analysis



Guidance and Control

Propulsion

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System Technology Division (STD) engineers at McDonnell provide "Task Force" support for all McDonnell systems engineering. These teams of technical specialists are assigned to specific engineering programs to advance the design and development of space, missile and aircraft products. While so assigned, they continue to receive technical and administrative direction from their functional department within the System Technology Division.

This "Task Force" approach facilitates rapid build-up of engineering effort without re-organization or disruptive administrative changes. Since STD engineers operate in all company design areas, the organization provides an effective avenue for interchange of ideas and developments between all McDonnell engineering divisions.

A member of this team achieves a high degree of product diversification experience which increases his capability in his particular area of specialization. When a project is completed, the STD engineer is assigned to a new program. In this way, the creative talents of these key specialists are continually applied to the most critical engineering projects.

If you are interested in the diversified opportunities inherent in the McDonnell System Technology Division, complete and mail, in confidence, the brief resume form below. For a comprehensive, immediate review of your qualifications, attach a complete resume of your education and experience.

Mail This Form To: D. F. Waters, McDonnell Employment, Dept. 62J, Box 516, St. Louis 66, Mo.

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Education: BS_____ (Date) MS_____ (Date) PHD_____ (Date) Major Field:_____

Present Job Title:_____

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the accessory gear box and are driven by the main rotor transmission. Exterior lighting consists of position lights, anti-collision lights on top of the pylon and on the bottom of the fuselage, two 450-w. landing lights and three hover flood lights. Two 40-w. lights, one inside the cabin and one on the underside of the tail pylon, provide light for the cargo loading area. Rotor tip lighting, which casts a dim light visible from above for formation flying, also is provided.

The electronics packages include the normal UHF and VHF communications, navigational systems and a radar identification set (IFF). Special equipment includes an AN/APN-117 radar altimeter and an AN/ARN-52 TACAN radio navigation set. Space, weight and power provisions also have been made for future installation of an AN/APN-130 radar navigation set, an AN/AYK-2 navigation computer group and a PT-429/A tactical display plotting board. Electronics packages are stored in compartments on either side of the nosewheel well.

Navy has an integrated avionics package under development, but it will not be ready for installation in the first production CH-53s. Provision will be made for retrofitting the integrated package.

Crew and passenger safety has been taken into consideration in the CH-53 with provision made for future installation of aluminum armor and flak curtains in the cabin and cockpit area. No provision has been made for installation of armament, because the specifications did not call for it. However, such provisions have been kept in mind, according to design engineers, especially for rearward-firing weapons which could provide covering fire for troops leaving the rear ramp.

A total of 11 emergency escape routes have been provided; nine in the cabin area and two in the cockpit.

AFOSR Awards

Air Force Office of Scientific Research recently awarded grants and contracts totaling approximately $4.5 million to universities and research firms in the United States and Europe.

Grants:

Stanford University, Stanford, Calif.—$22,260 for investigation of computation of the laminar compressible boundary layer; $6,000 for the international conference on nucleon structure.

University of California, Berkeley, Calif.—$16,620 for program of systems research.

University of Texas, Austin, Tex.—$7,608 for study of applied mathematics in the area of molecular quantum mechanics; $16,584 for research on interpersonal attraction and repulsion.

New York University, New York, N. Y.—$27,800 for randomization and factorial experiments; $24,976 for study of non-linear disturbances in unstable viscous fluid flow.

Rensselaer Polytechnical Institute, Troy, N. Y.—$32,330 for analysis of the dynamics of elastic systems; $42,399 for study of structure and physical properties of molten salts.

University of Illinois, Urbana, Ill.—$56,850 for studies in transistor RC network synthesis; $151,498 for comprehensive study of the theory and circuitry of systems with mind-like behavior.

University of Oklahoma Research Institute, Norman, Okla.—$13,838 for missile trajectory optimization.

University of Massachusetts, Amherst, Mass.—$45,100 for study of the polarization of light resulting from the excitation of atoms by electrons.

Catholic University, Washington, D. C.—$64,300 to study general problems of molecular physics.

Research Foundation of State University of New York, Albany, N. Y.—$40,464 to study effects of external magnetic and electric fields on small molecules.

Johns Hopkins University, Baltimore, Md.—$234,384 for investigation of new particles and their interactions with nucleons.

Physical Research Laboratory Navrangpura, Ahmedabad, India—$38,210 for investigation of short-period intensity variations and anisotropy of cosmic radiation measured with a very high counting rate mu-meson detector at Chacaltaya.

Ohio University, Athens, Ohio—$76,308 for study of elementary particle physics.

University of Wisconsin, Madison, Wisc.—$24,480 for study of mechanism of stress-corrosion cracking in face-centered cubic metals.

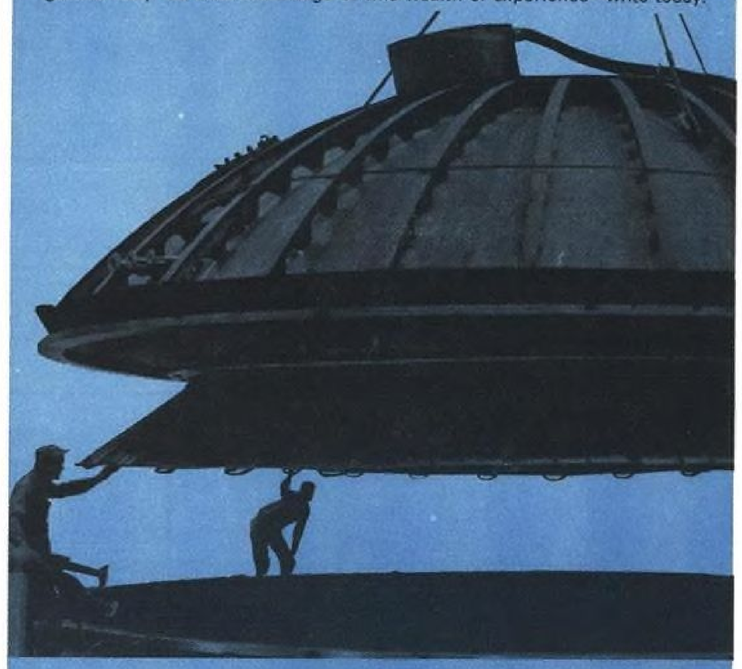
University of Chicago, Chicago, Ill.—$52,315 for experimental investigation of the electronic properties of solids; $13,387 to study reactive intermediate in cyclopropane chemistry.

University of Pittsburgh, Pittsburgh, Pa.—$370,192 for investigation of electronic properties of solids; $62,164 for investigation of inter-metallic lanthanide compounds.

Pennsylvania State University, University

Putting the lid on a big one

This top head is shown being lowered onto one of the three 39-foot spherical simulation chambers at the recently completed Space Simulation Test Facilities at the General Electric Space Technology Center, Valley Forge, Pennsylvania. CryoVac, a sub-contractor to the F. J. Stokes Corporation, Philadelphia, designed and installed the thermal shrouds, heat sinks—like the one suspended under the lid—cryopumps and associated cryogenic equipment including controls for the facilities. ■ This isn't the first lid we've helped put on a space simulation chamber and it certainly won't be the last. We helped place quite a few. In fact, the cryogenic equipment in many of the simulators now in existence or under construction has been designed and built by CryoVac. ■ CryoVac's experience goes even beyond cryogenic systems however, it includes responsibility for the design, fabrication and erection on many programs. Why not take advantage of this wealth of experience—write today.



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Ingots of Midvac Steels now produced by this furnace will permit the design of larger rocket motor components, forgings for nuclear reactor parts, turbine shafts and other large commercial parts with the same high reliability factors of the Midvac Steels now in service throughout the country.

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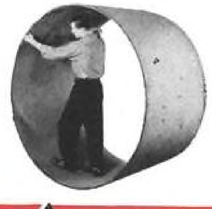
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Non-magnetic steel retainer ring of Gannalloy. In the production of these retainer rings for generators, rejects averaged 20% with air melted steels... were eliminated with Midvac vacuum melted steels.





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High strength thin walled fuel chamber for solid propellant rocket made of Ladish D6AC and produced by Midvac Process resulted in higher degree of cleanliness and improved mechanical properties.

TURBINE ROTOR
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Park, Pa.—$78,540 for study of reaction mechanisms and kinetics in solid-phase reaction from 1500-3000C; $57,778 for investigation of semiconductor physics; $9,480 for theoretical investigation of the surface potential and band structure of metals; $31,770 for theoretical investigation of the surface potential and band structure of metals.

Polytechnic Institute of Brooklyn, Brooklyn, N. Y.—$55,320 to detect disorder in crystals.

Oregon State University, Corvallis, Ore.—$54,508 for investigation of processes of crystal growth.

University of California, Los Angeles, Calif.—$152,731 for the AFOSR program for space chemistry; $35,207 for X-ray studies of unusual organic molecules.

Princeton University, Princeton, N. J.—$35,186 for study of inorganic structure and spectra.

Case Institute of Technology, Cleveland, Ohio—$34,038 for study of photo-induced redox reactions.

Purdue Research Foundation, Lafayette, Ind.—$54,791 for general study of the properties of silyl radicals.

University of Kansas, Lawrence, Kan.—$47,534 for investigation of bridge mechanism in electrochemical oxidation and reduction of metal ions.

University of Missouri, Columbia, Mo.—$23,770 for study of mixed heteropoly acid formation.

Howard University, Washington, D. C.—$38,417 for studies of the infrared spectra of compressed gaseous mixtures.

Yale University, New Haven, Conn.—$60,772 for investigation of molecular fragments.

Mellon Institute, Pittsburgh, Pa.—$69,302 for investigation of nuclear magnetic resonance.

University of Rochester, Rochester, N. Y.—$25,700 for study of primary photochemical processes in complex molecules.

Virginia Polytechnical Institute, Blacksburg, Va.—$14,016 for study of oxidation of Arsenic 3 and Antimony 2.

California Academy of Sciences, San Francisco, Calif.—$17,650 to study the astronavigation in birds.

International Union of Physiological Sciences, Philadelphia, Pa.—$2,500 to be used for the second international pharmacological meeting.

Brandeis University, Waltham, Mass.—$12,812 to study the effects of extraterrestrial irradiation on nucleic acids and for a comparative study of the evolution of nucleic acids.

University of Minnesota, Minneapolis, Minn.—$40,000 to investigate alterations of brain biochemistry and development of behavior.

University of Michigan, Ann Arbor, Mich.—$26,934 for research on information processing and decision making.

University of New Mexico, Albuquerque, N. M.—$29,859 for investigation of inelastic behavior of material by dislocation phenomena.

George Washington University, Washington, D. C.—$18,178 for studies of a dislocated continuum.

University of Toronto, Toronto, Canada—$12,908 for theoretical investigations of the dynamics of vehicles entering the atmosphere; $14,042 to study aerodynamically generated sound.

Ohio State University Research Foundation, Columbus, Ohio—$94,548 to investigate detonation wave formation in flowing gaseous mixture.

Contracts:

The Warner & Swasey Co., Flushing, N.Y.—$24,709 for study of IR molecular band models, and vibration-rotation line widths and strengths; $42,000 to investigate infrared temperature distribution measurements on combustion gases.

Martin-Marietta Corp., Baltimore, Md.—$35,365 to study the theory of pion-pion and elementary particle scattering; $67,805 to study properties of conduction electronics in ionic crystals; $39,270 to study silver-alumina alloys above the melting point of silver; $46,101 to investigate the theoretical and quantum chemistry of boron compounds.

Massachusetts Institute of Technology, Cambridge, Mass.—$940,000 to the national magnet laboratory.

General Dynamics Corp., Rochester, N. Y.—$17,934 for continuation of research en-



Navy/Boeing HTC Hydrofoil Begins Trial Runs

Fifteen-ton Boeing-built hydrofoil, designated HTC (Hydrofoil Test Craft) by the Navy, is undergoing basic hull-borne trial runs on Puget Sound. Boat was designed to have a top speed of 115 mph. A variety of foils and foil arrangements will be placed on the research vehicle during the test program. Power will be from a turbojet engine mounted between the catamaran hulls of the vehicle.

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QUIET ROOM — Dead sound chamber, 20'x20'x10' for noise level tests. 30-35 db background; measurements as low as 0.0002 g's can be made.

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CRYOGENICS & FUELS TESTING — Facilities for liquid oxygen, hydrogen, helium, nitrogen. Also for 90% H_2O_2 and mono- or bi-propellants, exotic fuels, oxidizers and pyrophoric fuels.

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* The recent acquisition of **Northeastern Testing Laboratories** further expands Aerotest's environmental testing facilities. Besides its work in radiography this new Aerotest subsidiary offers material radiation, metallurgical and chemical analysis, gas analysis, and gaseous leak detection services, both in the plant and at remote locations, with X-ray units available in sizes to 250 KV. **Northeastern** has AEC and military certification for the use of radio isotopes including Iridium 192 and radioactive Cobalt up to 50 Curies.

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titled "High intensity sound propagation."

Bolt, Beranek & Newman, Inc., Cambridge, Mass.—$24,000 for transmission and coding of information in auditory nervous system.

Texaco Experiment Inc., Richmond, Va.—$38,963 to study the properties of ions in flames.

General Electric Co., Cincinnati, Ohio—$10,000 for the third symposium on advanced propulsion concepts.

United Technology Corp., Sunnyvale, Calif.—$48,090 to study combustion of metallic beryllium.

North American Aviation, Rocketdyne Div., Canoga Park, Calif.—$64,088 for research in physical processes of solid-propellant combustion.

Stanford Research Institute, Menlo Park, Calif.—$33,922 to study the detonation characteristics of low density granular materials.

Olin Mathieson Chemical Corp., New Haven, Conn.—$47,427 for study of superoxidizers.

Jonker Business Machines, Inc., Gaithersburg, Md.—$54,206 for study toward implementation of retrieval networks for various fields of science and technology.

AFOSR recently awarded the following grants to European agencies:

Technion Research & Development Foundation, Haifa, Israel—$9,750 to investigate non-binary switching; $2,560 for analysis and applications of the physical tensor; $5,280 to study tactical configurations; $57,200 to study superparamagnetic behavior of solids at liquid helium temperatures; $22,672 to study the aerodynamics of supersonic wings and bodies oscillating at high frequency.

Weizmann Institute of Science, Rehoveth, Israel—$24,000 to investigate the numerical integration of equations of motion of a viscous fluid; $24,800 for investigation of three-body problem in atomic physics; $9,800 for studies on the mechanisms of photophosphorylation.

Hebrew University, Jerusalem, Israel—$15,270 for research in algebra and logic; $29,770 to study mathematical analysis; $102,760 to investigate paramagnetic spin resonance in single crystals; $19,185 to investigate the correlates of ambivalence, risk taking and rigidity.

University of Cambridge, Cambridge, England—$18,820 for theoretical research in high-energy physics and the quantum theory of many-particle systems.

University of Birmingham, Birmingham, England—$15,130 for study of the stability of the body-centered cubic structure in metals and alloys.

University of Durham, Durham, England—$18,600 to study magnetic interactions in dilute alloys.

Naturalia et Biologia, Paris, France—$30,000 to investigate nervous processes underlying behavior and learning.

University of Louvain, Louvain, Belgium—$36,000 to study dynamic behavior of plates and shells while under thermal stresses.

Max-Planck Institute für Stromungsforschung, Gottingen, Germany—$3,060 to investigate interaction of sound and turbulence.

Dublin University, Dublin, Ireland—$8,400 to study rough combustion in liquid-fueled rocket motors.

AFOSR recently awarded the following contracts to European agencies:

Free University of West Berlin, West Berlin, Germany—$26,000 for investigation of nonequilibrium reacting gases and research in quantum field theory.

Compagnie de Recherches et d'Etudes Aeronautiques, Paris, France—$7,400 to study control of circulation around a cylinder in a wind tunnel.

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FRUEHAUF CAPABILITY ADDS TO AMERICAN SPACE AGE MOBILITY

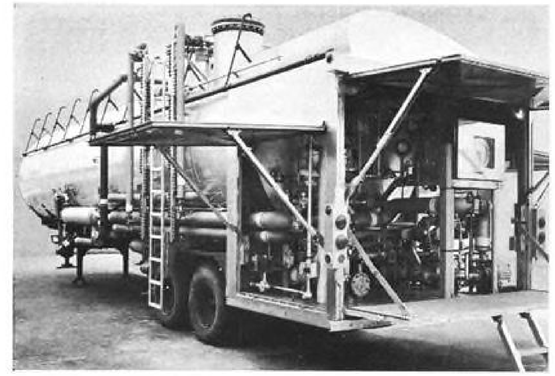
As a leading source for the designing, engineering and manufacture of military sub-systems, Fruehauf has added to America's space age mobility. On both prime and subcontracts, Fruehauf's resources have generated new savings and efficiency on a multitude of ground support and missile systems.

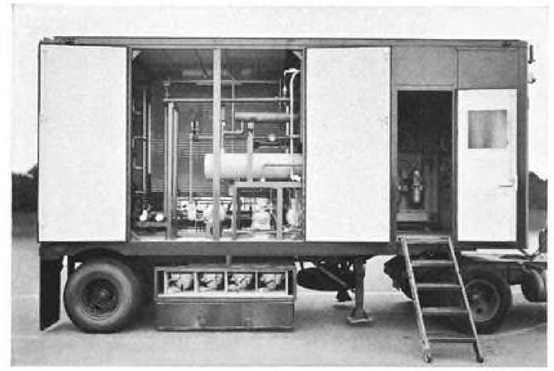
An outstanding example of Fruehauf participation in space age sub-systems, through the liaison of its commercial and military division, is a recent project currently completed for Paul Hardeman, Inc., of Stanton, California, the prime contractor for the U. S. Air Force TITAN II Propellant Transfer System.

To achieve effective mobility, Fruehauf provided the essential equipment for moving the fuel and oxidizer holding tanks, the propellant conditioning system, the control system, as well as the waste disposal equipment. The concept of mobility fulfills the U. S. Air Force's technical requirements for maximum efficiency and illustrates its continuing program of cost reduction and savings to the Government.

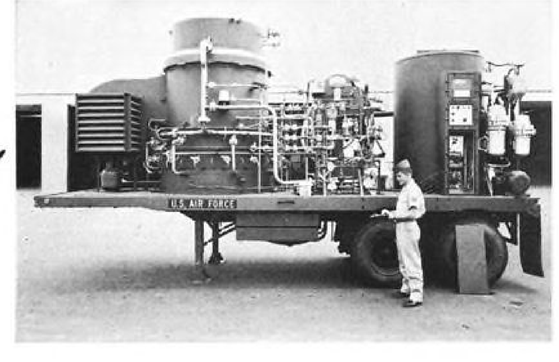
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Destination: EARTH

After a final, over-the-shoulder glance at the craggy lunar scene, moon explorers will apply themselves to the new task at hand—getting back home. How will the lunar declination at time of lift-off be interrelated with earth landing site latitude, time of flight and landing range from re-entry at $\gamma = -6°$ to touchdown?

Curves Provide Key

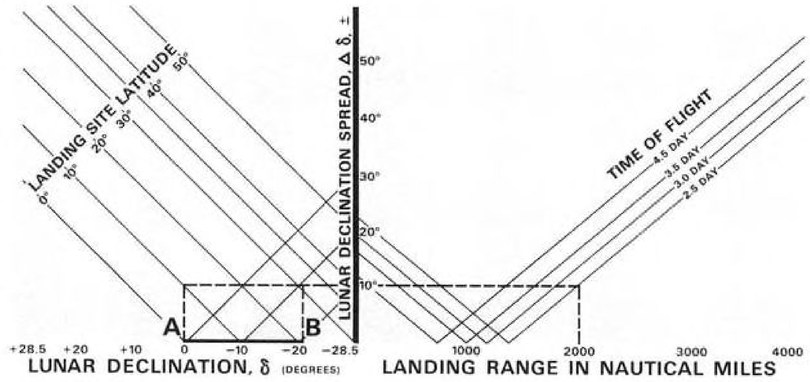
The curves at upper right provide the key. Window AB describes the range of lunar declinations, from $+0.5°$ to $-20.5°$, acceptable for returning to an earth landing site at a latitude of $+10°$, for a 2.5 day time of flight with a landing range of 2000 n.mi. from re-entry at $\gamma = -6°$ to touchdown. The schematic illustration shows the trajectory plane for a lunar declination of $-10°$. As lunar declination varies through the acceptable range shown in the curves, the trajectory plane will rotate around the radius from earth center to landing site.

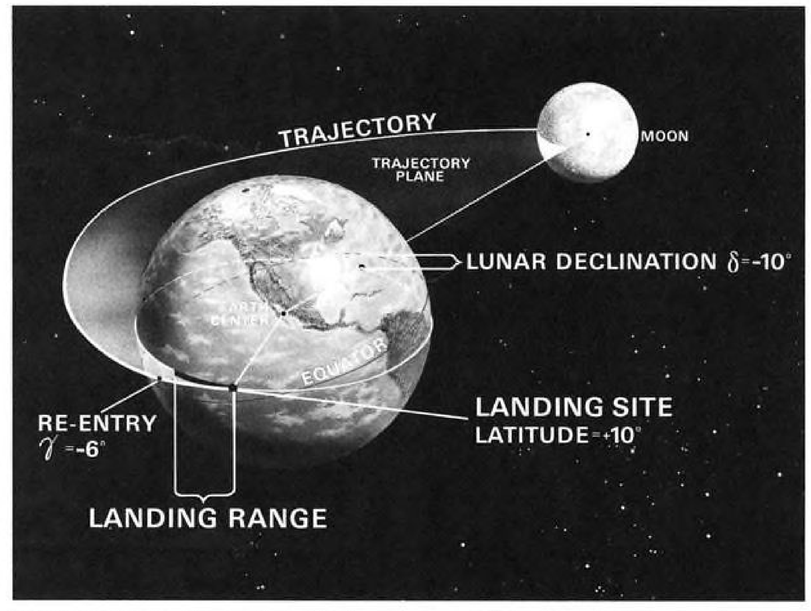
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At Astronautics, we are deeply involved with a great variety of space-oriented activities. These include the design and development of boosters and vehicles to accomplish far-ranging missions as well as the analysis of the paths they will follow. We're developing the precise electronic systems that will guide, track and communicate with the men and machines. Our efforts along many aerospace frontiers are creating a number of opportunities for engineers and scientists with exceptional abilities. If your interests and experience qualify you to fill one of these positions in advanced areas of activity, we urge your inquiry.

Details for Engineers and Scientists

You will find details of current positions on the next page. Your reply, which will be held in complete confidence, can be made on the attached Professional Placement Inquiry form or by writing Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics|Astronautics, 5830 Kearny Villa Road, San Diego 12, Calif.





LUNAR LIFT OFF AT $\delta = -10°$ *Heading for an earth landing site latitude of $+10°$, a vehicle will describe this approximate trajectory over a 2.5 day time of flight. Landing range from $\gamma = -6°$ to touchdown would cover some 2000 n.mi. in this case.*



RE-ENTRY MINUS 60 SECONDS *The earth will present this aspect to returning moon explorers as they near their destination. This photograph was taken at an altitude of 100 miles from a NASA Mercury capsule, boosted into orbit by an Atlas space launch vehicle.*

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A MESSAGE OF INTEREST TO ENGINEERS AND SCIENTISTS

Important positions exist in the following areas:

DYNAMICS ENGINEERING

BS or MS in engineering, physics or math with two or more years of experience and familiarity with the application of analog and digital computer techniques for openings in the following areas:

STABILITY AND CONTROL: to conduct theoretical studies on the control dynamics of large space boosters and space vehicles. To determine stability and transient response of space boosters in the presence of propellant sloshing, elastic bending modes, and non-linear servo characteristics. Must be familiar with analysis and synthesis techniques for establishing and evaluating control system parameters. Background in theoretical dynamics is required to simulate control system environments and general dynamics behavior of space boosters.

STRUCTURAL DYNAMICS: to determine response of an elastic space vehicle to transient loadings such as atmospheric turbulence, engine ignition, vehicle staging. Openings also exist in establishing vibration environment based upon test or empirical data for evaluation of components and systems . . . and for monitoring tests of complete or scaled dynamic models of space vehicles, including layout of test plan, instrumentation requirements, scaling factors, etc.

ADVANCED ELECTRONIC SYSTEMS

Assignments are on such projects as giant boosters, advanced tracking systems and payload programs. Experience should include advanced design work in such electronic areas as guidance, communications, telemetry, data processing systems, antenna systems, or electronic ground support systems. An advanced degree is desirable.

STRESS ANALYSIS

Specialists are required to perform stress analyses on advanced missile and space vehicle designs and associated ground equipment. The development of new analysis methods and test design for evaluation of structural adequacy are additional tasks in this area. BS or MS degree and at least three years of appropriate experience are prerequisites for these positions.

ELECTRICAL ENGINEERING

BS or MSEE with applicable experience required for assignments in launch control systems design, packaging, test equipment, missile electrical power systems or component and systems testing. Openings exist in design, development, vendor qualification selection, and test of ground and airborne missile electrical equipment.

THERMODYNAMICS ENGINEERING

BS or MS in ME or AE to develop design criteria and perform methods development in the area of thermodynamics. Particular considerations are re-entry heating, heat dissipation in free space, and aerothermal heat sources. Should have two years of experience.

INERTIAL GUIDANCE

BS degree in physics, EE or ME and 2 to 5 years of experience in one or more of the following:

TECHNICAL ANALYSIS: scope includes establishment of guidance and flight control system requirements, analysis of system performance, establishment of test parameters and initiation of design changes.

AUTOPILOT DESIGN: assist in the detail design and development of the Centaur space vehicle flight control system. The system includes the autopilot, programming devices, and passive tracking equipment. The designer is also responsible for design of necessary test equipment.

GUIDANCE SYSTEM: requires individual with design and fabrication experience for subcontractor control and to assure that the delivered guidance system is accurate and reliable. To achieve this goal, the tasks range from purest analytical study to configuration control.

DESIGN ASSURANCE and RELIABILITY

Specialists, including top-level supervisory and individual contributors at all levels of professional and academic achievement, with strong backgrounds in either design engineering or reliability, or both.

Tasks involve TECHNIQUE DEVELOPMENT in the following:

SYSTEMS: User-Operations Analysis, Reliable System Design, System Reliability Models, Cost-Effectiveness Evaluation, Man-Machine System Analysis;

COMPONENTS: Reliable Hardware Design, Hardware Analytic Evaluation, Component Evaluation, Parts and Materials Selection, Specification Criteria, Supplier Programs and Evaluation.

Openings exist for experienced engineers with applied higher mathematics education, preferably in statistics. BS degree required, higher degrees preferred. Circuit analysis with transistor and diode experience is also desirable.

AERODYNAMICS

BS or MS in AE or ME with experience in aerodynamic loading, hypersonic or supersonic flow, calculation of aerodynamic coefficients, and trajectory determination, to perform research and development into the space flight regime and space environmental conditions. Must have above average analytical ability.

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**If the inquiry card has been removed, or if you wish to furnish or request more detailed information, please write to Mr. R. M. Smith, Chief of Professional Placement and Personnel, Mail Zone 130-90, General Dynamics | Astronautics, 5830 Kearny Villa Road, San Diego 12, California.*

Openings also exist for graduate engineers in the following:

STRUCTURAL DESIGN, RELIABILITY, ELECTRONIC DESIGN AND DEVELOPMENT, OPERATIONS AND SYSTEMS ANALYSIS, WELDING ENGINEERING, MECHANICAL DESIGN, STANDARDS AND CALIBRATION LABORATORIES, and TECHNICAL WRITING.

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FAA, ATA Shown Anti-Collision System

Great Neck, N. Y.—Laboratory model of an airborne anti-collision system, which is adaptable to a fully automatic collision avoidance system or a less expensive, lighter-weight proximity warning indicator, was demonstrated recently by Sperry Gyroscope to members of the Federal Aviation Agency's collision prevention advisory group and the Air Transport Assn.

The Sperry system is a cooperative type that requires compatible elements in both aircraft involved in a collision threat before either is protected, similar to systems developed by Bendix Radio and by the National Co.

Sperry estimates that the fully automatic collision avoidance system (CAS), which evaluates the threat, alerts the pilot only when a hazard exists and shows him the required evasive pitch-axis maneuver, would weigh about 120 lb. A proximity warning indicator (PWI), which merely displays potential threats and requires pilot evaluation for evasive action, is estimated to weigh about 90 lb.

Stripped-Down Model

A stripped-down model suitable for smaller aircraft, which would enable them to be "seen" by larger, fully equipped aircraft, is estimated to weigh about 40 lb. The pilot of such minimum-equipped aircraft would largely depend upon the fully equipped airplane performing the required evasive maneuver, except where the minimum-equipped aircraft is climbing or descending and receives a "level-out" alarm from the aircraft equipped with the complete system.

Sperry built the present feasibility model under an FAA contract totaling $360,000, but initiated early work on the concept with company funds. Present contract funds will run out within 60 days and FAA has no present plans to extend the work into flight test phase pending results of basic computer studies (see box on p. 107).

The Sperry system is the most sophisticated and perhaps the most discriminating CAS/PWI to be developed to date. As the company points out, "the primary problem is not the detection of a potentially threatening aircraft, but discrimination against non-threatening aircraft and selection of the proper evasive maneuver when required." The problem of discrimination is one on which many CAS/PWI concepts have foundered. The evasive maneuver used by Sperry is the change in altitude first proposed by Bendix Radio for its CAS system.

Radar Beacon

The new system employs radar beacon techniques that bear some similarity to those used in the air traffic control transponders, but the latter can not be used for the CAS/PWI function. A fully equipped aircraft carries a flush-mounted rotating antenna which scans in azimuth at the rate of one-half revolution per sec., transmitting an interrogation message containing five suitably spaced pulses which indicate the interrogating aircraft's own barometric altitude.

When the narrow directional rotating beam from the interrogating aircraft is received by another equipped aircraft, the altitude of the interrogator is compared with the barometric altitude of the second aircraft. If the two are separated by more than the specified altitude guard band, the second aircraft does not reply.

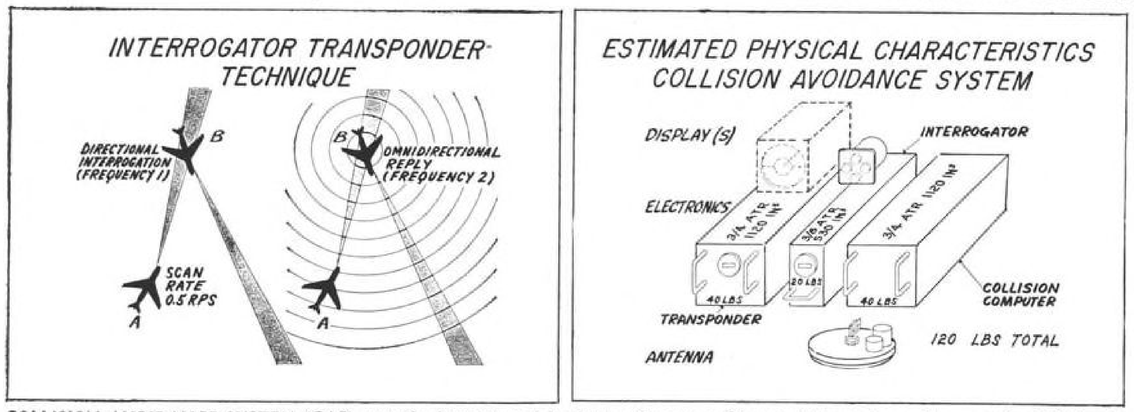
Current thinking is that the altitude guard band would be ±600 ft., except for aircraft that climb and descend at extremely high rates, such as military or supersonic transports.

Message Reply

If, however, the two aircraft are within 600 ft. of the same altitude, the second aircraft replies with a message containing seven pulses.

This message tells the interrogator the direction in which the second aircraft is flying and its airspeed in terms of the north-south and east-west components of its velocity.

By measuring the time delay between interrogation and receipt of the reply, the interrogator's computer can calculate the separation distance, while the position of the rotating beam at the instant the signal is received indicates the relative bearing of the second aircraft. All of this information, plus data on the interrogating aircraft's own heading and airspeed, are fed into an analog computer which then determines if the present situation will bring the two aircraft into close enough proximity to constitute a collision threat. The minimum distance criteria which constitutes a threat will depend upon the airspeed of the two aircraft involved, currently estimated to be about 1 mi. for subsonic



COLLISION AVOIDANCE SYSTEM (CAS) recently demonstrated by Sperry Gyroscope Co. uses interrogator and transponder, left, in aircraft to evaluate threat and show pilot required escape maneuver direction. However, smaller aircraft could carry only the 40-lb. transponder to make presence known to fully equipped aircraft, depending upon latter to take evasive action. Present Sperry estimate of size and weight of full CAS is shown in sketch, right. A lighter-weight proximity warning indicator function also is possible.

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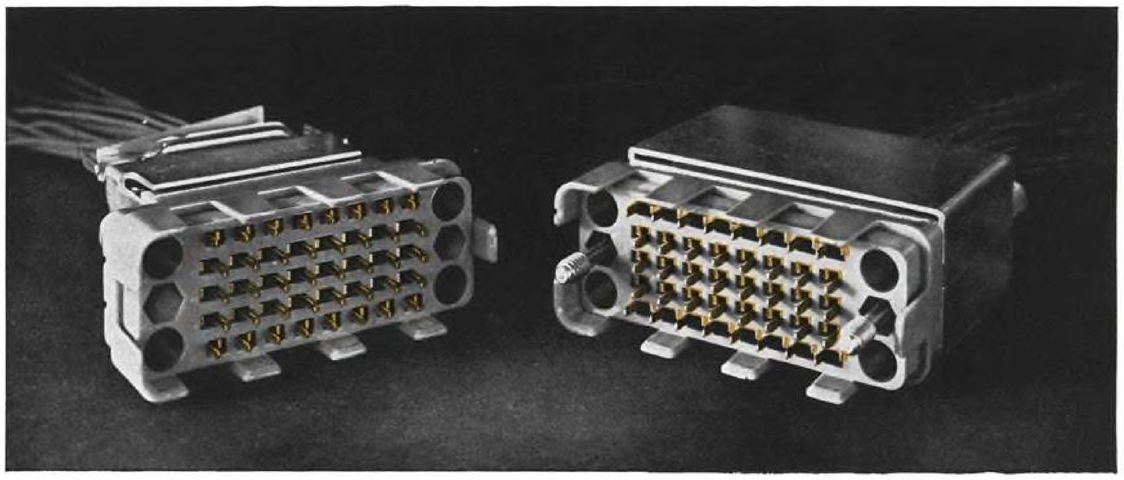




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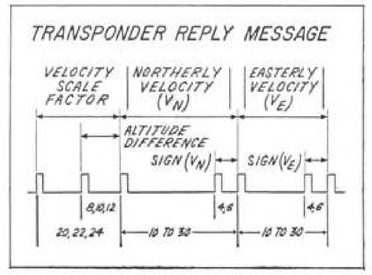
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TRANSPONDER COMPARES own-aircraft altitude with that of interrogating aircraft, or its projected altitude if climbing or descending and responds only if there is potential threat. Reply indicates altitude difference if threat exists by spacing between pulses two and three. Space between first and third pulses indicates general speed range of transponding aircraft while spacing between pulses three and six, and six and eight gives transponding aircraft airspeed in north-south and east-west coordinates.

be changed to 10 or 12 microseconds to provide a greater altitude separation guard-band.

When the interrogator aircraft is involved with a transponder-only equipped aircraft which is climbing or descending so that the escape maneuver is more convenient for the latter, the space between pulses four and five is increased from four microseconds to six to indicate a "level-out" signal to the intruder.

The seven-pulse transponder reply message varies the spacing between first and second pulses to show aircraft's speed range (0-300 kt., 0-800 kt. or supersonic), while the spacing between the second and third pulses tells the interrogator the difference in barometric altitude between the two aircraft. Spacing between pulses three and five and between five and seven tells the transponder aircraft's airspeed in a north-south and east-west direction, respectively.

During the laboratory tests here, Sperry introduced random pulses, shaped identical to those used for the interrogator and transponder messages, to simulate the spurious noise pulses which would be experienced in a multi-aircraft environment. This produced an occasional brief false alarm, which quickly disappeared when it failed to correlate with a subsequent interrogation. Theoretical analyses and experimental investigations indicate that an operational CAS system should experience a false alarm only once every 60 hr., according to Clem McKown, project engineer.

The system in present laboratory configuration uses 511 transistors for the full CAS system, but some simplification may be possible in production design, a company spokesman said. While Sperry is reluctant to estimate price for



SYSTEMS MEN: CONTACT MITRE

Because of the increasing need for more advanced defense systems, MITRE is expanding its technical staff.

MITRE's prime mission:

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- To explore every possible technique that might give the military commander extra seconds for decision and action.

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Here are listed the specific assignments now available — and information about how to get started, today, towards a rewarding career at MITRE.

Currently assignments are available in the following broad areas:

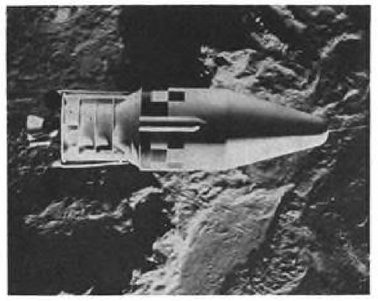
- Management Systems
- Data Processing Development
- Computer Applications
- Air Defense Systems Design
- Operations Research
- Communications
- Human Factors
- Range Instrumentation
- Advanced Systems
- System Cost Analysis
- Econometrics
- Radar Systems and Techniques
- Air Traffic Control
- Space Surveillance
- Space Systems Command and Control
- Astrodynamics

Minimum requirements, B.S., or M.S., or Ph.D. in these disciplines: electronics, physics, and mathematics. MITRE is located in pleasant, suburban Boston. Rewards are competitive. Write, in confidence, to Vice President — Technical Operations, The MITRE Corporation, P.O. Box 208H, Bedford, Massachusetts.

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Pioneer in the design and development of command and control systems, MITRE was chartered in 1958 to serve only the United States Government. The independent nonprofit firm is technical advisor and system engineer for the Air Force Electronic Systems Division and also serves the Federal Aviation Agency and the Department of Defense.





Here, at Lockheed Missiles & Space Company's Space Communications Laboratory, scientists are re-investigating the possibility of using the moon to facilitate earth communications. Possibilities for the use of the moon as a relay station for earth-to-earth communications have been largely neglected because the moon's shape and rugged surface greatly distorted a return signal. But Lockheed research into the extension of communications on difficult communication channels, using techniques applicable to dispersive time variant channels, is making significant inroads into this problem.

Another area receiving intense study at Lockheed is satellite tracking of deep space probes. Since tracking accuracy depends greatly on stations being as far from each other as possible, while retaining line-of-sight communications, Lockheed is studying the use of two earth-orbiting satellite tracking stations, 8000 miles apart. Not only would great accuracy be gained by the separation, but it would be further enhanced by the positioning of the stations above the earth's atmosphere, thus eliminating atmospheric distortion.

Examples of other research projects being pursued by Lockheed in the communications area include: Random multiplexing, satellite readout techniques, scatter communications, radar mapping, submarine tracking, modulation of optical energy, communications over multipath channels, and learning systems.

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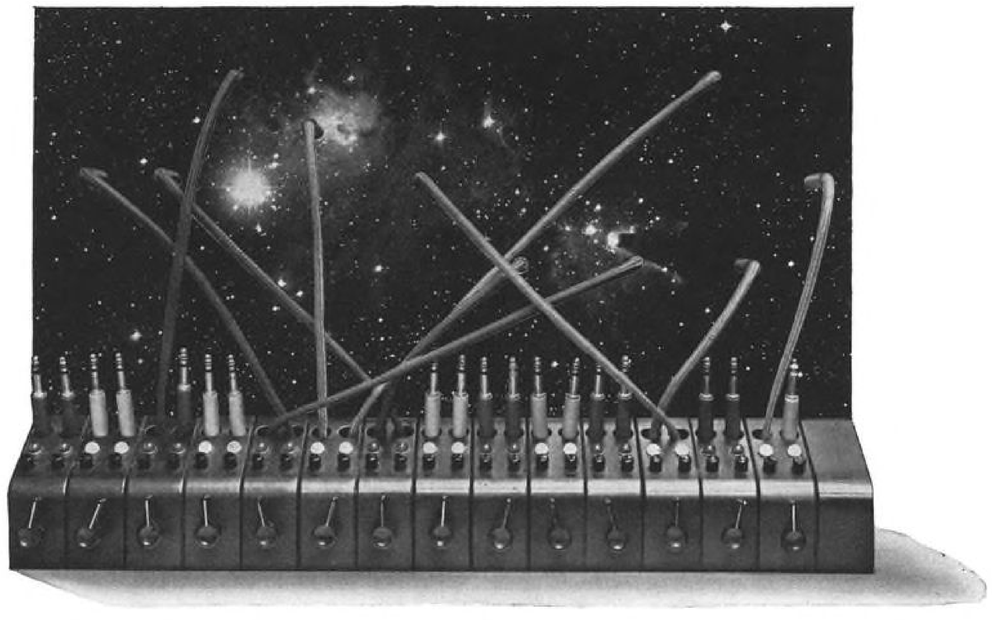
MISSILES & SPACE COMPANY

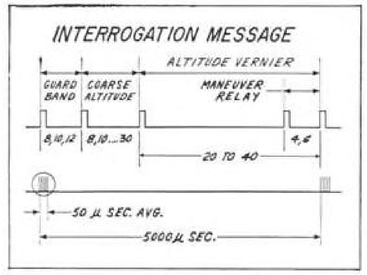
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INTERROGATION MESSAGE transmitted by each equipped aircraft consists of five pulses. Altitude of interrogating aircraft is indicated by spacing (in microseconds) between second and third pulses and between third and fifth pulses. If interrogating airplane is climbing or descending at very high rate of speed, requiring larger altitude guardband, pulse space between first and second will be increased. If interrogating aircraft, after receiving transponder reply, determines that other aircraft is climbing/descending into collision threat and does not have full anti-collision system, the interrogating aircraft changes spacing between fourth and fifth pulses to tell other aircraft to level out to avoid collision.

a production CAS system at this stage, an airline spokesman estimated it would cost $30,000 to $40,000 per aircraft. A Sperry spokesman said that large-quantity production units could be available three to five years after a decision was made to adopt the system—a decision which does not appear imminent.

The FAA at present has no plans nor funds allocated for flight tests of the Sperry system. Earlier, the FAA sponsored flight tests of the flush-mounted Luneberg lens-type scanning antenna and subsequently funded construction of the present laboratory equipment. The flight-tested antenna operated at X-band, but Sperry says a production system probably would be designed to operate at K_a band.

FILTER CENTER

▶ **Optical Transistor Promising**—New optical transistor recently announced by International Business Machines Corp., in which infrared light generated by gallium-arsenide junction is the mechanism for transferring energy to second junction rather than electron-hole carriers as in a conventional transistor, opens up the possibility of using a variety of new semiconductor materials with short carrier lifetime, Robert N. Rediker of Lincoln Laboratories reported at the recent Institute of Electrical and Electronic Engineers convention. The new optical transistor may be able to operate at frequencies as high as those obtained with mesa transistors, but it should be less expensive to fabricate, Rediker predicted.

▶ **Computer Reads Hand Printing**—Technique that permits automatic reading of hand-printed alpha-numeric characters and is largely unaffected by character size, style, tilt, thickness or position on the paper, was reported to the IEEE by Frank P. Kuhl, Jr., of Sperry Gyroscope Co. A general purpose computer can be programed to recognize character by its contour, number of free ends and the presence or absence of sharp angles, Kuhl said.

▶ **Monopulse Log Spiral Antenna**—Simple, lightweight log-spiral antenna which provides simultaneous sum and difference type patterns over a 5:1 frequency range, with constant beamwidth and gain, was reported to the IEEE convention by R. W. Logan, Airborne Instruments Laboratory. The antenna, consisting of a four-arm conical log-spiral array axially fed from a set of baluns and hybrid couplers, provides a circular polarized pattern with ellipticity ratio of better than 2 db. over the frequency range and over an angle of ±60 deg., Logan said.

▶ **Transistor Sampling Switch**—New mode of transistor operation which permits its use for high-speed analog-voltage sampling at rates above 100 kc. was reported at IEEE convention by Seening Yee of Sperry Gyroscope Co. Silicon precision alloy transistor with an "off" state impedance of 1,000 megohms is operated in what Yee terms a "neutral mode" in which both emitter and collector current are directed into the transistor. When emitter current is limited to small values, the collector drop also is very low. Several hundred such switches can be connected in parallel, because of the very high open impedance of each device, and operated as a multiposition sampling switch.

▶ **Sprague Moves Into Microcircuits**—Sprague Electric, one of the nation's largest electronic component suppliers, is moving into the semiconductor microcircuit field and hopes to have sample quantities available by this fall. Company recently announced its entry into the thin-film microcircuit field.

▶ **Long-Lived Transistor**—Not a single failure occurred during a total of 2,287,968 hr. of life testing on the Philco 2N2651 planar silicon transistor, company says, despite the fact that 56% of the tests were carried out with units operating above their maximum rating of 360 mw. at 25C temperature and less than 15% were operated under maximum rating. Subsequent high-stress tests above maximum ratings produced only four failures in 1,151,668 accumu-



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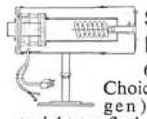
325 – 5,000 volt with output to 20,000 joules.
330 – 10,000 volt with output to 20,000 joules.

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Model 322–Complete, self-contained Power Supply and Energy Storage. Voltage continuously variable 0 to 3,000. Output to 800 joules.



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6 models available. Choice of air or liquid (nitrogen) cooling for helix or straight arc flash tubes. Maximum powers, 2,000 to 20,000 joules.

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SPECIAL DEVICES...
Model 3C-4000 Rotary Arc Quench for fast quenching.
Model 3C-4039 External Reflector
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ELECTRO POWERPACS, INC.
A subsidiary of Hydra-Power Corp.
12 Hadley Street
Cambridge 40, Mass.

lated hours, giving a failure rate of 0.35%/1,000 hr., Philco says.

► **Army Seeks Silicon RF Amplifier**—Industry proposals for 12-month research effort to develop a universal radio frequency amplifier on a single silicon chip are due at Army Electronics Materiel Agency, Fort Monmouth, N.J., by Apr. 29. Amplifier is to be designed to perform functions of a video amplifier, narrow-band amplifier, mixer and oscillator. An external crystal can be used for some functions, Army says.

► **Executive Communications**—Recent survey of Raytheon executives reveals that they spend 90% of their time in some form of communications, company says. Survey indicates that 35% is spent listening, 30% in talking, 16% in reading and 9% in writing. Raytheon has installed two-way, citizen-band radios in the cars of its executives to enable them to talk with their offices while driving between any of the company's 26 plants and laboratories in eastern Massachusetts.

► **Straws In The Wind?**—Industry observers, remembering that the first signs of semiconductor industry market saturation were price cutting and sell-offs of transistor operations, are speculating that the computer/data processing field may be reaching a similar situation. Recently, the Bendix Corp. sold its computer division to Control Data Corp. of Minneapolis, withdrawing from the commercial computer business. Packard Bell Electronics has just announced price cuts of as much as $7,000 on its PB-250 computer, a reduction of 17½% from its former $40,000 price tag. Earlier, the company had cut prices on its expanded memory computers. General Mills, Inc., a comparatively late entry in the digital computer field, recently has decided to withdraw completely from the computer market.

► **Improved Polaris SINS Navigators**—First of the improved SINS Mark-2, Mod.-2 inertial navigation systems for use on 10 Lafayette-class Polaris submarines has been delivered by North American's Autonetics Div. Improvements include a new computer of enlarged capacity with trouble-diagnosing capability, improved integrating accelerometers and gas-spin bearing gyros with a beryllium shaft.

► **Signed on the Dotted Line**—Major contract awards recently announced by avionics manufacturers include:

• **Martin Co.**, Orlando, Fla.; **Motorola**, Chicago; and **Radio Corp. of America**, Camden, N.J., have been selected to develop random access communication systems (RADA) by Army Electronics Materiel Agency. Each company contract is for nearly $2 million.

• **Radio Corp. of America**, Electron Tube Div., will build 72 klystron amplifiers for use in two-mile-long linear accelerator being built by Stanford University under Atomic Energy Commission contract. Each tube will deliver 24 megawatts of peak power in pulses 2½ microseconds duration with a repetition rate of 360 pulses per second. Sperry Rand Electron Tube Div. also is building same number of 24-megawatt klystrons which will operate at 2,856 mc. Total of 240 klystrons will be used to generate 10-20 billion electron volts.

Chemical Source for Pumping Lasers Studied

Los Angeles—USAF's Space Systems Div. is sponsoring development of a lightweight, medium-power, fast-repetition-rate chemical source for pumping lasers. Proposals for the nine-month, 5,000-manhour task were to be submitted last week.

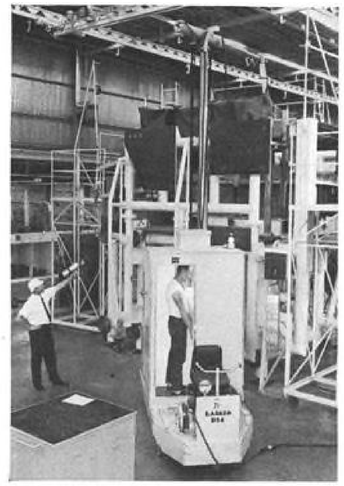
Philosophy behind the program is that optical masers (lasers) have reached a state of development so that consideration can be given to specific military systems utilizing lasers, but that laboratory versions of lasers are not feasible for a self-contained powerpack in a field or space environment because of size, weight and component complexity.

Use of flash powders and explosives are seen by SSD planners as definite possibilities, utilizing either direct conversion of energy to laser pumping light or through an intermediate electrical energy stage. Such a pump source, SSD feels, would be light in weight, insensitive to severe environmental conditions, simple and handy for personnel use. Broad object of the program will be:

• Development of a chemical energy source in the 1,000 to 10,000 joules-per-pulse range, incorporating simple, compact construction and repetitive operation near one pulse-per-sec. on the same laser crystal.
• Construction of an engineering model of a chemically pumped ruby laser.
• Investigation of extension of the basic scheme to energies near 100,000 to 1 million joules or higher.

Contractor efforts will include at least output energy pulse width of less than 500 microsec. and laser operation for 5 min. on a few pounds of chemicals.

Pumping source emission spectrum will be analyzed to consider possibility of optimizing spectral output by changing gas mixtures.

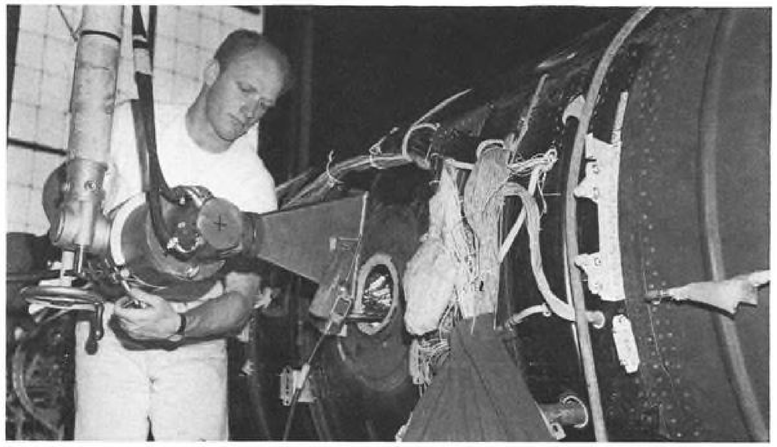


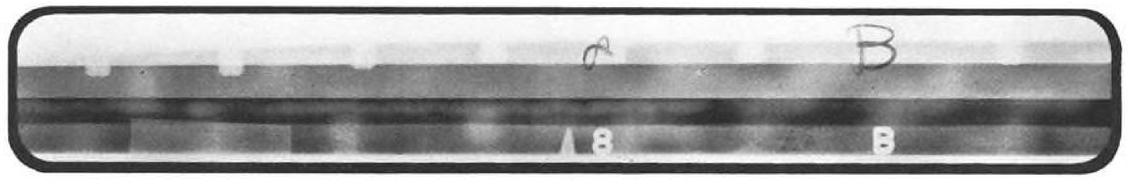
The "Cherry Picker" reaches hard-to-get-to places.

The x-ray head is positioned to radiograph a seam weld on the X-15.

Radiograph of butt weld made on "Cherry Picker" rig. Shooting through honeycomb panels and a silver-brazed area.

The weld can't come to the X-ray—
SO the X-ray goes to the weld





NOW . . . Ready Pack in ROLLS and SHEETS—
KODAK Industrial X-ray Film, Types AA and M in listed sizes.

- No darkroom loading — film sealed in lighttight envelope.
- Just place Ready Pack in position and expose.
- Film protected from dust, dirt, light, and moisture.
- In the darkroom, remove film from envelope and process.

North American Aviation, Inc., Los Angeles Division, designed a "Cherry Picker" for on-line radiography of parts and welds on supersonic aircraft

Radiographic inspection of fusion welds is so important, North American Aviation designed a mobile x-ray truck. It was quickly dubbed the "Cherry Picker." It can be maneuvered into confined areas, reach up twenty-seven feet and outward twelve feet. An X-15 fuselage or airplane's honeycomb panel can be examined without being removed from the working jig.

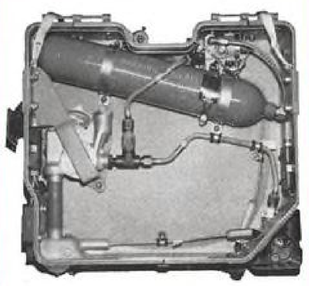
Radiography is increasingly important in proving the soundness of welds, of castings, of concealed assemblies. Companies large and small rely on radiography for assurance that only high-quality work is delivered—highly important in maintaining the kind of reputation that attracts and holds business. It can work for you too. To find out how, contact an x-ray dealer or write us to have a Kodak Technical X-ray Sales Representative call.

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Scott life support components for the A3J are integrated into the compact individual crewman's survival kit assembly.

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The "Vigilante" installation is typical of Scott's capability in the research and development of versatile environmental control and life support systems to meet fast-changing requirements in aviation and aerospace fields.

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Angular Motion Compensator

Angular motion compensator, Compen-Theta Model AAC-252R, is designed to improve accuracy of avionic and control systems by compensating



for repeatable angular position errors.

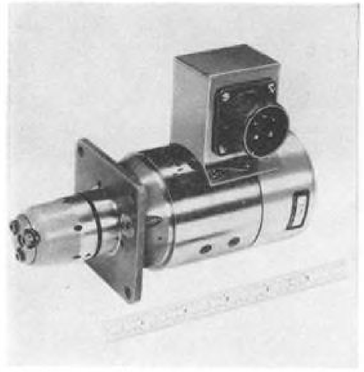
Unit has a series of adjustable cam mechanisms that function as precision variable shaft couplings. Device has 36 radial adjustment points at 10-deg. intervals. Each point is independent of the others. Unit measures 3 in. in diameter and has a repeatable accuracy of ±30 sec. over a total adjustment range of 2 deg.

American Aerospace Controls, Inc., 123 Milbar Blvd., Farmingdale, N. Y.

Miniature Hydraulic Pumps

Series 68-000 miniaturized, variable-displacement hydraulic motor-pump package is designed to supply hydraulic power for aircraft and missile control systems.

The series includes 1, 3, 5, and 7 piston variable displacement pumps driven by a.c. or d.c. motors. A typical unit delivers 0 to 0.35 gpm. at 3,000 psig., measures 6.6 in. in length, and



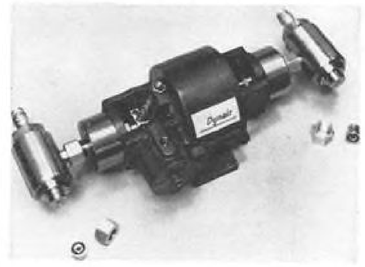
weighs 4 lb. Units with pump displacement as low as 0.008 cu. in. per revolution and discharge pressure of 5,000 psig. are available.

Over-all package efficiency is from 61% to 64% at maximum flow rate, according to the manufacturer.

Hydro-Aire Div. of Crane Co., 3000 Winona Ave., Burbank, Calif.

Air-operated Fluid Pump

Portable fluid pump (CVP Dynair) for hydraulic system checkout and other applications develops 10,000 psi. fluid



pressure from an air bottle charged to 80 psi. maximum.

Air-driven reciprocating pump delivers two full pumping strokes for each operating cycle to supply fluid. Fluid pressure, directly proportional to air pressure, can be governed by an air regulator. Operation is automatic once the regulator has been set. Pump operates until discharge pressure is equal to the total force exerted by the large piston of the air motor. When discharge line pressure drops, the pump restarts and restores the pressure balance.

Combination Pump and Valve Co., 851 Preston St., Philadelphia 4, Pa.





WREN 460 STOL AIRCRAFT (left) uses full-span flaps, ULS control system to achieve short-field capability. Note movable vortex generators located on aircraft's wing (right).



Aviation Week Pilot Report:

Control Features Boost Wren 460 STOL

By David A. Brown

Ft. Worth—Excellent pitch control down to minimum flying speed of 24 mph., coupled with a lateral control mechanism which reduces aileron-induced yawing at very low airspeeds, give the Wren 460 bush airplane the capability of operating from 300- to 400-ft. landing and takeoff areas.

Flown here recently by this AVIATION WEEK & SPACE TECHNOLOGY pilot, the Wren, a short takeoff and landing development of the Cessna 182, showed adequate controllability in all axes through its entire speed regime.

Wren embodies a modified version of the nose-mounted control surfaces developed by designer James L. Robertson for Army's Transportation Research Command (AW May 28, p. 89) and has a Cessna Skylane airframe fitted with double-slotted, Fowler-type flaps and a drooped leading edge on the wing.

Movable vortex generators mounted atop the wing and interconnected to the ailerons damp aileron-induced yaw when the aircraft is operating at low speed, and they do not noticeably affect its performance at higher speeds.

Wren Vice President-Production A. E. Morris flew in the co-pilot's seat during the flight from Ft. Worth's Meacham Field. Wind was from the south at 6-10 mph. and the temperature was approximately 35F.

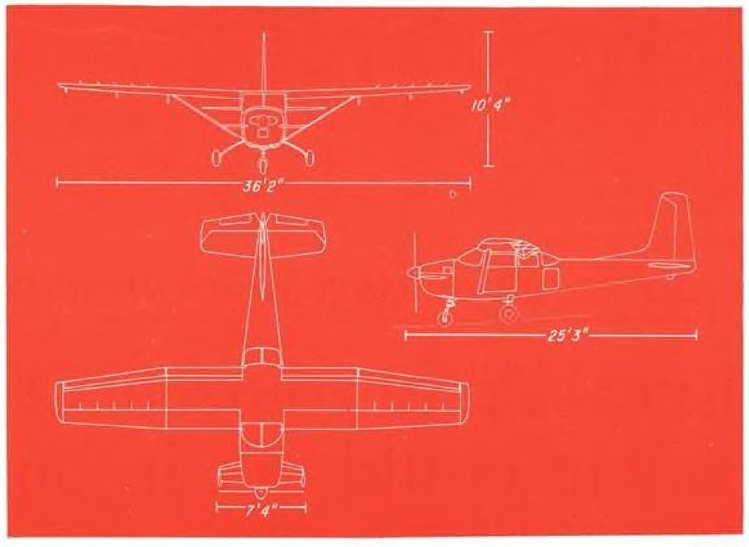
Internally, the Wren cabin is identical to the original Cessna. Only change made has been installation of a push-pull control rod from the control column forward through the firewall to the nose-mounted ultra-low speed (ULS) control surfaces.

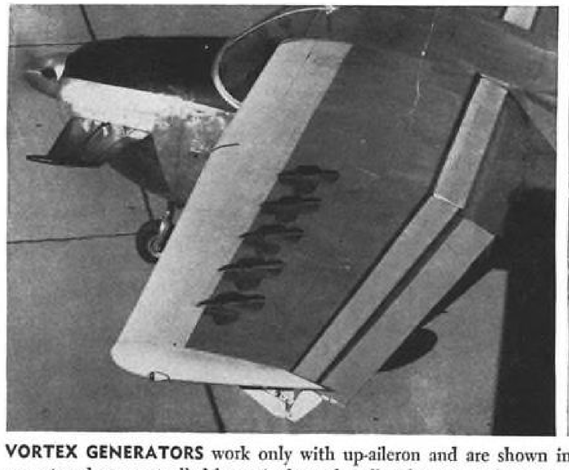
Additional instrumentation consisted of an indicator for a Weather Bureau-type anemometer mounted on the right wing strut. The device provided accurate true airspeed readings in the low-speed range where conventional airspeed indicators are inaccurate.

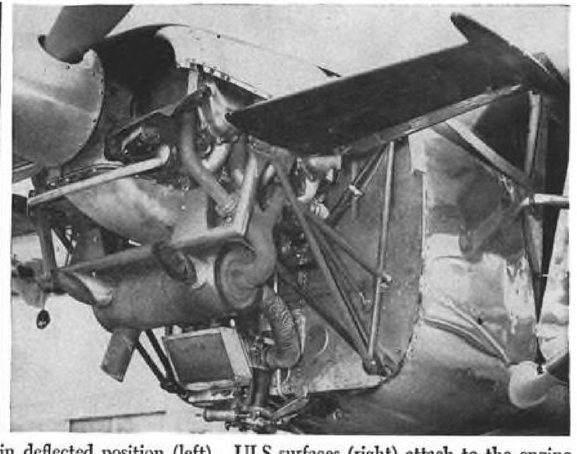
Flaps were lowered 30 deg., brakes were set and the 230-hp. Continental O-470-R engine was advanced to full power. Cruise trim setting was used for takeoff.

Brakes were held until some slippage was felt, then released. Positive rotation

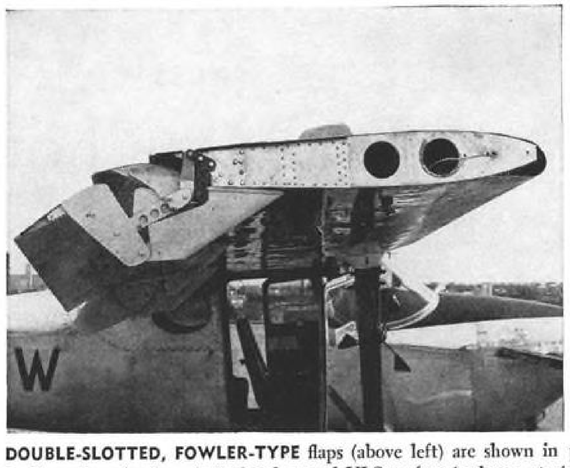
Performance

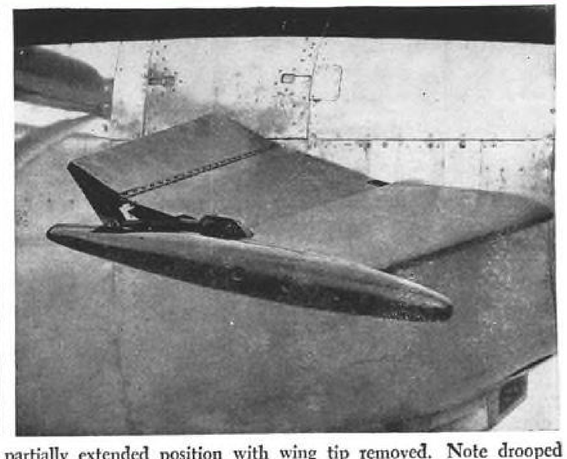






VORTEX GENERATORS work only with up-aileron and are shown in deflected position (left). ULS surfaces (right) attach to the engine mount and are controlled by a single push-pull rod connected to the conventional elevator control system.





DOUBLE-SLOTTED, FOWLER-TYPE flaps (above left) are shown in partially extended position with wing tip removed. Note drooped leading edge of wing. Articulated canard ULS surface is shown at right. Three-view (center) shows dimensions of the Wren.

was begun when the anemometer indicated an airspeed of 25 mph. and the Wren came off the ground immediately. Takeoff roll was about 125-150 ft.

Brakes were applied to stop wheel shimmy, power was reduced to climb configuration (23 in. Hg. manifold pressure and 2,300 rpm.) and the flaps were eased up. Flap control is still the original Cessna floor-mounted lever. Flap settings on the Wren prototype are 15, 30 and 60 deg., although the flaps are capable of being extended to 70 deg. Production aircraft will have flap settings of 20, 40 and 60 deg.

Rapid Acceleration

The aircraft accelerated rapidly as the flaps were raised. With the flaps fully up, the Wren flies and handles much like an unconverted Cessna. Robertson says there is approximately 1% more frontal area on the Wren than on the original aircraft. This causes a drop in maximum speed of about 11 mph., but some of this—Robertson estimates about 6 mph.—is regained through the use of drooped wing leading edges.

Immediately after lift-off, the Wren climbed steeply with the nose slightly above the horizon. As the flaps were raised, the nose held about the same attitude, but the rate of climb decreased and airspeed increased.

Major divergence from the unconverted Cessna noted during the first few minutes of familiarization flying was that the lateral control system was quite stiff and an unusual amount of force was needed to turn the control wheel.

This did not reduce the effectiveness of lateral control, but it did make maneuvering the aircraft tiresome. Since the flight, ball bearings have been installed in the aileron system to ease this problem and some of the tension has been taken out of the cables in the wing.

With the flaps up, it was possible to hold the aircraft to about 60 mph. and maneuver comfortably. Flaps were then lowered 15 deg. and slow flight at 50 mph. was attempted. Maneuverability remained good and the aircraft did not feel mushy or excessively heavy on the controls.

With flaps lowered to 45 deg., flight control speed dropped to 40 mph. and the feeling of adequate control power remained. Aileron response rate showed tendencies of becoming noticeably slower at this speed, but it remained positive.

With full 60-deg. flaps, the Wren maneuvered nicely at 30 mph. and would make tight 360-deg. turns in the 30-35 mph. speed range. It was possible to make a 180-deg. turn in 11 sec. without pulling excessive g-forces and to make a 360-deg. turn in 19.5 sec. Turn radius appeared to be about 150 ft.

Considerable maneuvering was done with flaps down, and the speed never exceeded 35 mph. During the slow flight work, the Wren maintained good lateral and pitch control and there were no detectable areas where control surfaces were blanketed out or where control force available was so low that safety was jeopardized.

Stall Characteristics

Care must be taken, in fact, to limit the amount of back pressure used on takeoff, since control force is sufficient to stall the aircraft with power on. With power off, the aircraft will not stall. Full back pressure on the control wheel with flaps down and power off will set up a slightly nose-high glide at about 40 mph. forward speed and a rather high rate of sink. Control response in the glide remains good, especially laterally.

Power stalls were first attempted with flaps up and the engine retarded to 15 in. Hg. manifold pressure and 2,200 rpm. The Wren stalled cleanly forward at about 42 mph.

With 15-deg. flaps lowered, the aircraft stalled at 38 mph., again forward, and with 30-deg. flaps, it stalled at approximately 30 mph.

Final stall was with full 60-deg. flaps and the airplane fell through at 24 mph. The Wren was maneuvered at 26 mph. (precise speed control was possible by flying with reference to the anemometer gate in the cockpit, pictured on p. 121), and was fully controllable.

Again, aileron response rate was slower than at higher airspeeds but yaw tendency was not noted, even when aileron deflections were large.

Of note during the slow flight work was the movement of four strands of yarn tufting taped to the right wing strut. Airflow over the struts with full flaps was slow enough so that at times the tufts were hanging almost limp. An occasional turbulent gust would turn them forward, but these gusts apparently were not strong enough to affect stability, since they did not disturb the aircraft nor could they be felt in the controls.

Wren Landing

Landings were made both into the wind and into a slight crosswind from the left, although the breeze was so light as to be negligible.

Aircraft was stabilized at 60 mph. on the downwind leg and trimmed nose high with flaps still up. First 15 deg. of flaps was lowered, which caused the nose to pitch down below the horizon. Aircraft then was retrimmed nose up and no further trimming was needed

Wren 460 Specifications, Performance

Performance and specifications of the Wren 460 and the unmodified Cessna 182/Skylane series are listed below. Performance figures are for sea level, standard day, full gross weight, unless otherwise noted. Left and top figures in right column refer to 182. Right and bottom figures in that column refer to Skylane.

	Wren 460	Cessna 182/Skylane
Empty weight	1,595 lb.	1,555/1,635 lb.
Useful load	1,205 lb.	1,245/1,165 lb.
Gross weight	2,800 lb.	2,800 lb.
No. of seats	4	4
Fuel capacity	65 gal. (84 gal. optional)	65 gal. (84 gal. optional)
Top speed, sea level	160 mph.	167/170 mph.
Cruise speed, 75% power, 6,500 ft.	153 mph.	159/162 mph.
Minimum speed, power on	24-26 mph.	.....
power off	35 mph.	.....
Range, 75% power, 60 gal.	658 mi. at 153 mph.	685 mi. at 159 mph. 695 mi. at 162 mph.
Rate of climb, sea level	972 fpm.	980 fpm.
Service ceiling	18,900 ft.	18,900 ft.
Takeoff distance, no wind	300 ft.	625 ft.
2,200 lb. gross, 10 mph. wind	150 ft.	.....
gross weight, no wind, over 50-ft. obstacle	500 ft.	1,205 ft.
Landing distance, ground roll	200 ft.	590 ft.
over 50-ft. obstacle	350 ft.	1,350 ft.
Length	25 ft. 3 in.	27 ft. 4 in.
Height	10 ft. 4 in.	9 ft.
Wingspan	36 ft. 2 in.	36 ft. 2 in.
Wing area	175 sq. ft.	174 sq. ft.

A frank message to a career-minded engineer:

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Advanced Systems Development—staff engineer—B.S. and engineering degree—6 to 10 years' experience related to military tactical battle field missions. Intimate knowledge of Army, Marine, Air Force and Navy tactical problems necessary. A broad technical background in military organizations and their field requirements is essential. Individual will work directly with engineering management in planning, scheduling, staffing, etc., for the weapons system group.

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for the balance of the landing approach. More trim is needed than for a conventional Cessna, but once the trim is stabilized for the 15-deg. flap setting, it may be disregarded for the remainder of the approach.

Flap deflection was increased to 30 deg. at 400 ft. altitude and to 60 deg. at approximately 200 ft.

The Wren holds a slightly nose-down attitude during the entire approach, which gives the pilot a good field of vision. Power is held on until the airplane is ready to land and the aircraft is flown to the selected landing spot. There is no need to bleed off speed gradually during the approach, since the Wren will hold about 30 mph. easily.

Landing Procedure

Power is reduced to idle as the aircraft is rotated for landing, and there is no tendency to float. Once the Wren's nose comes up, the airplane is committed to an almost instantaneous landing. However, it can be flown out under power any time before the flare is begun if the landing has to be aborted.

Pilots will need some time to adjust to the Wren's landing characteristics before they will be able to get the performance the company claims, although the claims themselves are probably conservative. First is the psychological barrier of flying at speeds of 30-35 mph. on final approach. After that is overcome, some practice is needed to be able to flare the aircraft and retard the throttle for precise landings.

As soon as the wheels touch, flaps are immediately raised to prevent the Wren from riding with the weight off the wheels, and brakes are applied. Braking intensity can be varied depending on the amount of space available, but fairly hard braking is required for a maximum-performance landing.

Short Stops

Even with all this, impressively short stopping distances can be achieved from almost the first landing. Stopping distance of about 350 ft. was achieved on the second landing and distances as short as 200 ft. were attained after some practice.

Approximately six landings were made and none of them took more than 500 ft. to achieve a complete stop. Morris, who has done the test piloting work on the Wren, was able to land consistently in about 160 ft. from touchdown to stop.

Rudder control remains positive throughout the low-speed regime, partly because of the 11-in. extension added to the top and partly because the movable vortex generators reduce the yawing tendency of the aircraft in a bank, so that less rudder is needed to compensate for it during landing.



STANDARD CESSNA COCKPIT arrangement has been altered only by the addition of an anemometer gage (top center) which gives accurate low-speed true airspeed readings. There are no additional flight controls for the ULS surfaces.

Robertson has been able to achieve the Wren's slow-speed capability by making only five major changes in the basic Cessna, none of which involve the load-carrying structure, gross weight or engine.

Vertical fin and rudder, as noted above, have been lengthened 11 in. Straight rudders will be standard on production models, rather than the swept Cessna design, because of their slightly better performance at low speeds.

Small ventral fin, made of ⅛-in.-thick aluminum, was added to increase the fin surface and to provide a tail skid in case the aircraft was flared or rotated too abruptly.

On the prototype, panels were added to the fuselage aft of the cabin doors to give the aircraft—a 1958 Skylane—the same slab-sided fuselage that the production aircraft will have. Wren plans to use new Cessna 180/182s as the basis for production aircraft.

Also on the prototype, twin trim tabs were added to the elevator to duplicate the arrangement found on the 182.

Full-span, double-slotted, Fowler-type flaps were added to the wing, with the rear outboard section acting as the aileron in both the retracted and extended positions.

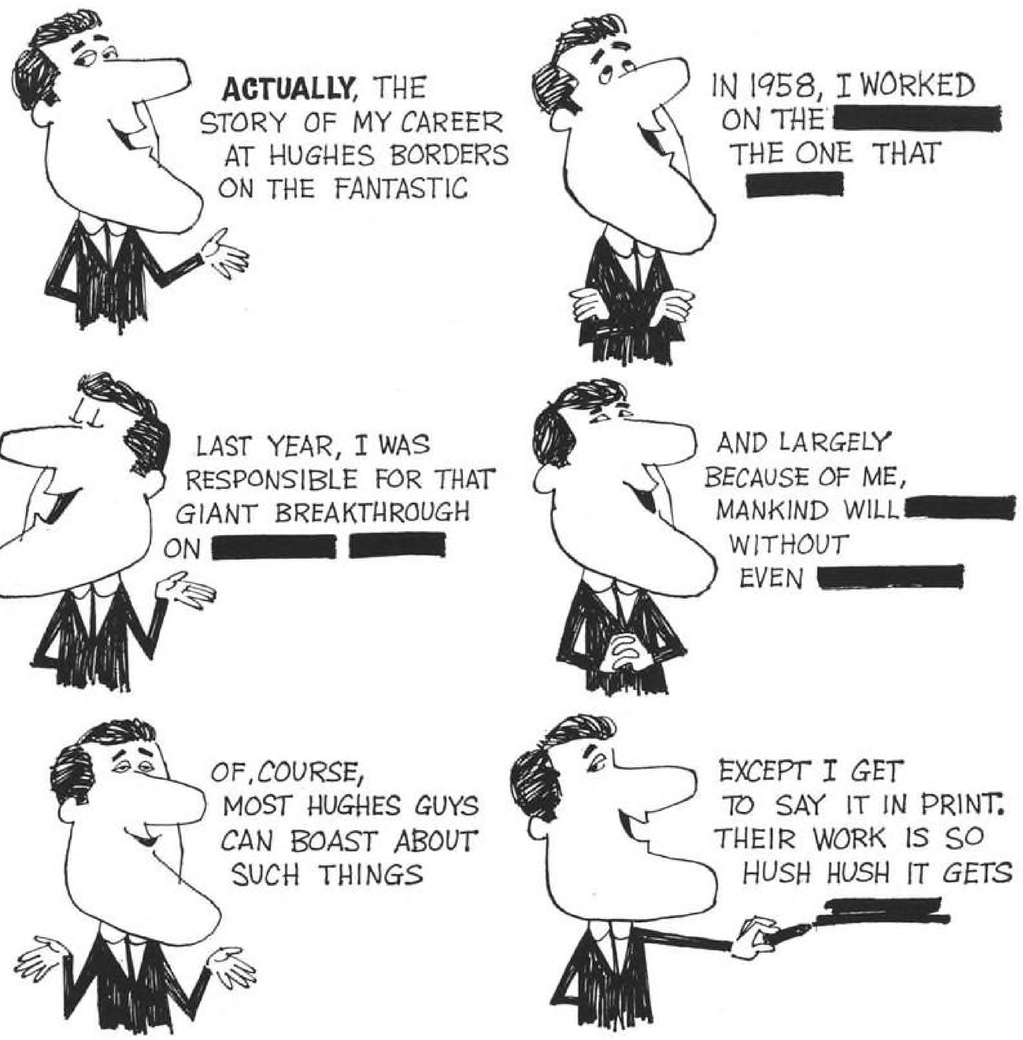
Doublers of .064-in.-thick aluminum were added to the rear wing spar at each of the four hinge points and ⅜-in.-thick flap hinge support plates were bolted to the doublers.

Flap Hinges

An inset sealed bearing is located at the bottom of the hinge and the flaps work entirely on the hinges, without tracks or rails. Three pivot points are provided. Dead-center linkage moves the hinge so that the three pivot points are in line when the flaps are fully extended.

Controls are the standard Cessna cabin lever and pushrod arrangement,

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with two outboard spools added to the flap control cable.

Aileron on the prototype is counterbalanced by a weight on an arm extended forward under the wing. In the production version, this will be done with a mass counterbalance in the aileron leading edge. Counterbalance will be 110%. Conventional aileron control is used.

Vortex Generators

Movable vortex generators (called Wren's Teeth by the company) are linked to the ailerons by a direct push-pull control rod which works over a dead-center linkage so that the vortex generators move only with up-aileron.

They are flat pieces of aluminum slanted outboard 30 deg. from the wing's upper surface (see three-view, p. 117). Normally, the vortex generators face into the airflow across the wing. When up-aileron is applied, they pivot so that the forward edge moves outboard toward the wing tip and the trailing edge moves inboard.

This not only causes turbulent airflow over the rear upper-wing surface and increases aileron effectiveness, but also creates drag to counter-balance the drag generated by the low aileron on the oppoiste wing. Yawing tendency created by this aileron drag is thereby reduced.

Robertson estimates that the ailerons would begin to lose their effectiveness at about 45 mph. without the vortex generators. With them, he says, the ailerons remain effective through the airplane's 24-mph. stall speed.

Leading Edge

There are no structural changes forward of the rear wing spar, but the leading edge of the wing has been increased to about twice its normal radius by adding a .040 aluminum glove at about the 1% chord line on the top of the wing and making the leading edge of the wing droop slightly.

This method of reducing the aircraft's stalling speed was chosen over the more complicated slat arrangement because it is simpler and constantly operating. There is no speed at which it ceases to be effective.

It is not as efficient as slats would be, but Robertson says it is good enough for Wren's needs and that it does not have a tendency to give asymmetrical lift, as slats occasionally do.

The increased diameter gives laminar flow characteristics back to about the 30% chord point. Robertson said a normal wing will stall at about a 15-deg. angle of attack. One with a slat arrangement will stall at about a 35-deg. angle of attack. The Wren wing falls in between these two extremes, stalling at approximately a 28-deg. angle of attack, he said.

Ultra-low speed controls, mounted immediately behind the propeller to make use of the slipstream in providing pitch control at low speed, are of single-spar construction with .032 wrap-around aluminum skin.

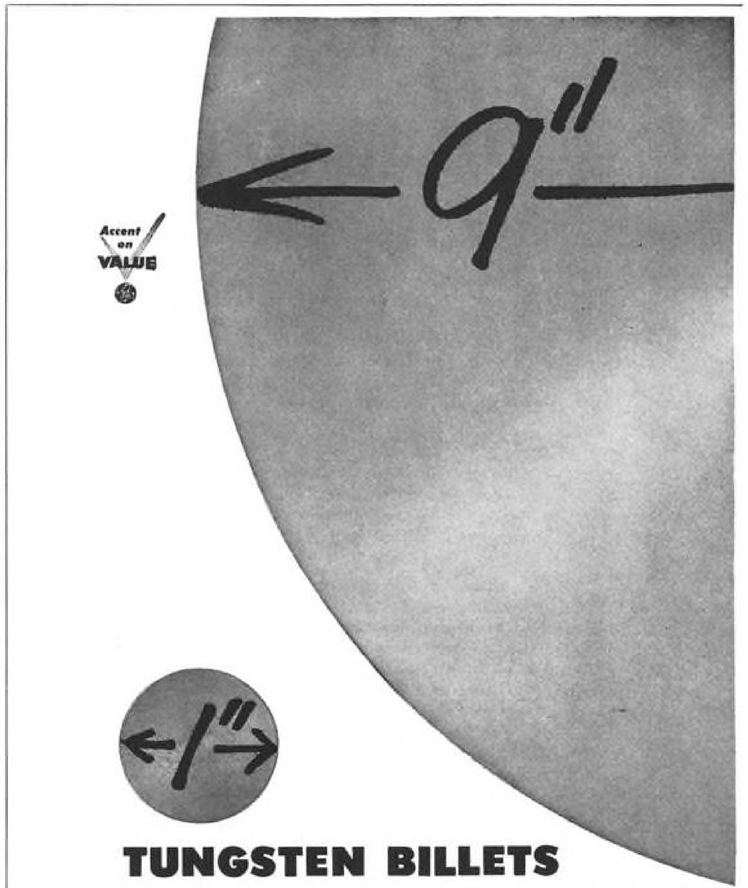
Single spar of 4130 chrome alloy attaches to triangle side frames located beneath the engine cowling. Side frames are jointed by a center wishbone piece.

Entire system, including the push-pull rod extended through the firewall, weighs about 33 lb.

Two two-side frames attach directly to the engine mount with four bolts, and a fifth bolt is located at the outboard end of the spar, to hold the control surface on. Wishbone is attached to the engine mount with two bolts and takes the lateral loads. Side frames take the vertical loadings.

Control surface is articulated by means of a linkage which holds the second movable section of the control surface at a given distance from the linkage's pivot point. End cap is balsa wood on the prototype, but will be plastic on the production aircraft, Robertson said.

The canard ULS surfaces are forward of the aircraft's center of gravity and work in opposition to, but in conjunction with, the elevators. Robertson



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estimates they provide about a 660-lb. upload and increase the total lift of the aircraft about 32%. Download on the horizontal tail required to balance the aircraft is reduced from approximately 300 lb. to about 100 lb.

Wren plans to purchase new 180/182 aircraft from Cessna dealers, paying standard market prices, since Cessna has a marketing agreement with its dealership organization not to sell direct from the factory to anyone except a government organization.

Aircraft will be flown to Wren's production facility—currently located at Meacham Field—and modified. Since space here is limited, Wren has been considering larger production facilities. Current manufacturing space would permit production of only about 10-15 aircraft per month.

Entire development program has been privately financed by Robertson, Morris and E. H. Pickering, vice president-marketing, who formed the company early last summer. Robertson has applied for patent rights on the control system.

Morris has flown extensively in South America, where he engaged in back country aircraft charter work, and much of the design of the 460 reflects his experience.

Interest has been shown in the Wren by Cessna, and that company now has a report in hand recommending the modification of one or two Cessna 205 aircraft.

The Air Force and Army may be interested in the modified aircraft.

It is possible that if the Army's fleet of O-1E (L-19) Bird Dog aircraft were fitted with the Wren control system, their useful life would be considerably increased.

Federal Aviation Agency certification is expected this summer by the company. Sales, at first, will be handled directly from the factory, with emphasis initially on domestic and South American markets. Tentative plans call for a South American sales tour during August and September.

PRIVATE LINES

Mooney Aircraft dollar volume for the first quarter of Calendar 1963 is up 46% over the same period of 1962. Increase is attributable largely to addition of the Mooney Master fixed-gear version of the Mark 21 to its line. Between Jan. 1 and Mar. 15, Mooney delivered 60 Masters and 90 Mark 21s.

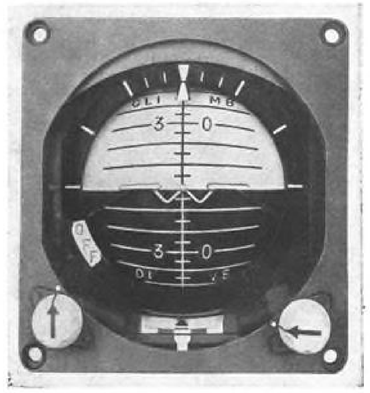
Private heliport will be constructed by Franklin Engine Co., Syracuse, N.Y., adjacent to its factory, to facilitate test installation of Franklin engines in various model helicopters. At present, engines are being shipped to modification centers for installation. Once helicopters can land at the Franklin factory, the company will undertake engine retrofit work on older helicopters.

"**Starting and Managing** an Aviation Fixed-Base Operation" is a new booklet available through the Small Business Administration, Washington. SBA points out that fixed-base operators are eligible for agency loans up to $350,000.

General aviation malfunctions and defects reported to the Federal Aviation Agency rose 45% in 1962, the FAA has reported. In 1962, 5,660 malfunctions or defects were reported, compared with 3,897 in 1961. Rise in the number of defects reported was largely due to added emphasis by FAA on such reports being made, rather than because of added malfunctions, the FAA said. As a result, 39 mandatory Airworthiness Directives were issued along with 506 manufacturers service instruction or recommendation reports.

Full-scale mockup of the de Havilland DH-125 twin-turbojet executive transport has been airfreighted by Seaboard World Airlines to Timmins Aviation, Ltd., in Montreal, where it will be assembled and decorated for exhibit in the next National Business Aircraft Assn. convention in Houston, Sept. 24-27. Timmins is Canadian distributor for the DH-125.

Lycoming T5309A and T5309B gas turbine engines, commercial versions of the T53-L-9 and -9A respectively, have received Federal Aviation Agency certification. Both are scheduled for use in the Bell 204B helicopter.



Attitude Indicator

Two-axis helicopter attitude indicator with turn and bank needle and ball is being marketed by Lear Siegler, Inc. Model 4005T fits standard 5-in. panel opening and will operate from either 5- or 28-v. power supply. Pitch trim is provided up to 10 deg. nose up or 20 deg. nose down.

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WHO'S WHERE

(*Continued from page 23*)

In the Front Office

Raymond D. Kelly has been named to represent the Air Transport Assn. on the Federal Aviation Agency's new supersonic transport Systems Analysis Team. Mr. Kelly is on leave from United Air Lines where he is director of technical development.

Col. Gerald J. Dix, commander, Tactical Air Command's 1st Air Commando Group, Hurlburt Field, Fla.

Dr. Frederick A. Muckler has been appointed by the National Aeronautics and Space Administration to its Research Advisory Committee on Control, Guidance and Navigation. Dr. Muckler is a senior staff scientist in the human factors department of Martin Co.'s Electronic Systems and Products Div.

Honors and Elections

Vernon R. Rawlings, vice president of Martin Co.'s Baltimore facility, has received the first Air Force Achievement Award for his "outstanding contribution to the deterrent strength and security of the United States and the Free World by insuring timely activation of the Titan 1 and Titan 2 weapon systems."

Gen. Thomas Dresser White (USAF, ret.) has been named the 1963 recipient of the General William E. Mitchell Memorial Award which is presented annually to "the United States citizen making the outstanding individual contribution to aviation progress."

Changes

Dr. Arthur H. Benner, director of engineering-military systems, Lockheed Electronics Co., Plainfield, N. J.

C. R. Rao, appointed Middle East representative for the International Civil Aviation Organization with offices in Cairo, Egypt.

James G. Houser, director of advanced programs for Martin Co.'s Orlando (Fla.) Div., and **John P. Butterfield**, executive director of technical operations. Also: **Hugh E. Webber**, director of research; **Dr. Alden H. Ryan**, head of a newly established development unit; **Dr. C. D. Pierson, Jr.**, technical director-reliability and maintainability.

Fred W. Wolcott, head of the newly established Systems Engineering Directorate, Research Analysis Corp., Bethesda, Md. Also: **Dimitri M. Gallik** and **Bernard S. Beckler**, operations analysts at RAC.

R. Henry Lesser, manager, Range Instrumentation Laboratory, Western Development Laboratories of Philco Corp., Palo Alto, Calif.

Douglas Epps, manager, Digital Systems Dept., Canoga Electronics Corp., Van Nuys, Calif.

Rollin Gillespie, chief of Planetary Missions Planning, Office of Manned Space Flight, National Aeronautics and Space Administration, Washington, D.C.

Roger Lee, administrative director, Telecomputing Corp.'s Electronic Systems and Data Instruments Divisions, North Hollywood, Calif.

Harold E. Shigley, value analyst, Procurement Dept., Beech Aircraft Corp., Wichita, Kan.

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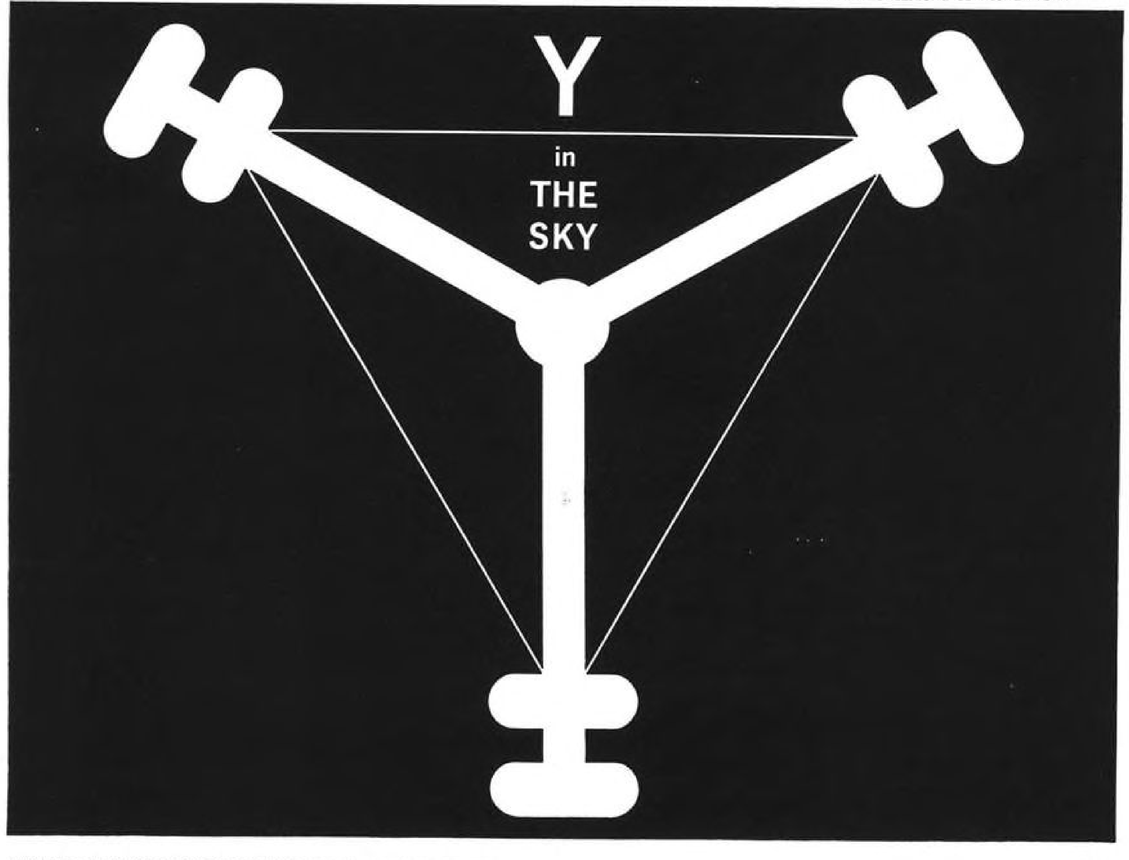
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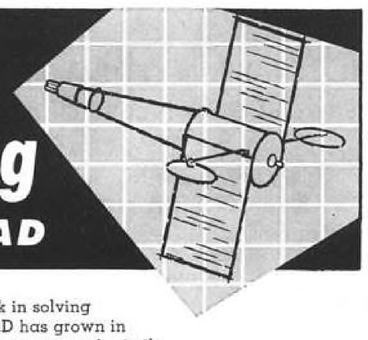
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CHARLES R. DOMINY
Supervisor

April 1, 1963

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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.

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Pumps all jet fuels, water, hydraulic oils, cryogenics, etc.
Pressures to 4,000 psi
Flows and speeds as required
Meets MIL-5009-B for jet engine main fuel pumps

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AVIATION & SPECIAL PRODUCTS DIVISION

Communications Equipment Overhaul and Repair

(Depot-level Maintenance)

■ Lear Siegler Service maintains two depot-type shops for the overhaul and repair of communications equipment. One is at Harrisburg, Pennsylvania; one at Los Angeles, California. Capabilities include: systems and components for communications, telemetry, radio tracking, command and control—regardless of manufacturer. Services performed include: system alignment, repair, overhaul and modification.

Both Lear Siegler shops maintain a wide range of specialized test equipment and utilize only thoroughly experienced technicians. Resident military inspection.

If your responsibility includes maintenance of communications equipment—and you require quality workmanship, fast turn-around, and competitive pricing—consult LSSI. For details, write: Director of Marketing,

LEAR SIEGLER SERVICE, INC.
21 Ottawa Ave., N.W., Grand Rapids 2, Mich.

LETTERS

Leader of the Band

My name is McNamara,
  I'm the leader of the Band.
Since survival is our business,
  We will always take a stand.

To buy performance, or do the job,
  Is the question to be faced.
The costs are huge, the future grim,
  If the frills can't be erased.

Why buy a Bird that does a job
  That's done by many others?
Or one that's oversexed (or overpriced)
  In relation to its brothers?

Ask what you get for what you pay,
  And what's the weapon's role?
Performance for its own sake
  Can never be the goal!

PETER SCHWARTZ
Inglewood, Calif.

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.

Commonality

Is it true that Mr. McNamara is about to announce a $20 billion contract with the Texas Barge and Boilerplate Corp. for a high commonality heavy tank-aircraft carrier? I've heard that he expects to save at least $5 billion by selecting a company with experience in this type vehicle. According to my source, McNamara expects shortly to convince the Navy that it will float, in spite of Archimedes and 10 source selection boards.

JOHN OGLE
San Jose, Calif.

"It's The Ultimate Deterrent Weapon . . . Only 50 Parts, Each Manufactured In A Different State!"



THE WASHINGTON POST

Advancing Schedules

With the successful completion of the fourth Saturn research and development flight, and the impending launch of the Gemini spacecraft, a question comes to mind.

The Saturn 1 launch vehicle can put 20,000 lb. into a near-earth orbit. The Gemini spacecraft weighs 7,000 lb., and is capable of two weeks stays in earth orbit. With a Gemini spacecraft mounted atop a Saturn 1, some 13,000 lb. will be available to inject the Gemini on a circumlunar mission. This circumlunar flight could have a perilune of several hundred miles altitude to avoid lunar impact, and midcourse guidance could be furnished by DSIF as in the successful Mariner 2 mission. Furthermore, it could be accomplished by the end of 1964 which is several years ahead of the present schedule using the Saturn 5 vehicle.

Of course, additional heat shield material would have to be added to the Gemini for superorbital entry. However, only 10,000 out of the available 13,000 lb. would be necessary for translunar injection.

The question is: why don't we attempt such a mission?

DON MCALLISTER
Research Specialist
Space and Information Div.
North American Aviation, Inc.

Querying MATS

I am a subscriber to your fine magazine and have enjoyed reading the "Letters to the Editor" section especially.

Having been a flight navigator, both military and professionally, for the past 18 years, I wonder if I may be permitted to ask a few impertinent questions relative to the Military Air Transport Service (MATS)?

- **Why does MATS dislike civilian** air carriers?
- **Why can a commercial air carrier** fly MATS' routes at less cost than MATS?
- **Why has MATS run out of funds** for "call business" for the last quarter of this fiscal year?
- **Does MATS realize that there** are many flight crews on furlough, both on the East and West coasts, because of the lack of "call business?"
- **Considering the number of furloughs** that flight crews are susceptible to because of erratic and inconsistent MATS business, where are the airlines going to obtain flight crews to fly MATS routes in case of a national emergency? Is MATS so naive as to think that civilian flight crews are going to accept recalls from furloughs so that they may fly into combat zones during a crisis when they did not have the opportunity to fly during normal times in order to earn a living?

If any responsible MATS official would care to answer the above questions, I would be most interested in learning the answers.

JOHN MOTTOLESE
Flight Navigator
Wantagh, L. I., N. Y.



NEW, IMPROVED SERVO MOTORS
to Help Solve Special Servo Problems

Do you have a particular servo motor problem such as Power Consumption? Torque? Starting Voltage? High Temperature? Efficiency? Single Phasing? Length?

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The new Clifton motors feature more torque for considerably less power input. This results in a more efficient and cooler running motor.

Acceleration is increased up to 160,000 rad/sec² at between 2 and 3 watts per phase. This is such an improvement that in certain motor generator requirements a new Clifton motor will now suffice.

Starting voltage in our new motors is now guaranteed to be 1%.

New heat resistant materials and improvements enable these motors to withstand 200°C plus.

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APR. 16 1963



Patrolling the seas— a regiment of sentries, armed and fuzed by Avco!

A fleet of nuclear submarines cruising somewhere beneath the Seven Seas is keeping a watchful eye on Peace. Each submarine carries sixteen Polaris missiles—powerful sentries—whose arming and fuzing systems were designed and manufactured by Avco.

Avco's Ordnance Division works as a team with the Naval Ordnance Laboratory to develop the detonation equipment for these fleet ballistic missiles. Their joint efforts were proved on May 6, 1962, when the United States successfully test-fired a "live" Polaris.

Avco received the U.S. Navy's coveted Certificate of Merit for its work on Polaris. Avco is proud to have a part in this important defense program as well as other missile programs to which it is contributing some of its arming and fuzing know-how.

For more information about Avco's capabilities in arming and fuzing and related ordnance fields, write: Director of Marketing, Ordnance Division, Avco Corporation, Richmond, Ind.

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