Aviation Week and Space Technology

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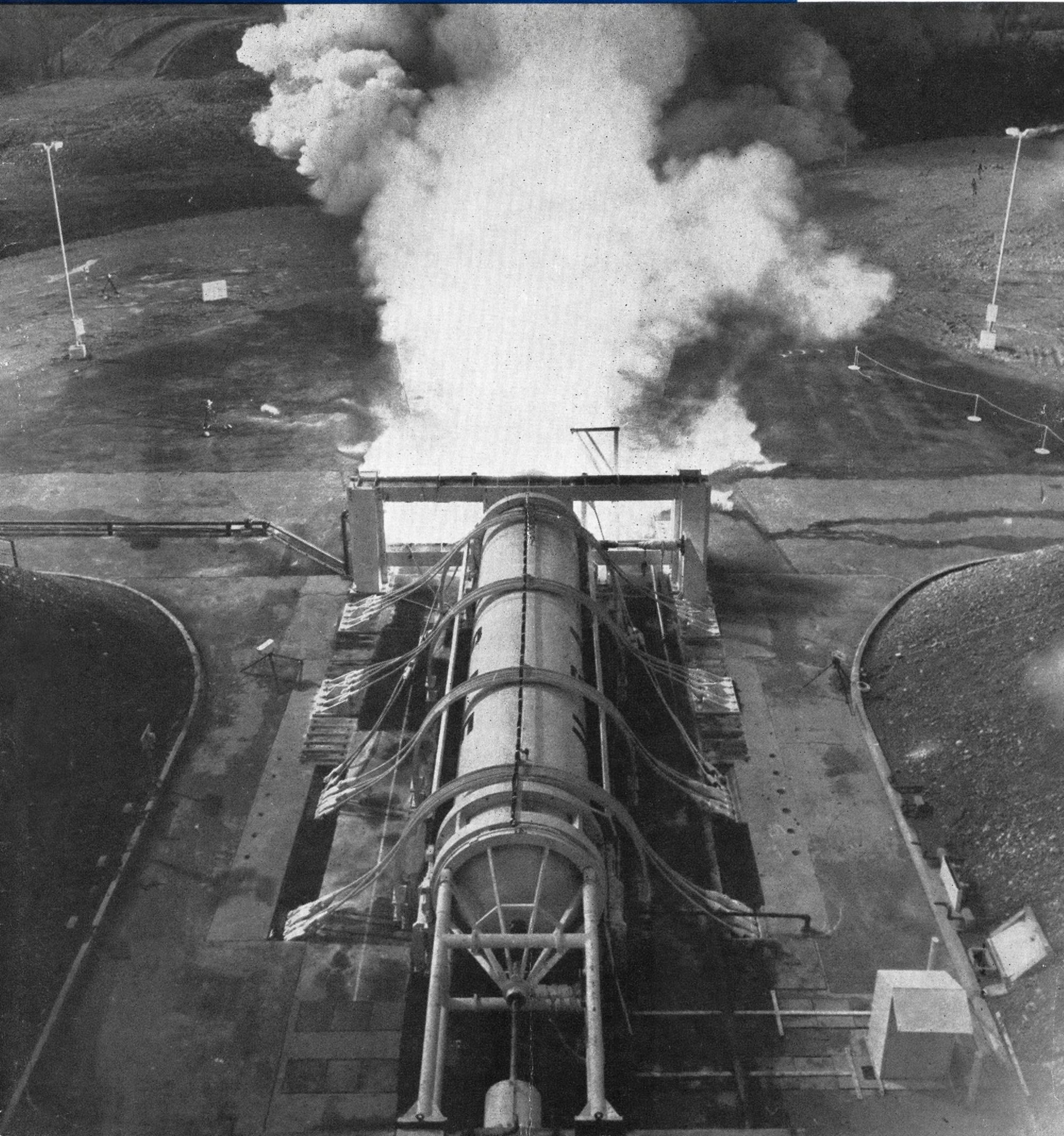
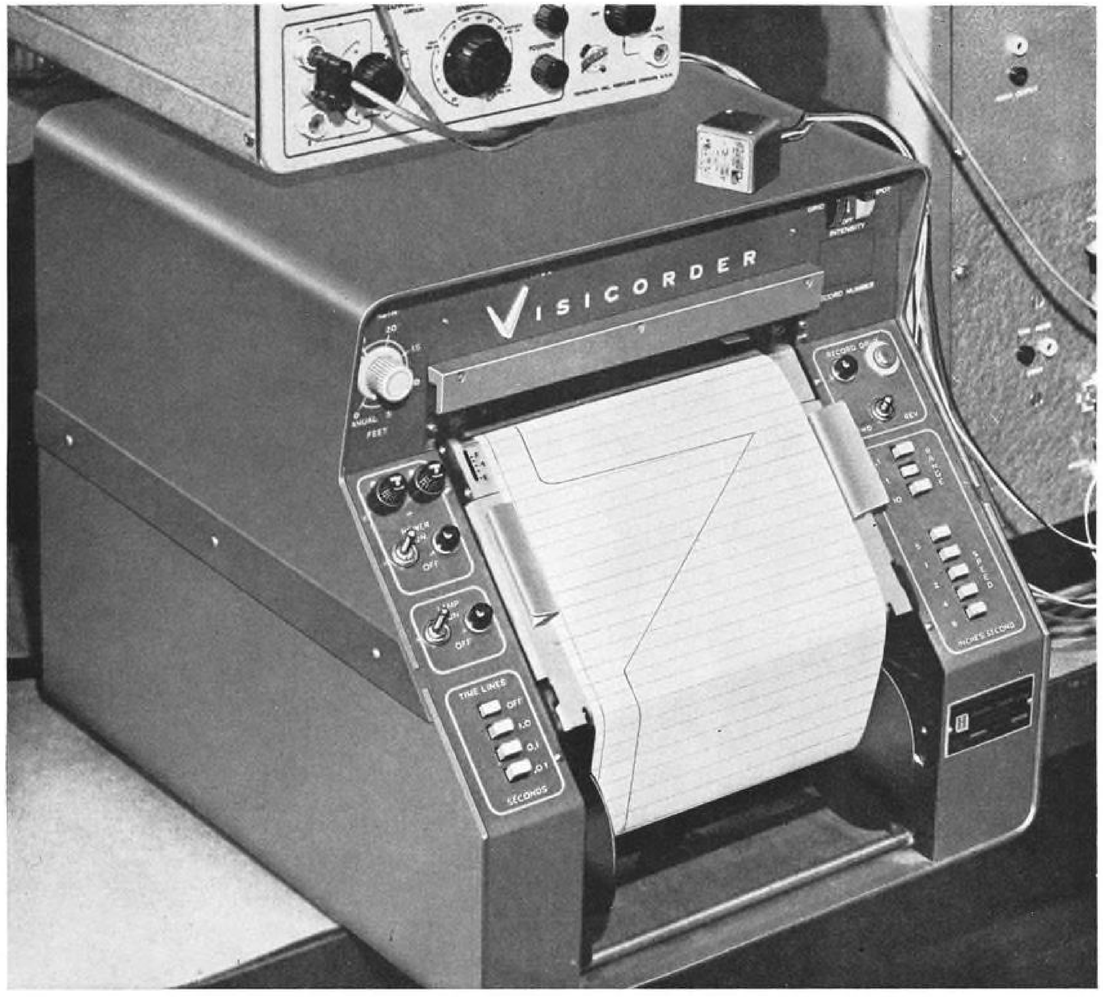
March 5, 1962

Lunar-Landing Altimetry System Devised

Aerojet Large Solid Rocket Firing





Honeywell Visicorder Oscillograph checks resolution of an event marker

Electro Development Corporation, Seattle, Wash., uses a Model 1108 Honeywell Visicorder Oscillograph to prove the linearity and resolution of signal conditioner-event markers which they supply to the Boeing Company.

A missile telemetering system samples each channel only once every 30 milliseconds, but missile engineers want to know when some events occur to an accuracy of better than one millisecond.

The event marker (the small cube atop the Visicorder) produces a highly-linear ramp output that starts exactly when the marker is triggered by the event in question. This ramp continues for about 100 milliseconds . . . enough time so that the telemeter system can sample the ramp at least three times. A straight line drawn through these points will accurately determine the occurrence of the event.

To check event marker linearity, the ramp is recorded at the very high record speed of 80″/sec. It's this high speed, the .01-second timing lines, the ease of operation, and the wide deflection capabilities of Honeywell galvanometers (approx. 7″ in this application) that caused the Electro Development Corporation to select the Model 1108 Honeywell Visicorder.

For more details about the Model 1108 (24 channels), the 1012 (36 channels) and other Honeywell Visicorders, write Minneapolis-Honeywell, Heiland Division, 4800 E. Dry Creek Road, Denver 10, Colorado. Our DDD phone number is 303-794-4311.

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For this crucial operation, American Machine and Foundry Company was able to select *exactly the right unit* to drive the missile launching platform from Vickers' broad line of heavy-duty hydraulic motors. This immediate availability saved time in design, purchasing, manufacturing and installation.

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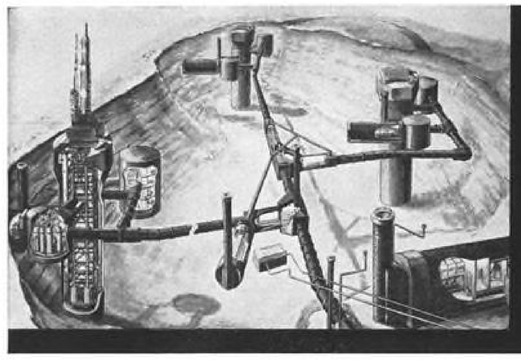

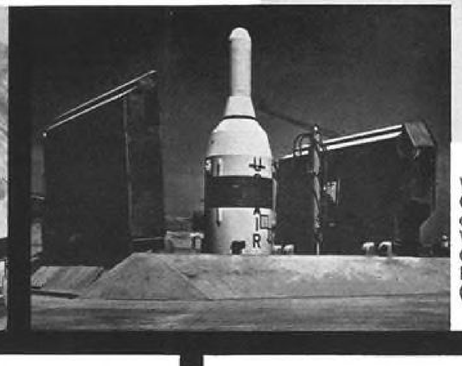

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SILICONE NEWS from Dow Corning

Where reliability counts

Silastic LS parts at left show negligible swell after prolonged immersion in JP-4 fuel. Identical parts at right were not immersed.

Here's why Silastic® LS is specified to seal jet fuel in . . . trouble out

Seals that come into contact with jet fuel must always perform as if they are *brand new* . . . installed only moments before take off on today's intercontinental jetliners.

Chances are, however, these seals have been in use for months. Hundreds of hours of *over-the-weather* flying have exposed them to the attack of ozone. Minutes after take off these seals can plunge from oven-like runway conditions to high altitude temperatures of —60 F. Yet, despite repeated thermal cycling and exposure to rubber-killing conditions, these seals must maintain their integrity . . . exhibit no evidence of cracking or checking. They must remain flexible in the bitter cold at high altitude to assure completely reliable operation . . . and, though they are in constant contact with jet fuel, resist swell and tenderizing.

When you study the photograph and chart of properties at right, it's easy to see why Silastic LS, the fuel-resistant silicone rubber is specified as standard material for many jetliner seals.

PROPERTIES CHART

Physical Properties	
Hardness, (Shore A)	50-65
Tensile Strength, psi	800-1000
Elongation, percent	150-170
Brittle Point	—90

Fuel Resistance (JP-4)

	Durometer Change	*Tensile Str'gth Change %*	*Volume Change %*
After 30 days immersion	—5	—31	+10

Weather Resistance

After 31 months (3549 sun hours) at Florida Test Station	no visible effects

For information about Silastic LS and a list of part suppliers, write Department 1403, Dow Corning Corporation, Midland, Mich.

first in silicones

Dow Corning

AEROSPACE CALENDAR

Mar. 14-16—Electric Propulsion Conference, American Rocket Society, Hotel Claremont, Berkeley, Calif.

Mar. 16—Annual Robert H. Goddard Memorial Symposium, "Torques and Attitude Sensing in Satellites," American Astronautical Society, Washington, D. C.

Mar. 20-21—University of Denver's Second National Symposium on Hypervelocity Techniques, Denver, Colo.

Mar. 26-29—International Convention, Institute of Radio Engineers, Coliseum and Waldorf Astoria, New York.

Mar. 28-29—Third Symposium on Engineering Aspects of Magnetohydrodynamics, University of Rochester, Rochester, N. Y. Sponsors: American Institute of Electrical Engineers; Institute of the Aerospace Sciences; Institute of Radio Engineers; University of Rochester.

Mar. 29-30—Fourth Annual Electron Beam Symposium, Alloyd Electronics Corp., Cambridge, Mass.

Apr. 1-4—Mid-Year Conference, Airport Operators Council, Shoreham Hotel, Washington, D. C.

Apr. 3-5—Launch Vehicles: Structures and Materials Conference, American Rocket Society, Ramada Inn, Phoenix, Ariz.

Apr. 3-6—National Aeronautic Meeting (including production forum), Society of Automotive Engineers, Hotel Commodore, New York, N. Y.

Apr. 9-12—33rd Annual Scientific Meeting, Aerospace Medical Assn., Chalfonte Haddon Hall, Atlantic City, N. J.

(*Continued on page 7*)

AVIATION WEEK and Space Technology

March 5, 1962

Vol. 76, No. 10

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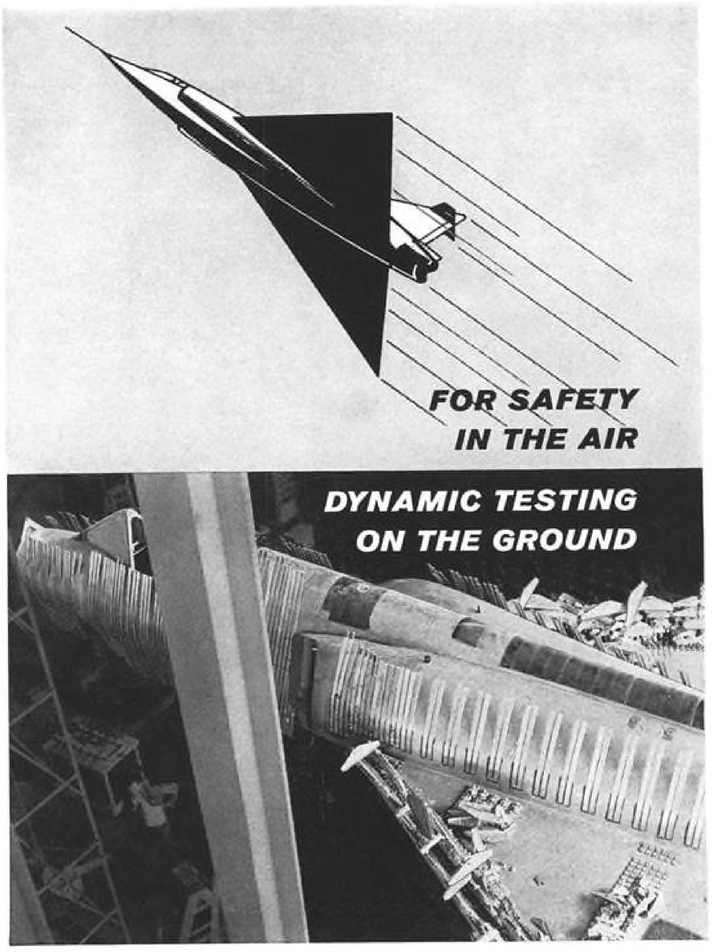

Pretesting high performance aircraft is a job for automatically controlled high speed dynamic loading. The old sand bag techniques measuring only static load capacity leave vital performance knowledge undiscovered—cannot predict flight safety.

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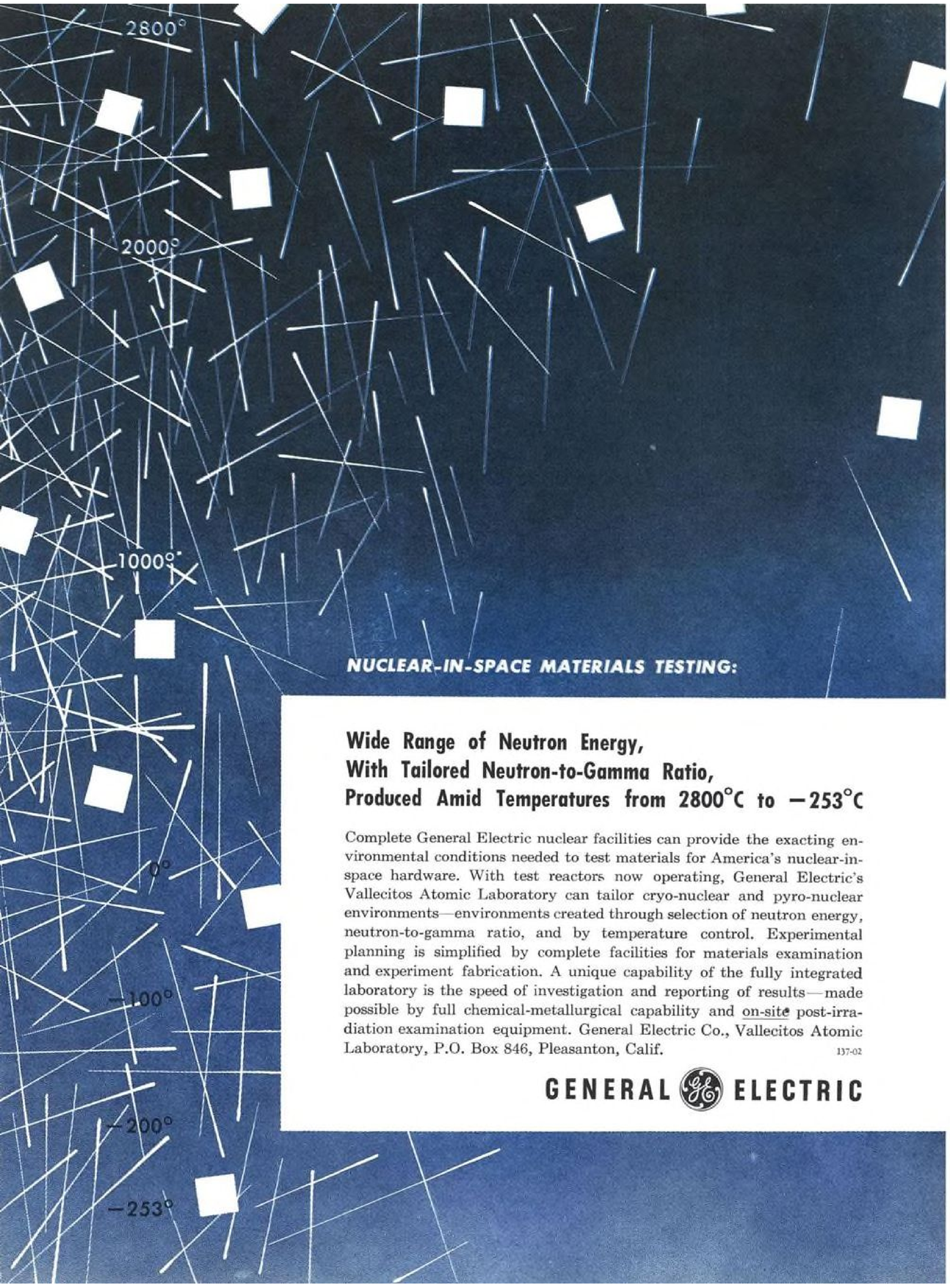

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GENERAL ELECTRIC

AEROSPACE CALENDAR

(Continued from page 5)

Apr. 10-12—Second Symposium on The Plasma Sheath—Its Effect Upon Re-entry Communication and Detection, New England Mutual Hall, Boston. Sponsor: AF Cambridge Research Laboratories.

Apr. 11-13—Southwestern Conference and Electronics Show, Institute of Radio Engineers, Rice Hotel, Houston, Tex.

Apr. 11-13—Annual Technical Meeting and Equipment Exposition, Institute of Environmental Sciences, Sheraton Chicago Hotel, Chicago, Ill.

Apr. 12-13—Eighth Annual Heat Transfer Conference, Oklahoma State University, Stillwater, Okla.

Apr. 13—Government Contracts Symposium, National Assn. of Professional Contracts Administrators, Ambassador Hotel, Los Angeles, Calif.

Apr. 14-16—Second Conference on Kinetics, Equilibria, and Performance of High Temperature Systems, University of California, Los Angeles, Calif. Sponsor: Western States Section/Combustion Institute.

Apr. 16-18—Second International Flight Test Instrumentation Symposium, College of Aeronautics, Cranfield, England.

Apr. 16-18—Aerospace Systems Reliability Symposium, Institute of the Aerospace Sciences, Salt Lake City, Utah.

Apr. 24-26—Polytechnic Institute of Brooklyn's Symposium on the Mathematical Theory of Automata, United Engineering Center, New York, N. Y.

Apr. 25-29—Western Space Age Industries and Engineering Exposition, Cow Palace, San Francisco, Calif.

Apr. 26-27—Quarterly Regional Meeting, Assn. of Local Transport Airlines, Hilton Inn, Atlanta, Ga.

Apr. 30-May 1—Annual Meeting, National Aeronautical Services Assn., Shoreham Hotel, Washington, D. C.

Apr. 30-May 2—Meeting on Manned Space Flight, Institute of the Aerospace Sciences, Hotel Chase, St. Louis, Mo.

May 1-3—Spring Joint Computer Conference, Fairmont Hotel, San Francisco.

May 2-4—18th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D. C.

May 2-11—International Space Research and Technology Exhibition, London, England. Sponsor: British Interplanetary Society.

May 3-4—First International Congress on Human Factors in Electronics, IRE, Lafayette Hotel, Long Beach, Calif.

May 7-9—Materials & Processing for Space Environments Symposium, Society of Aerospace Material and Process Engineers, Hotel Statler, St. Louis, Mo.

May 7-11—Annual Conference, Society of Photographic Scientists and Engineers, Somerset Hotel, Boston, Mass. Cosponsor: AF Cambridge Research Laboratories.

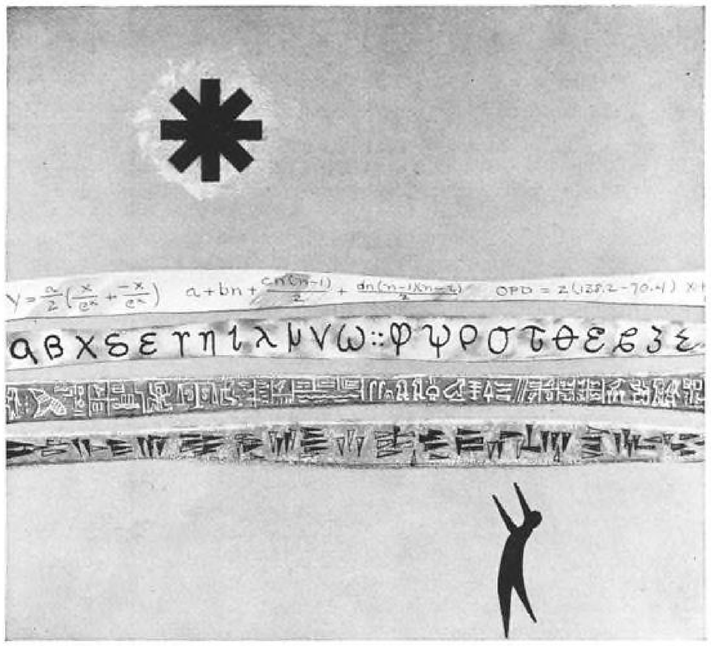
May 7-11—1962 Tool Exposition & Engineering Conference, Public Auditorium, Cleveland, Ohio.

May 8-10—12th Annual Electronics Components Conference, Marriott Twin Bridges Motor Hotel, Washington, D. C.

May 14-16—National Aerospace Electronics Conference, Institute of Radio Engineers, Biltmore Hotel, Dayton, Ohio.

(Continued on page 9)

Involvement: ***LIFE***



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AEROSPACE CALENDAR

(*Continued from page 7*)

May 14-16—Joint Technical Society-Department of Defense Symposium on Thermionic Power Conversion, Antlers Hotel, Colorado Springs, Colo.

May 14-17—21st Annual National Conference, Society of Aeronautical Weight Engineers, Benjamin Franklin Hotel, Seattle.

May 20-24—Annual Conference, American Assn. of Airport Executives, Ambassador Hotel, Los Angeles, Calif.

May 20-26—Annual Meeting, Aviation/Space Writers Assn., Mark Hopkins Hotel, San Francisco, Calif.

May 21-25—Eighth Aerospace Instrumentation Symposium and National Telemetering Conference, Sheraton Park Hotel, Washington, D. C.

May 22-24—Conference on Self-Organizing Systems, Museum of Science and Industry, Chicago, Ill. Sponsors: Office of Naval Research; Armour Research Foundation.

May 22-24—National Microwave Theory & Techniques Symposium, Institute of Radio Engineers, Boulder, Colo.

May 24-26—Seventh Region Conference on Space Communications, Institute of Radio Engineers, Seattle, Wash.

June 6-7—Symposium on Standards for Filament-Wound Reinforced Plastics, Naval Ordnance Laboratory, Silver Spring, Md.

June 6-8—Eighth Annual Radar Symposium (classified secret), Institute of Science and Technology's Radar Laboratory, University of Michigan, Ann Arbor.

June 8-9—13th National Maintenance and Operations Meeting, Reading Aviation Service, Inc., Reading, Pa.

June 13-15—Annual Meeting, Heat Transfer and Fluid Mechanics Institute, University of Washington, Seattle, Wash.

June 19-21—39th Meeting, Aviation Distributors and Manufacturers Assn., Ambassador Hotel, Los Angeles.

June 19-22—Summer Meeting, Institute of the Aerospace Sciences, Ambassador Hotel, Los Angeles, Calif.

June 20-22—Annual Convention, Airline Ground Transportation Assn., Barclay Hotel, New York, N.Y.

June 25-27—Sixth National Convention on Military Electronics, Institute of Radio Engineers, Shoreham Hotel, Washington.

June 25-30—Symposium on Electromagnetic Theory & Antennas, Copenhagen, Denmark. Sponsors: Technical University of Denmark; International Scientific Radio Union.

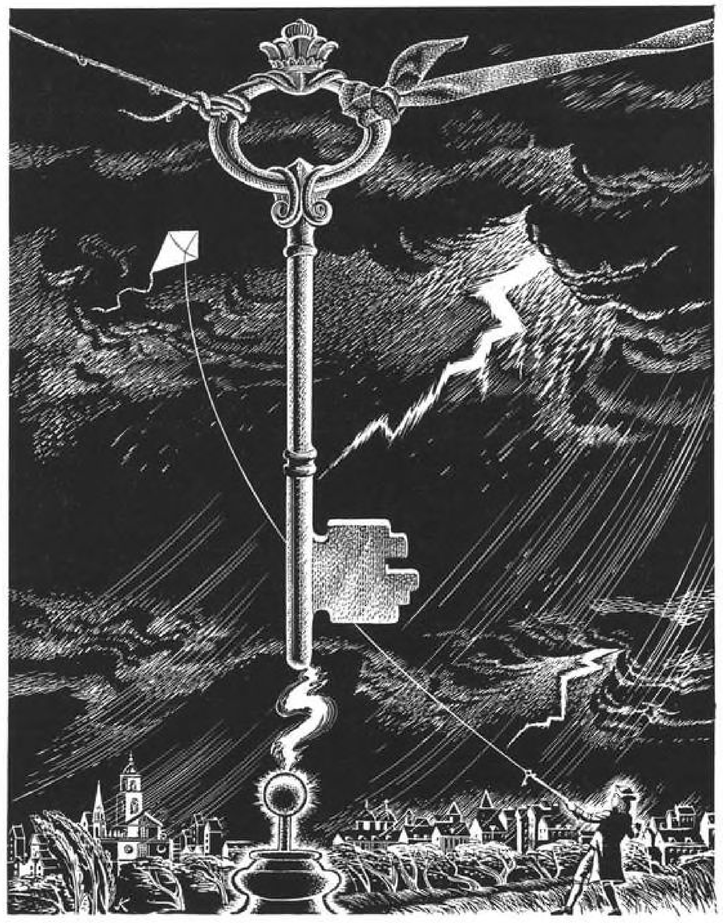
June 27-28—Ninth Annual Symposium on Computers and Data Processing by the University of Denver's Denver Research Institute, Elkhorn Lodge, Estes Park, Colo.

June 27-29—Joint Automatic Control Conference, Institute of Radio Engineers, New York University, New York, N. Y.

July 16-18—Lunar Missions Meeting, American Rocket Society, Pick Carter and Statler Hilton Hotels, Cleveland, Ohio.

Aug. 10-11—Future of Manned Vehicles in Air and Space, Institute of the Aerospace Sciences, Olympic Hotel, Seattle, Wash.

Aug. 21-24—Western Electronics Show and Conference, Institute of Radio Engineers, Los Angeles, Calif.



IN AEROSPACE, MARQUARDT MEANS . . .

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Plasma studies typify only one aspect of Marquardt's continuing programs of advanced research and development. Plasma physicists interested in participating in these are invited to contact us.

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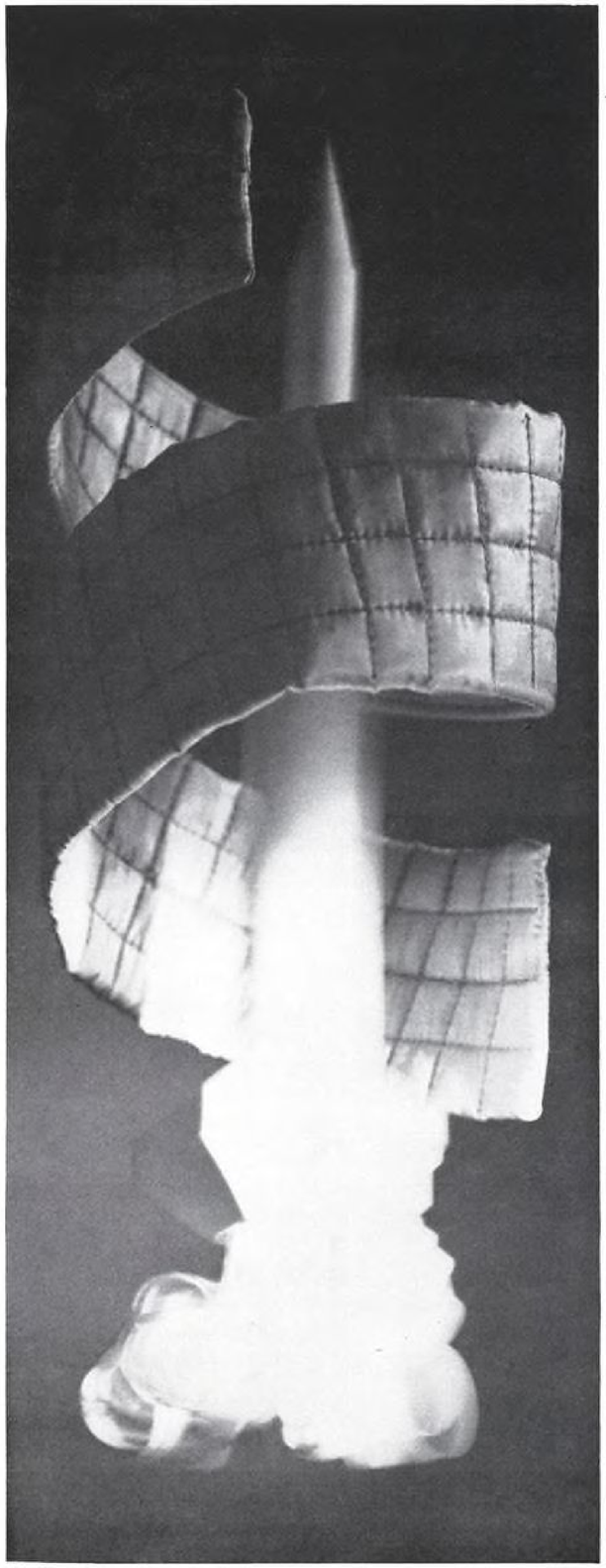

Insulation news from Johns-Manville

Now Min-K® is flexible!

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Min-K, the unique insulating material developed and produced by Johns-Manville, now has an added quality . . . flexibility! Min-K is a new concept in missile insulation. The higher it flies, the better it insulates. Min-K's thermal conductivity drops as atmospheric pressure decreases. Its superior performance has been proved in hundreds of operational U. S. missiles.

New Flexible Min-K offers many special advantages. For example, it is the ideal way to lower prototype costs. You can test performance without the expense of special tooling. The flexible blankets lend themselves to bonding, lamination with reinforced plastics, service coatings and as a component of insulation systems. Further, Min-K can be tailor-made to wrap around a cylinder, cone or other geometric shape. And, it is also available in 1½" and 2" tapes for spiral winding on a duct or pipe.

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March 5, 1962

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Spacecraft to Be Simplified as Result of MA-6 Flight . . 18
▶ Mercury capsules for 18-orbit missions will reflect greater reliance on astronaut for control of flight.

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▶ Lower New York-Miami price, elimination of some meals aims at economy, better distribution.

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COVER: Second firing of an Aerojet-General 100-in.-dia. solid-propellant rocket motor at Sacramento, Calif., lasted 97 sec. and produced about 600,000 lb. maximum thrust and an average thrust of about 500,000 lb. (see photo p. 70). This was the first time in an Aerojet motor of this size that thrust vector was controlled by fluid injection of reactive nitrogen tetroxide, although this type of control was used in Polaris firings late last year, as well as in smaller test motors. In the 100-in.-dia. motor application, vector control by fluid injection contributed 6,000 to 10,000 lb. additional thrust. Firing was sixth in USAF's Edwards AFB large motor program. Two more 100-in.-dia. rockets will be fired, the first probably in May.

PICTURE CREDITS

Cover—Aerojet-General; 18-21—NASA; 36—General Electric; 37—Westinghouse; 39, 75—USAF; 43 (top)—Reflectone Electronics, (bottom) Ohio State; 46, 47, 49, 50—Kaman Aircraft; 57—Helicab; 59—Mercury Helicopter Services, Inc.; 61—Lockheed; 63—SIPA; 64—Beech; 65—Cessna; 68—Jet Propulsion Laboratory; 69—Air Products & Chemicals; 70—Aerojet-General.

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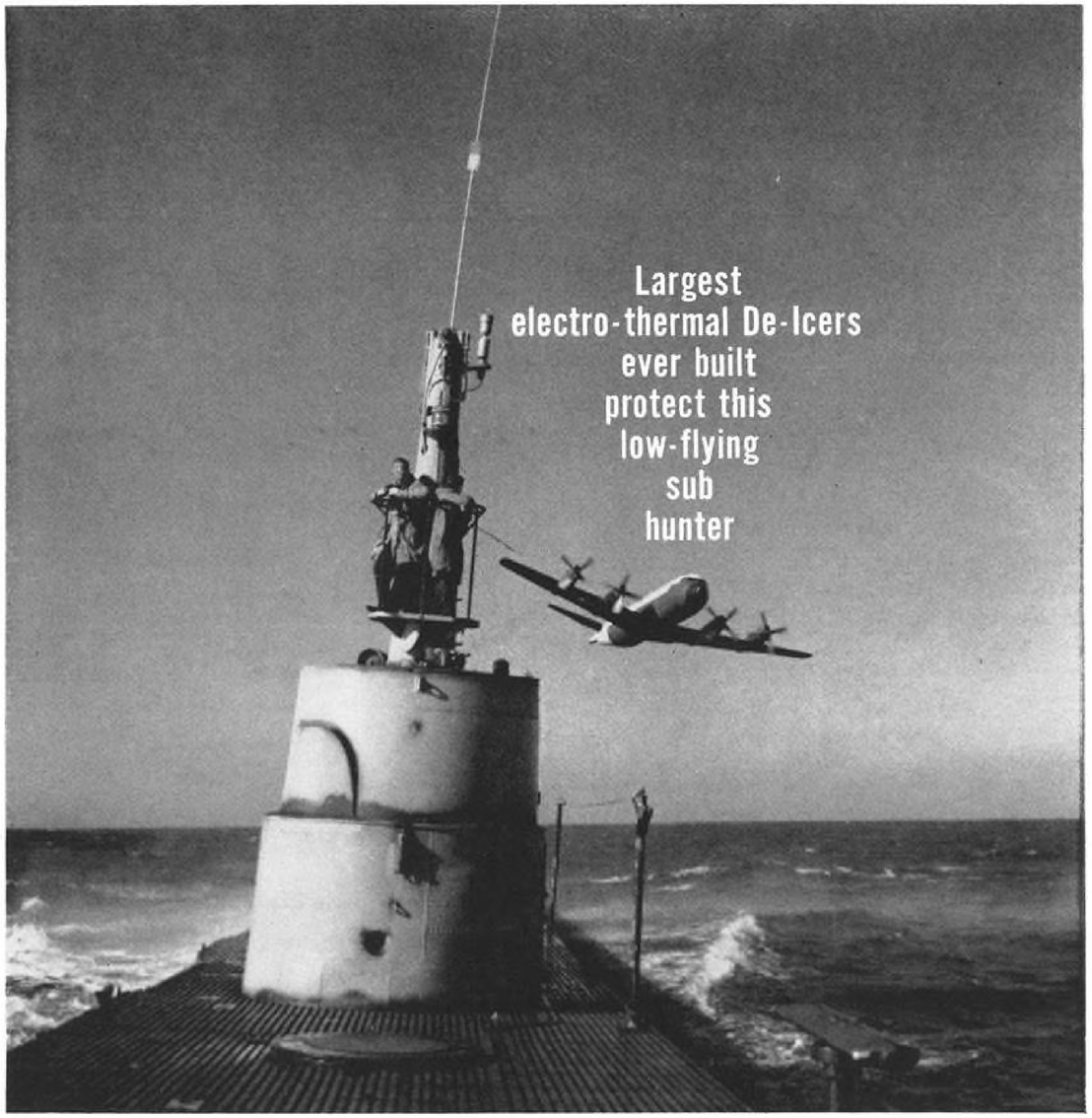

The new Lockheed P3V, destined for anti-submarine duty, must fly in extremely adverse weather and icing conditions. Thus, BFG Electro-thermal De-Icers are used to prevent and remove ice on leading edges of the empennage.

Heating elements up to 10 feet in length are sandwiched in resin-impregnated glass fiber, and bonded to an aluminum shield. The assemblies also serve as structural members and weigh less than a comparable ducted hot air system for ice removal.

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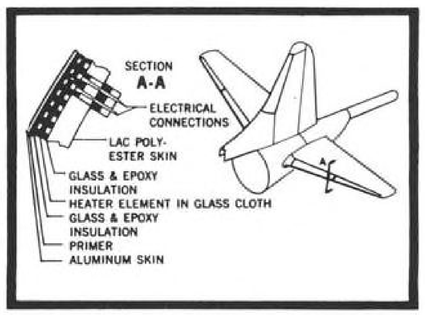

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EDITORIAL

Man in Space

Lt. Col. John Glenn's orbital flight in the Mercury capsule offers some significant evidence on the role of man in space. The ballistic trajectory flights of Cdr. Alan Shepard and Capt. Gus Grissom were too short and simple to yield much data in this area. The orbital flights of Majors Gagarin and Titov have been so steeped in Soviet secrecy and political hoopla that their international scientific contributions have been negligible.

Thus Col. Glenn's performance is really the first valid data generally available. The most important fact is that the three-orbit mission could not have been completed without his physical and mental capabilities inside the capsule. It would probably have been aborted at the end of the first orbit because of the difficulties with a yaw jet in the automatic stabilization and control system. Similar trouble with a roll jet in this system forced the Mercury ground flight controllers to terminate the mission with Enos the chimpanzee after two orbits. If this and other difficulties encountered by Col. Glenn during his three orbits had occurred in any of the unmanned military space systems now being tested in polar orbits, they would have caused complete failure of the mission.

The ability of the properly trained human pilot to apply his judgment and skill to the functioning of the automatic systems, evaluate their performance, and shift to other methods of operation in the event of their malfunction is the biggest reliability factor that can be designed into space systems. This is a well known fact to those with experience in experimental flight testing of manned aircraft. But it is an axiom that seems to elude many of the top scientists now pontificating on the space program.

X-15 Parallel

Experience in the flight test program of the X-15, which bridges part of the gap between aircraft and spacecraft, indicates the value of the trained pilot in the vehicle. Of some 48 flights in the X-15 to date, some 24 would have resulted in mission failures without the ability of the pilot to cope with failures of the vehicle's subsystems or components, and 10 would have resulted in the destruction of the vehicle and its experimental data. We predict that when the Mercury program is completed, this same type of curve relating pilot performance to mission completion will prevail.

Specifically applied to the Mercury orbital mission, Col. Glenn's performance indicates that several hundred pounds of equipment may safely be eliminated from the critical capsule weight to make way for the additional life support supplies required for the 18-orbit, 27-hr. missions that will climax the initial phase of NASA's manned space flight program. Without this trade-off of pilot's skill for additional useful weight, the 18-orbit mission would still loom far in the future when a booster larger than the Atlas would be available.

Col. Glenn's "eyeball reconnaissance" also displayed a scope and analytical quality that would be impossible to achieve with automatic equipment. The direction that he could provide for the finest reconnaissance equipment available would enhance its performance in space far beyond the pre-determined, pre-set missions now performed in the unmanned Samos and Midas satellite systems.

Real time communications provided by Col. Glenn certainly provided far more useful mission data than all the telemetry available on experimental flights of missiles and unmanned satellites.

There are, of course, many problems of man's survival and functioning in space that were not answered by Col. Glenn's flight nor are any of the currently planned Mercury flights likely to yield this necessary data. Although providing the longest period of weightlessness yet endured by an American, the 4 hr. 56 min. flight was much too short to provide a true gage of the effects of prolonged weightlessness on the human system. Col. Glenn's 100-162-mi. orbit was also too low to expose him to the radiation hazard that looms for deeper explorations of space. Providing the answers to these and many more questions regarding the human system in prolonged deep space environments is a continuing challenge that will face both astronauts and bio-astronauts for many years to come.

Experts Refuted

We recall listening some four years ago to a panel of distinguished scientists in Denver debate the usefulness of man in space. The unanimous opinion of these savants at a symposium, sponsored jointly by the USAF Office of Scientific Research and the Institute of Aerospace Sciences, was that there was nothing man could do in space that could not be done better by automatic equipment, and that consequently, man's weight and environmental equipment would represent squandered payload. Col. Glenn's performance during the MA-6 mission refuted their arguments in every respect.

Thus it is appalling still to find at the very top levels of presidential scientific advisers and at the top levels in the Pentagon the residue of this 1958 vintage thinking on man in space and obstinate parroting of the theory that man can contribute little to the functioning of spacecraft. This musty thinking is particularly dangerous when applied to the role of man in military space systems where the degree of the systems' reliability may be the exact measure of this nation's ability to survive.

It was Scott Crossfield, test pilot veteran of the Douglas D-558 Mark 2 and the North American X-15, who several years ago stated the case for the pilot aboard a flight vehicle of any type when he said:

"Where else would you get a non-linear computer weighing only 160 lb. having a billion binary decision elements that can be mass produced by unskilled labor?"

Where indeed, distinguished scientists who are still skeptical of man's role in space, where indeed?

—Robert Hotz

300,000 psi bolting... and how you can use it

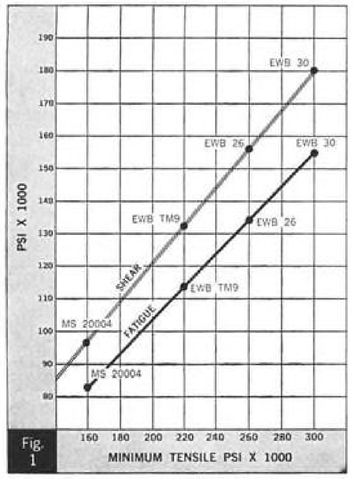


Fig. 1. Comparison of EWB 30 with predecessor bolts, showing proportionate increase in tensile, shear and fatigue.

Look back 10 brief years and you realize that in the new SPS EWB 30 you have a bolt which has actually cut the weight of steel fastening in half. Offering twice the tensile strength and three times the fatigue endurance of an MS 20004 Series, this—the first practical 300,000 psi superbolt—now pushes steel to a point comparable to titanium in the strength-to-weight spectrum.

All Physicals Upped Proportionately

Fig. 1 depicts the evolution of the EWB 30 in terms of increasing tensile, shear and fatigue values. Most significant is the fact that the EWB 30 offers a *proportionate* increase above lower strength bolts in static and dynamic strength.

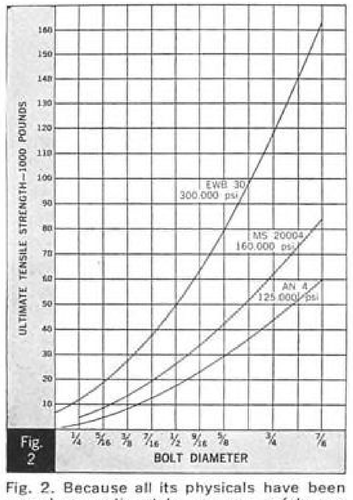
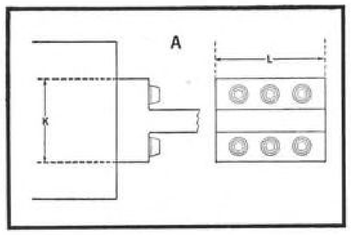


Fig. 2. Because all its physicals have been upped proportionately, you can safely use the EWB 30 in place of larger, heavier bolts.

Precisely because its tensile, shear and fatigue have been increased in proportion, you can safely compare the EWB 30 with its predecessors in terms of tensile strength vs. bolt diameter. And from such a comparison (Fig. 2) you can—again safely—derive the substitution of, say, a $^{9}/_{16}$ in. EWB 30 for a ¾ in. MS 20012 at a tensile level of approximately 65,000 lb.

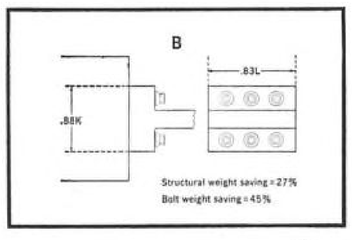
Weight Savings Approach 50%

Design implications of the new EWB 30 are therefore far-reaching, to say the least. As an example, take the hypothetical situation below—a simple joint fastened with six bolts. Note that in instance A we have designed around MS 20004 Series bolts; in B, around the new EWB 30.



A
MS 20008-16

Bolt diam.	½ in.
Head diam. (max.)	.828 in.
Ultimate tensile (min.)	27,400 lb.
Grip	1 in.
Length	1.812 in.
Approx. weight per bolt	0.147 lb.



B
EWB 30-6-16

Bolt diam.	⅜ in.
Head diam. (max.)	.725 in.
Ultimate tensile (min.)	28,500 lb.
Grip	1 in.
Length	1.739 in.
Approx. weight per bolt	0.0805 lb.

Thus you can go from ½ in. MS 20008 to ⅜ in. EWB 30 and actually *gain* tensile strength. And because EWB 30 shear and fatigue are in proportion, you can do it without risk. Result: a reduction of .399 lb.—or approximately 45% —in fastener weight alone!

Related Components Can Be Miniaturized

Savings in fastener weight are not the only design opportunity offered by the new EWB 30. Associated components—flanges, "T" sections, etc.—can also be miniaturized. In our hypothetical joint, for example, the smaller EWB 30 permits the width of the flanged member to be reduced 12%, flange length reduced 17%. In space vehicles or missiles, where weight is of paramount importance, these small savings on large-size joints can be significant.

A Complete Fastening System

In designing with this new ultra-high-strength bolt, full utilization of the advantages can only be accomplished by proper design and installation. Thus SPS offers with the EWB 30 a related fastening system . . . a special-design socket wrench which prevents damage of the wrenching area by contacting the less vulnerable midportion of the wrenching flats; and a preload indicating washer (PLI) which assures accurate preloading to 80% of bolt yield strength.

EWB 30 bolts and companion FN 30 locknuts are available only from SPS—in sizes #10-32 to ⅞-14. Also available is a shear bolt and nut combination in protruding (EWSB 30) and flush head styles (SFT 30, SFH 30) for 180,000 psi shear strength. For more information write AIRCRAFT/MISSILE DIVISION, SPS, STANDARD PRESSED STEEL CO., JENKINTOWN 3, PENNSYLVANIA • SANTA ANA, CALIFORNIA. Warehouses: Atlanta, Ga. • Dallas, Tex. • San Diego, Calif. • Seattle, Wash. • Tuckahoe, N.Y. • Wichita, Kans. IN EUROPE: Elektro-Metall Export G.m.b.H., Düsseldorf, West Germany.

New SPS EWB 30 bolt and companion FN 30 locknut. Tensile strength: 300,000 psi.

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WHO'S WHERE

In the Front Office

Thomas H. Morrin and **Hugh P. Moore**, directors of Radiation at Stanford, Palo Alto, Calif., a subsidiary of Radiation, Inc. Mr. Morrin is general manager-engineering, Stanford Research Institute; Mr. Moore is president, Technical Systems, Inc.

Charles S. Hobbs, San Francisco retail executive, a director of Trans World Airlines, Inc. succeeding **John A. McCone**, resigned (AW Feb. 5, p. 25).

Arthur J. Cussen and **William E. Standring, Jr.**, vice presidents, Infrared Industries, Inc., Waltham, Mass. Mr. Cussen is general manager of the Instrumentation Division; Mr. Standring is general manager of the Photoconductor Division.

Reginald G. Clarke, vice president of central administration, Autonetics, a division of North American Aviation, Inc., Downey, Calif. Also: **Reuben J. Bierke**, vice president of manufacturing, Columbus (Ohio) Division of North American.

Dr. Robert R. Bennett, director of the expanded Electronics Division of Space Technology Laboratories, Inc., Los Angeles, Calif., succeeding **Robert B. Muchmore**, now director of STL's new Physical Research Division. Dr. Bennett continues as a STL vice president. **Dr. James R. Burnett** succeeds Dr. Bennett as director of the Minuteman weapon system program.

Brig. Gen. Charles H. Terhune, Jr., has been promoted from acting commander to commander, Electronics Systems Division, Air Force Systems Command, Hanscom Field, Mass., succeeding **Maj. Gen. Kenneth P. Bergquist** (AW Feb. 19, p. 34).

Dr. Orr E. Reynolds, director, Bioscience Programs, National Aeronautics and Space Administration, Washington, D. C.

Col. E. E. Wilhoyt, Jr., commander Corps of Engineers Ballistic Missile Construction Office, functioning under Air Force Systems Command's Ballistic Systems Division, Inglewood, Calif., succeeding **Brig. Gen. Thomas J. Hayes** (AW Feb. 12, p. 32).

Changes

Gen. Don Flickinger, USAF (ret.) has joined Lear, Inc. as a biomedical adviser to the Instrument Division, Grand Rapids.

N. Elliott Felt, Jr., general manager-programs review, and **William G. Martin**, director-performance analysis, The Martin Co., Baltimore, Md., the Aerospace Division of Martin Marietta Corp. Also: **Murray Kanes**, director-advanced programs for The Martin Co.'s Space Systems Division, succeeding **Edward E. Clark**, now special assistant on the staff of the division's vice president and general manager.

E. H. "Tex" Boullioun, assistant Minuteman program manager, The Boeing Co.'s Aero-Space Division, Seattle, Wash.

Ray E. Horner, manager of the W2F-1 Project at General Electric Co.'s Light Military Electronics Department, Utica, N. Y. **Mark C. Lewis** succeeds Mr. Horner as manager-marketing for LMED.

R. B. Sheeline, program manager, Advanced Propellant Processing, Solid Rocket Division of Rocketdyne, Canoga Park, Calif.

INDUSTRY OBSERVER

► Search continues for materials that will withstand the extreme corrosiveness of hydrogen peroxide fuel used in reaction jets on Mercury capsules. In both the Mercury Atlas 5, which carried the chimpanzee Enos, and the Mercury Atlas 6 flight, which Marine Lt. Col. John H. Glenn, Jr., piloted, the minute orifices on one jet nozzle apparently became clogged by particles from either the pipes or the aluminum catalyst screen. Theoretically, neither should corrode enough to produce these particles unless there are impurities in the metals.

► **Proposals for a 7-lb. long-range (300 km.) radar altimeter to be used by planetary spacecraft on approaches to planets (see p. 36) are being evaluated by Jet Propulsion Laboratory, which manages National Aeronautics and Space Administration's planetary and interplanetary program. Feasibility study contract will be awarded soon by JPL's Systems Division. Goal of a 300-km. range represents a factor of 10 increase over 30-km., 6.8-lb. altimeter on Ranger 3. Five proposals were submitted for the job.**

► Bristol Siddeley Olympus 593 turbojet engine, under consideration for the joint British-French Mach 2.2 transport, made its first flight Feb. 23 on an Avro Vulcan bomber. Engine is slung in an extra pod under the belly (AW Feb. 5, p. 36), and is the civil version of the Olympus 22R for the TSR.2 strike fighter.

► **Navy's Mailbuoy satellites, to be designed as experiments to investigate possibilities of extending fleet line-of-sight UHF communications through satellite relay (AW Feb. 12, p. 26), will weigh roughly 35 lb., the lightest of the government-funded active communications satellites. Unstabilized Mailbuoy satellites will be drumshaped, approximately 1.5 ft. in dia. and about 10 in. high. They are intended initially for launch by boosters such as the USAF-Aeronutronic Scout into low-altitude earth orbits. Operational versions may involve sea launch. Aeronutronic is building two satellites for Naval Electronics Laboratory under a $200,000 contract.**

► Study of a ground operations support system (GOSS) will be initiated soon by NASA as a step toward satisfying ground control requirements for its Apollo program. Industry proposals were submitted the week of Feb. 19.

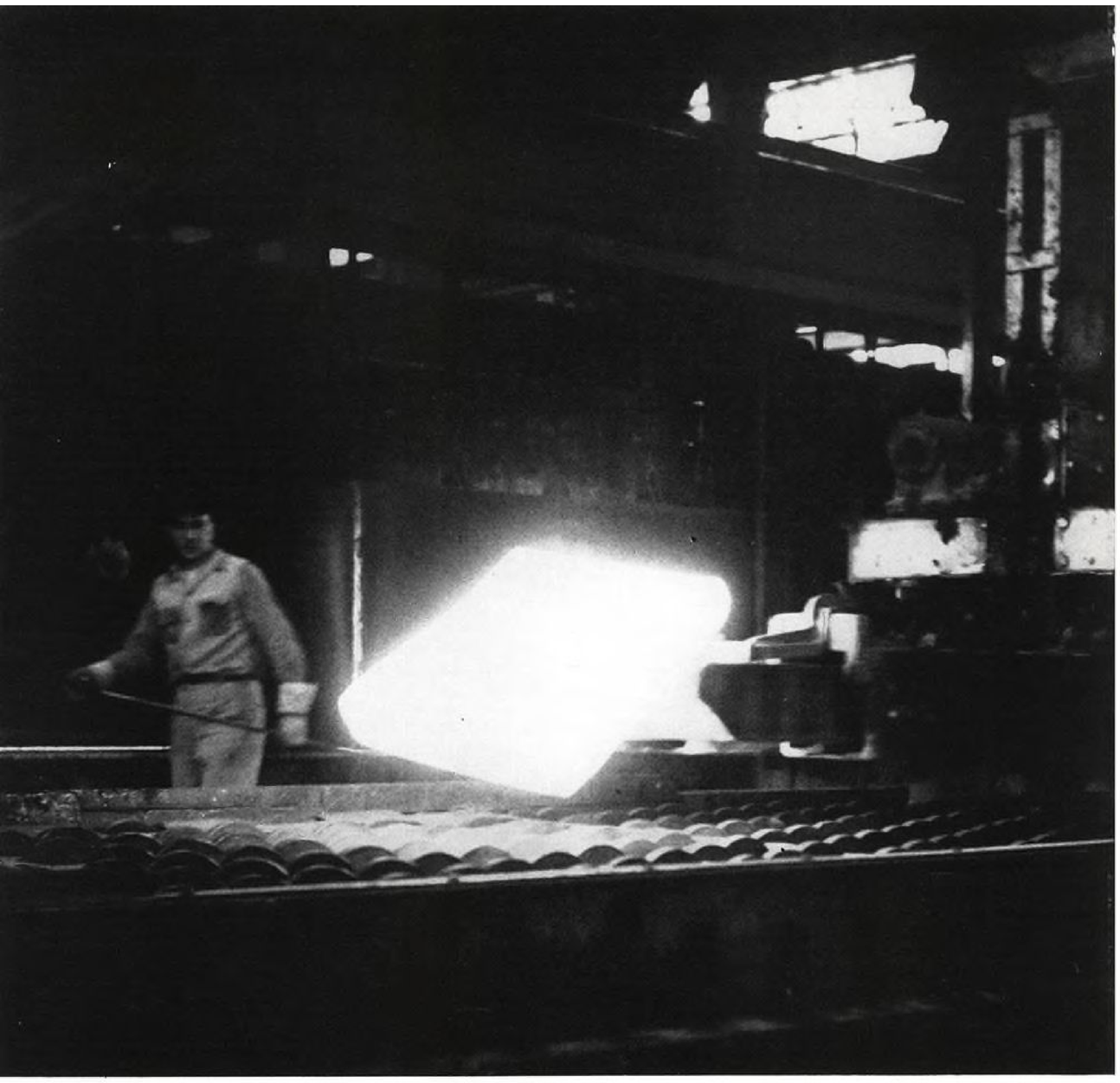
► **Turbomeca, French manufacturer of small jet engines, expects to begin bench tests of its new Aubisque fan engine by mid-year. Engine is rated at 1,543 lb. thrust, weighs 595 lb. fully equipped. It will be used in the Saab 105 twin-engine trainer prototype.**

► NASA is evaluating industry proposals submitted in a competition for a generalized study of spacecraft attitude control systems.

► **Contract to convert Jet Propulsion Laboratory's Deep Space Instrumentation Facility (DSIF) to S-band and to boost capabilities of the space tracking network will be awarded early this month. The award, due earlier but delayed, is to cover production and delivery within a year of S-band receivers and transmitter exciters (AW Feb. 5, p. 59) for stations to be located at Goldstone, Calif.; Woomera, Australia; Johannesburg, South Africa, and a transportable station. S-band operation on the complete network is scheduled by June of next year.**

► Air Force's 6560th Operations Group at Patrick AFB, Fla., is sampling patterns of ionospheric refraction of radio signals, using a new General Electric refractometer. Prototype is carried aboard a Convair JC-131 which porpoises through atmospheric layers to an altitude of about 30,000 ft. Some aircraft were used to test Atlas guidance systems and Mistram tracking system equipment.

► **Heavy construction of North American Air Defense Command's underground combat operations center at Cheyenne Mountain near Colorado Springs, Colo., is expected to be completed in May at a cost of $8.5 million. Entire installation is budgeted at $16.8 million. Work was begun last May and occupancy is scheduled for December of next year. Excavated area will equal a multi-story building and will have 154,000 sq. ft. of floor space.**



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Washington Roundup

Chinese Nuclear Test

Watch for the Chinese Communists to explode their first nuclear test device by mid-year at their test center in Sinkiang province in northwest China. It is expected to be a small-yield explosion in the 10 to 20 kiloton range. Soviet nuclear experts have visited the Chinese test site but the Chinese have declined offers of Soviet technical assistance on the grounds that it would reduce the international prestige they expect to gain from a nuclear technology developed without foreign help.

President Kennedy's long-overdue message outlining federal responsibilities in the field of transportation may go to Capitol Hill this month. One reason for the silence from the White House has been the desire to avoid pressure from the railroad, airline and trucking lobbies. This also has been a reason why an over-all transportation report, prepared by the Commerce Department and sent to the White House early last November, has not been made public.

Soviet Space Tracking

Russia apparently is beginning to develop a space tracking and communication network beyond the geographical boundaries of the Soviet Union itself. The Soviet technical mission that recently delivered four Russian W-class submarines to the Indonesian navy at Suribaya also surveyed proposed sites for a tracking and communication station on the islands of Ambon and Buru in the Banda Sea. The mission made no secret of its requirements for docking facilities that could handle heavy electronic equipment for this station. In another part of the world, the shipment of men and equipment to Soviet Antarctic weather stations at Mirnyy and Vostok by Il-18 and An-10 aircraft has been increased. All but one of Russia's space vehicles have been launched into orbits having an inclination to the equator of 62 to 64 deg. Stations in Indonesia and the Antarctic would be able to monitor satellites in these orbits and in polar orbits, which are the best for reconnaissance vehicles.

Congressional testimony by Adm. George W. Anderson, chief of naval operations, regarding Soviet missile-firing submarine strength is based on intelligence that about 25 G and Z-class submarines have been converted to fire missiles from the surface. These conventionally-powered subs use snorkels and have an estimated time on station of only about 10 days.

Missile Contract Probe

Investigation of government missile contracts by the Senate Permanent Investigations Subcommittee is to begin within the next two weeks—probably Mar. 19 or 20. Chairman John L. McClellan, who is concerned about possible "pyramiding of profits," will ask Defense Department officials and aerospace executives to defend contracts already executed, especially in regard to the fees negotiated. Staff members who are planning the hearings do not expect them to return to the subject of work stoppages at missile sites since it was dealt with thoroughly last year. But a recent upsurge in the number of stoppages probably will lead the Senators to raise the issue again.

Secretary of Labor Arthur Goldberg, who is working quietly with both labor and management leaders in hopes of achieving harmony in the missile program, talked extensively with Sen. McClellan last week.

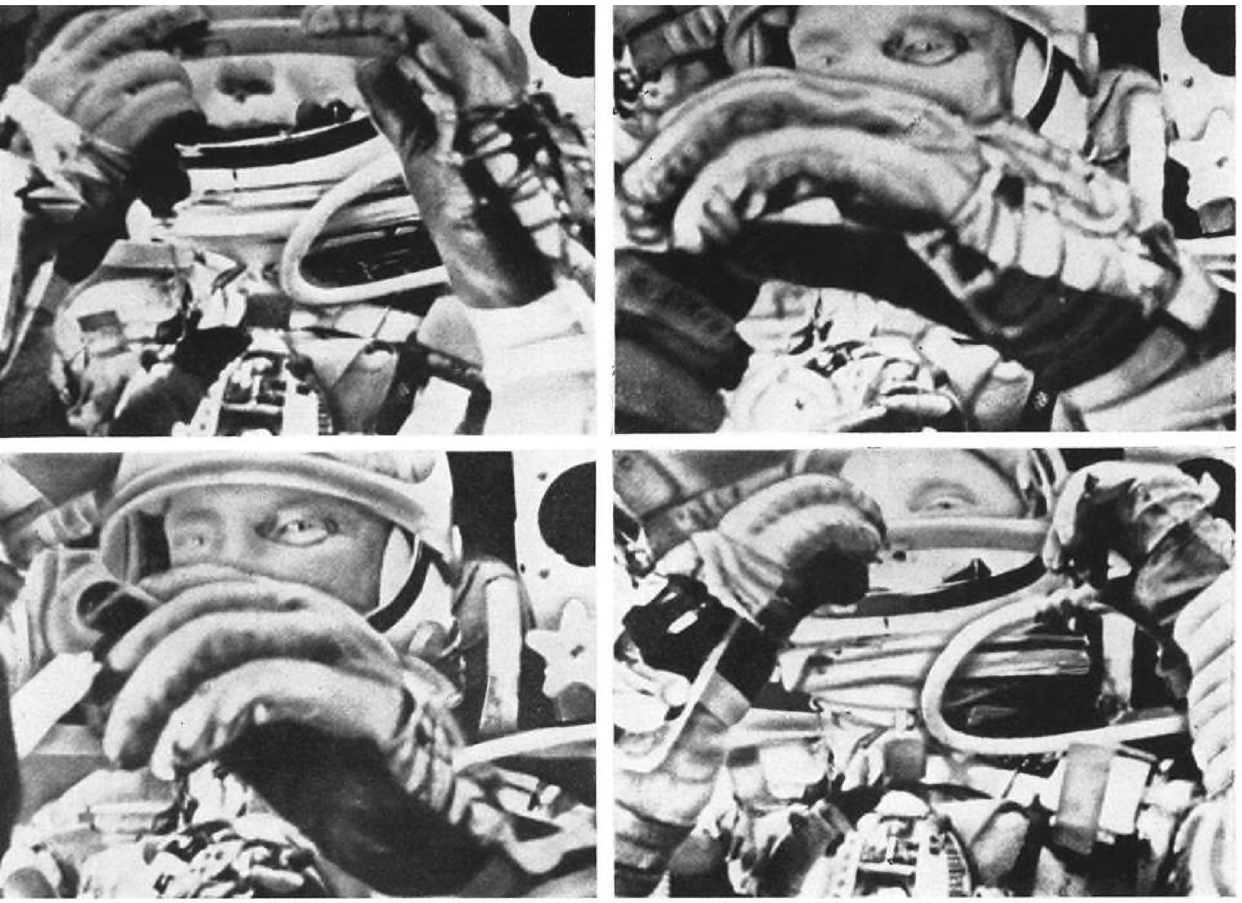
House commerce committee is scheduled to open hearings Mar. 5 on communications satellites with Dr. Edward C. Welsh, executive secretary of the National Aeronautics and Space Council, as the leadoff witness. But Welsh, who has been ill with heart trouble (AW Feb. 12, p. 25), was hospitalized again last week after overtiring himself by taking part in welcoming ceremonies for Astronaut John Glenn (see p. 22), and may not be able to appear.

NASA Information Plan

Sweeping reorganization of National Aeronautics and Space Administration's public information office is planned in an attempt to improve the space agency's public image. The pattern will follow that used in Air Force headquarters, with information officers assigned as special assistants to the major technical offices. Of 17 staff professionals, all but half a dozen are to be given such assignments.

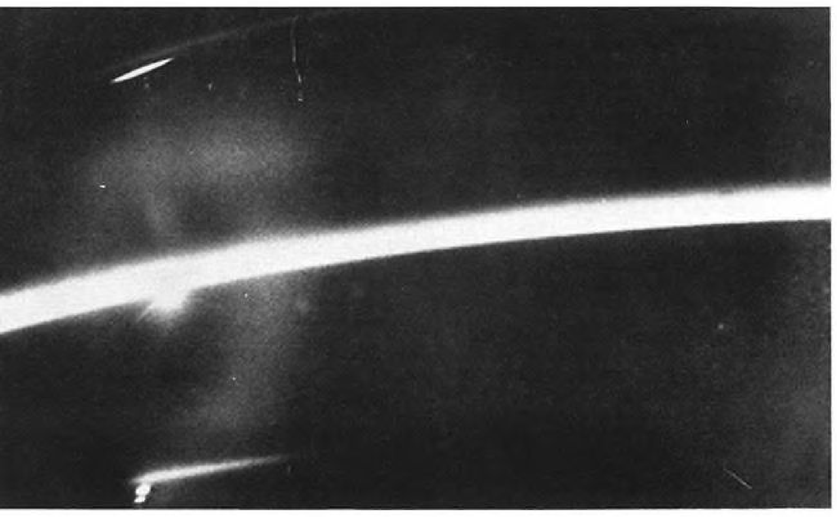
Some see this as a way to make information officers better acquainted with technical details of NASA's programs. But others fear domination and management of information by scientific and technical officials, who traditionally have favored release of less information than the agency's managers and information specialists, and who prefer to publish extensive reports of experiments in scientific journals before the information is made available to the general public.

Comprehensive statement on Air Force's space plans, made before the House Armed Services Committee recently by Lt. Gen. James Ferguson, USAF deputy chief of staff for research and technology (see p. 75), was cleared beforehand by the Office of the Secretary of Defense, indicating that Air Force at last may have gained top-echelon approval for some of its more advanced ideas on the importance of having a military capability in space. —Washington Staff.



MARINE LT. COL. JOHN H. GLENN eats from collapsible tube while in orbit. Top left, he opens the visor of his helmet, top right, reaches for food in pouch, lower left, extracts tube from pouch and, lower right, eats. Sequence occurred at 10:09 a.m. EST.

Spacecraft to Be Simplified as Result



GLENN EFFECT is seen in this photo taken by Glenn's hand camera at sunrise. Bright line is horizon with sun at left. Streak in upper left is believed to be "space firefly." Streak at lower left probably is reflection in capsule window.

By Edward H. Kolcum

Washington—Many automatic and backup systems considered necessary for manned space flight prior to Mercury Atlas-6 can be eliminated in extended missions because of the intelligent performance and quick adaptability demonstrated by Marine Lt. Col. John H. Glenn, Jr., in the first U. S. manned orbital flight.

Although complete results of Glenn's flight are still under analysis, one of the most striking aspects was the demonstration that a well-trained pilot is able to outperform some of his automatic systems, and at the same time use judgment and discretion in his scientific observations.

This means that a space pilot can be a versatile and dependable part of the over-all control loop, the same as he is in an aircraft.

Col. Glenn's performance probably will be reflected in the detailed design of the 18-orbit Mercury capsule, scheduled for a 27-hr. manned flight early

EARTH CURVATURE is evident in photo taken by Glenn through capsule window. Area shown in photograph was not definitely identified, but sun appears to be at right. Glenn took 128 photos with his hand camera, most of which have not yet been identified.

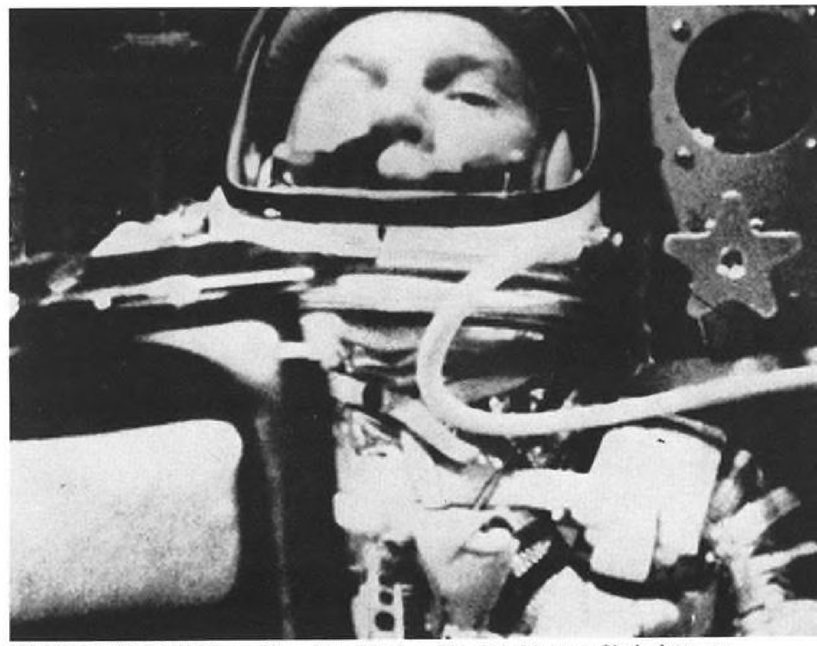
# of MA-6 Flight

next year. The extended mission, which is the next major Project Mercury milestone, will see increased reliance on the astronaut as a pilot, rather than as an observer and monitor.

George M. Low, director of National Aeronautics and Space Administration Spacecraft and Flight Missions, said no specific systems have been picked for elimination from the three-orbit Mercury capsule to extend its capabilities to 18 orbits. He said the approach being used is to determine those systems where more capabilities are needed, and then consider others for elimination.

There is a need for a slightly larger supply of environmental oxygen, hydrogen peroxide reaction jet fuel, battery power and cooling water.

Less than 10 more pounds of oxygen is required to extend mission to 27 hr., and the amount of fuel used in the orbital flight is about 25% of that expended during the entire flight. Most reaction fuel is used to orient the capsule blunt face forward after it is inserted into orbit and to stabilize it for



RETROROCKET FIRING forces Glenn's head back and he shuts his eyes. Clock above star-shaped object reads 2:24 p.m. EST. Retrofire sequence was initiated at 2:20 p.m. EST.

STILL IN PRESSURE SUIT, Glenn inspects capsule after being hoisted aboard destroyer Noa.

BIOMEDICAL SENSORS are still attached to Glenn as he disrobes aboard the Noa. Sensor on the left arm reported blood pressure. Others determined heartbeat.

retro-firing and during re-entry. Battery power can be conserved by activating systems only when they are needed. This, in turn, will reduce the amount of coolant needed, because the major heat source is from electrical units powered by batteries.

Among systems which may be eliminated is the 80-lb. periscope, which has proved to be less effective for attitude reference than the window, both in the MA-6 orbital mission and the Mercury Redstone 4 ballistic flight of Capt. Virgil I. Grissom. Cdr. Alan B. Shepard's Mercury Redstone 3 capsule had a small port, and he depended on his periscope for reference.

One of the three manual control systems may be eliminated to conserve weight, and it is likely that some of the capsule's 11 transmitter-receiver units will be eliminated for the same reason.

Control Systems

The Mercury capsule has an automatic stabilization and control system (ASCS), essentially an autopilot: rate stabilization and control system (RSCS), a manual system using fuel from separate tanks and connected to reaction control jets through a rate command electronic link; fly-by-wire, a manual system using fuel from the automatic control tanks, which actuates reaction jet valves through the autopilot link; and the fully manual proportional system, which links pilot stick movements mechanically to reaction valves and uses fuel from the manual tanks.

Although Col. Glenn did not use RSCS, some pilots may prefer this system over fly-by-wire, Low said. For this reason, no choice has yet been made on which mode to eliminate.

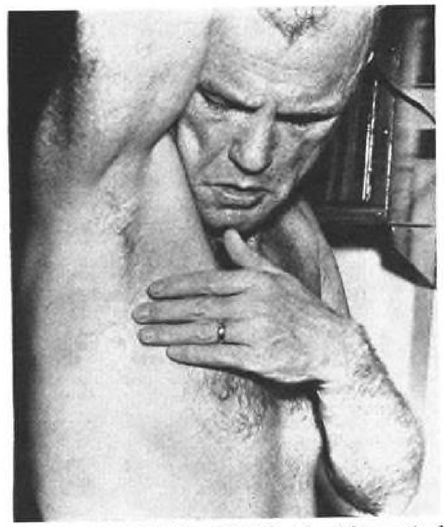
Objective of any change is to keep the 18-orbit Mercury capsule weight as close as possible to the three-orbit capsule, since it is now within the capabilities of the Atlas D launch vehicle.

MA-6 capsule with the escape tower weighed 4,265 lb. at launch. At apogee in the orbital configuration, it weighed 2,987 lb. Impact weight, after dumping excess fuel, the retropack, parachutes and recovery aids, was 2,493 lb. Apogee and impact weights are based on pre-launch computations.

Glenn's Warning

Although the MA-6 mission was considered completely successful both technically and from its unsurpassed prestige value, Col. Glenn injected a sobering note during an interview before the House space committee here last week when he cautioned the nation not to expect only successes.

"We must be prepared for failures and sacrifices . . . we don't envision every flight coming back as successfully as the three we have had so far," he said.



SENSOR ATTACHMENT POINT under right arm is checked by Glenn. All sensors are reported to have worked correctly. At Grand Turk Island, right, Glenn has lunch with Astronaut Don Slayton, extreme right, during post flight examinations.

It was brought out that 150-175 critical situations were foreseen before the flight, and corrective action was mutually decided on between Glenn and flight control.

The possibility of a loose heat shield —erroneously signaled by a faulty switch —was one which had not been foreseen.

Full analysis of the MA-6 mission may take another month, but Low pointed out that the orbit was so close to that predicted that the significant numbers probably will not change a great deal. Physically, Col. Glenn was obviously unaffected by his extended weightlessness.

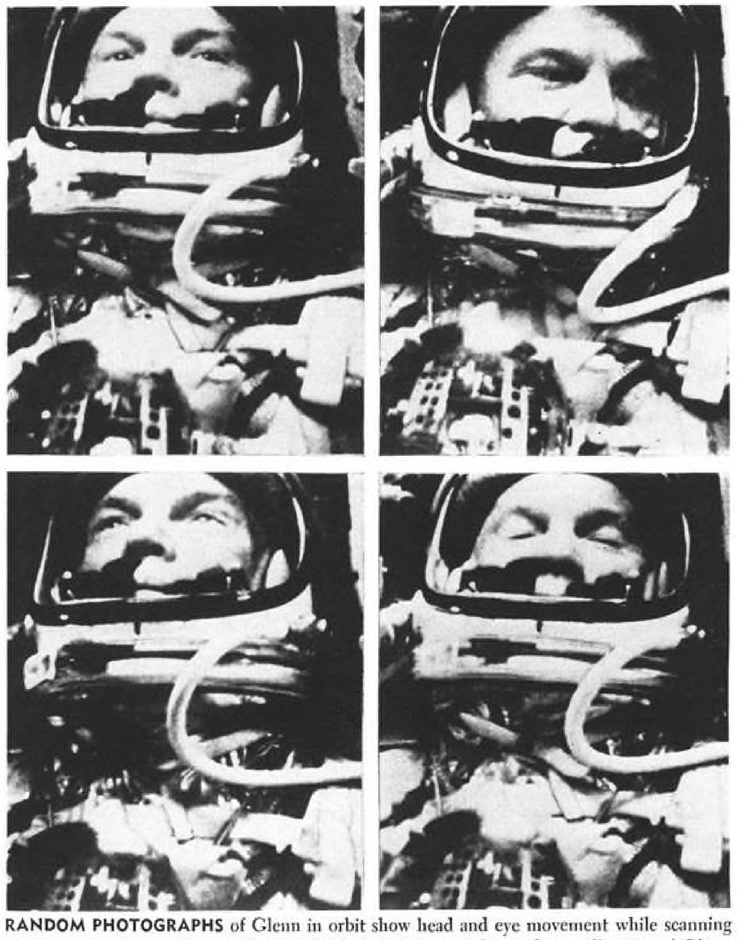
His voice transmissions were loud, clear and reflected assurance throughout the flight.

The astronaut showed no tendency toward vertigo, nausea or disorientation, and he performed violent head movements to induce any latent effects which have been reported in the flight of Soviet Maj. Gherman Titov in Vostok 2. Titov's illness did not occur until after the sixth hour of his flight, but all indications at this time are that Col. Glenn would not have been affected during an extended space flight.

Col. Glenn said several times he has probably become an "addict to zero g," and he found the sensation pleasant.

Other highlights of the MA-6 flight which have come out since the initial findings are:

• **Automatic control** problem has not yet been isolated, but most likely occurred when the pinpoint-size orifice to the 1-lb. reaction jet thruster catalyst bed became clogged. The hydrogen peroxide reaction jet system works this way: the fuel is fed to a catalyst bed through anodized aluminum tubing. It



RANDOM PHOTOGRAPHS of Glenn in orbit show head and eye movement while scanning instruments and observing earth through the Mercury capsule window. All views of Glenn in orbit were taken by an automatic 16 mm. motion picture camera with color film, from which these black and white prints were made.

Glenn Tells Congress of MA-6 Significance

Washington—Marine Lt. Col. John H. Glenn, Jr., told a joint meeting of Congress last week that his three-orbit flight in the Mercury Atlas 6 proved the soundness of the Mercury program and proved "that man can operate intelligently in space and can adapt rapidly to his new environment."

Col. Glenn and five of the other six astronauts appeared at the joint meeting with top officials of the National Aeronautics and Space Administration and the Mercury project itself—an honor usually reserved for heads of state and top military heroes. Astronaut Leroy G. Cooper, Jr., was on his way back from Australia. Col. Glenn flew here from Florida with President Kennedy, visited with him briefly at the White House and rode to the Capitol with Vice President Lyndon Johnson, chairman of the National Aeronautics and Space Council, in a formal parade. Col. Glenn's 19-min. speech was interrupted 12 times by applause.

Col. Glenn and Robert R. Gilruth, director of the Mercury project and NASA's Manned Spacecraft Center, had received NASA's Distinguished Service Medal from the President at Cape Canaveral, Fla., three days earlier. Navy Cdr. Alan B. Shepard, Jr., and Air Force Capt. Virgil I. Grissom, the other two astronauts who have made flights, so far, also have received the medal.

Col. Glenn, Cdr. Shepard and Capt. Grissom also appeared before the House and Senate space committees last week and went to New York for a parade and award of the city's medal of honor to them and to Gilruth.

Col. Glenn was to go to his home town of New Concord, Ohio, for a reception, but NASA Administrator James E. Webb said other tours will be kept to a minimum. As for letting the astronauts be received in foreign cities, Webb said: "The image of the United States is in the completion of this project and not in wonderful parades in some foreign city."

When a visit by an astronaut can "contribute to knowledge and technology," it will be approved, Webb said. This may mean the door is open for astronauts to participate in scientific and engineering society meetings here and abroad.

is decomposed on a silver screen and exits through the nozzle as steam. It is possible that the orifice to the catalyst bed became clogged with flakes from the feed tube.

Col. Glenn overrode the automatic system as he approached Guaymas, Mexico, on his first orbit, and he controlled capsule attitude on fly-by-wire and manual proportional systems for the rest of the flight. He estimated that he divided his time on these systems about in half. He used the manual mode to damp capsule oscillations during re-entry.

• **Erroneous signal** indicating a loose heat shield has been traced to a faulty switch, but the experience provided an opportunity to make an unforeseen, critical decision. The signal was seen by the Muchea tracking station on the first orbit, and in a period of a few minutes, a decision was made by Flight Director Christopher C. Kraft not to jettison the deceleration rocket package, but to keep the package strapped to the heat shield. The straps holding the rocket package are made of titanium, and if necessary could have held the shield secure to the capsule until it reached the dense layers of the atmosphere. The wind velocity vector would have been head-on, and strong enough to hold the shield in place.

The decision to retain the retrorocket package was the most critical made during the MA-6 flight. Wind tunnel tests conducted early in the program had shown theoretically that the straps holding the rocket package can withstand part of the re-entry maneuver.

The retrorocket package in a normal situation is jettisoned immediately after the rockets have fired. The heat shield remains attached to the capsule until the main parachute deploys at 10,000 ft. At this time, the shield drops and becomes the base of the 4-ft. rubber-nylon landing skirt, used to reduce impact shock.

In discussing his flight, Col. Glenn agreed that the heat shield was his greatest concern. The re-entry plasma sheath interrupted communications with the ground, and the astronaut missed the transmission from Shepard at Cape Canaveral instructing him to retain the rocket package until he was over Texas. The transmission was given while he was over California, and repeated over Cape Canaveral where he first heard it.

As a result, he thought the package had been jettisoned by ground command, and during re-entry, he saw flaming portions of it streaming past his window. He thought momentarily his heat shield was breaking apart, in which event, he said, it "would have been a bad day for all of us."

• **Glenn Effect,** or luminous particles which Col. Glenn observed for 3-5 min. at each sunrise, has become a matter of interest and speculation among astronomers. The astronaut thought they might be the cloud of Project West Ford needles launched last fall as a dipole communications experiment and then lost. However, they were boosted to a 1,200-mi. orbit., and Col. Glenn's apogee was 159 mi. Dr. John O'Keefe of NASA's Goddard Space Flight Center believes they may have been vapor drops from the environmental system outflow and the reaction jets.

Col. Glenn said he saw thousands of the firefly-like particles, which he passed at a relative speed of 3-5 mph. Dr. Robert Voas, a psychologist on the Mercury de-briefing team, said the capsule apparently touched the fringe of the earth's atmosphere, causing the particles to be pushed around the capsule.

• **Observations:** sunsets are the most impressive sights, and the horizon stays lit 4 to 5 min. after the sun has set. Clouds were viewed over a good part of the orbital track, with most of the Pacific Ocean area covered by clouds. A demonstration of the adaptability of a human pilot to unusual conditions came when he took some photographs with his 35 mm. hand camera, placed the camera in mid-air to operate a switch, and then picked his camera from its mid-air spot and resumed hand photography. Most welcome sight was the drogue parachute deploying.

At the Mercury orbital altitude, stars do not blink, but shine steadily. Light reduction through the capsule window is about the same as it is through the atmosphere. The astronaut saw patterns in the ocean currents, and squares of irrigated land in the Western U. S.

Col. Glenn said he left the capsule through the emergency hatch because he was very hot in his full pressure suit. He first attempted to exit through the neck of the capsule, and could have done so, but he decided to blow the explosive hatch to get out as quickly as possible.

Seven Orbits Possible

The transmission "you are good for seven orbits" from Mercury Control to Glenn's Friendship Seven capsule came from the flight dynamics officer (Fido) Tecwyn Roberts, who computed that the orbit was dynamically precise enough so that the capsule would remain up for at least seven cycles. This is the minimum desired for a three-orbit mission, and actually, the capsule would have remained in orbit several days if the deceleration rockets were not fired.

After the flight, Col. Glenn described his impressions of the program as "not just a human experience . . . but [a search for] vital information on which to build the future. These things are worthwhile for our own benefit even if there were no such place as Russia, no competition."

Col. Glenn, 40, and Cdr. Shepard, 38, do not feel their ages proved a hindrance on their flights. Cdr. Shepard said criteria for the next generation of astronauts will be about the same as that used when the original seven Mercury pilots were chosen three years ago.

Col. Glenn also feels the basic qualification should be engineering test pilot experience, since it probably will be easier to train a person with this background in a scientific specialty than it will be to train a scientist in test flying, and to provide him with training and experience to react under stress.

Additional Astronauts

NASA Administrator James E. Webb told the House space committee the agency plans to augment the current astronaut roster, and will make an announcement on this shortly. It is expected that NASA may include some of its own X-15 pilots in the new group, which may be as large as 21. Most, however, will be Air Force and Navy test pilots.

Cdr. Shepard said the question most frequently asked of him is "where do you get your luck?" His response is "we make our own luck by careful attention to detail and design . . . reliability may take more time and money," but it assures attaining mission objectives.

MA-7 Booster Check

Washington—Rollout inspection of Atlas 107D, the booster assigned to Astronaut Donald Slayton's Mercury Atlas-7 mission, will be held today at the General Dynamics/Astronautics plant in San Diego. The vehicle is scheduled to be airlifted Mar. 7 to the Atlantic Missile Range, where it will be erected and mated to the Mercury capsule which has been at the launch site several weeks.

Preliminary decision has been made not to remove the plastic foam blanket which insulates fuel from liquid oxygen. The blanket was removed on the pads from both Ranger 3 and MA-6 vehicles when fuel seeped into the blankets (AW Feb. 26, p. 61). It is estimated that it would take 10 days to remove the insulation at the plant.

Meanwhile, the National Aeronautics and Space Administration is undecided on the number of three-orbit flights it will schedule before moving to the 18-orbit mission early next year. The agency has four three-orbit capsules, four 18-orbit capsules and eight Atlas D boosters remaining. There were indications last week that the three-orbit program could end after the MA-7 mission, to be flown by Maj. Slayton.

The Atlas D rollout inspection today was to be conducted by USAF Space Systems Division, General Dynamics/Astronautics and Aerospace Corp., technical manager of the Mercury Atlas space booster program.

LeMay Charges U. S. Is Losing Its Strategic Force Superiority

By George C. Wilson

Washington—Air Force Chief of Staff Gen. Curtis E. LeMay broke the military unity on President Kennedy's Fiscal 1963 defense budget by charging that it starts a trend which may destroy U. S. superiority in strategic forces.

Gen. LeMay's testimony prompted the House Armed Services Committee last week to recommend adding $501 million to President Kennedy's Fiscal 1963 Air Force budget. Of this, $491 million would be used to start building three reconnaissance strike B-70s and $10 million would be spent on additional Boeing Minuteman missiles. The committee also added $55.3 million to its Defense Department authorization bill for an assortment of Army helicopters and aircraft.

The additional funds were recommended after Gen. LeMay in closed hearings told the committee President Kennedy's Defense budget started a trend toward downgrading strategic forces. He repeated his views during Senate hearings.

He told the Senate defense appropriations subcommittee last week he was not opposing the build-up of limited war forces in the new budget, but said "You cannot fight a limited war except under the umbrella of strategic superiority. I think we are all right now," Gen. LeMay added. "It is the trend that I'm worried about that I see starting in this present budget."

He said if continued for the next four years, the trend will result in reducing emphasis on strategic forces from 18% to 8% of the budget total. He cited Lebanon as a case where U. S. troops would not have dared enter "without strategic superiority which kept the enemy air force off of them." He said, "strategic power comes first. I do not believe that we are going to have that superiority in the future."

Specifically, Gen. LeMay recommended enlarging the North American B-70 and Boeing Minuteman programs in President Kennedy's Fiscal 1963 budget. He said this could be accomplished through reprograming and rearranging funds rather than through an additional appropriation above the $51.6 billion requested for Fiscal 1963.

Air Force Secretary Eugene M. Zuckert told the Senate subcommittee that President Kennedy had rejected an Air Force request to proceed with the B-70 as a full weapon system rather than as a limited development aircraft. "My current recommendation," Zuckert said, "is that we should go ahead with an expanded development program."

The expanded program favored would cost about $5 billion, Zuckert said, and produce "a quantity of operational B-70s." The Air Force declined to specify how many aircraft $5 billion would finance. The three B-70s now under development will cost about $1.3 billion and will be weapon systems. Two aircraft will be flight articles, and the third will be equipped with a bombing and navigation system.

Gen. LeMay recommended converting those three B-70's already programed to reconnaissance strike aircraft and building an additional three for a total of six RS-70's, saying this will demonstrate "the capability of building this type of weapon system.

"I do feel that we must go on with manned systems development, the RS-70 and the full weapons system," Gen. LeMay said. "I do not think we ought to make a decision now to go into production on it, but I think we have to do the things to give us the option of going into production if it is necessary. It is my personal belief that it will be necessary."

Asked if he still felt more B-52s should be built, Gen. LeMay said because of the time lag needed to get those aircraft back in production, he would rather spend the money for something else. "I think we have just plain missed that boat" on the B-52 program, he said. Congress last year appropriated $514.5 million for additional B-52s or B-58s, but President Kennedy declined to spend it.

In the Minuteman program, President Kennedy has asked Congress to appropriate enough money for an additional 200 to give the Air Force 800 of them. Gen. LeMay recommended procuring another 100 Minutemen in Fiscal 1963 as well as the long lead-time items for 150 more, which would boost the force to 1,050 missiles.

As for applying technological breakthroughs to weapons in production, the Air Force chief said Russia has been "much more successful" in this than the U. S. "Russians seem to be able to shorten the time period between the gleam in a scientist's eye and hardware in the hands of their crews," Gen. LeMay said.

In other testimony, Navy Secretary Fred Korth said anti-submarine warfare was a primary concern of the Navy since "we fully expect any potential aggressor to exploit to the fullest the same near-invulnerability which makes the Polaris such a potent weapons system."

Korth said the Navy plans to spend

$2.2 billion on anti-submarine warfare in this manner: research and engineering, $286 million; shipbuilding and conversion, $1.2 billion; and procurement, $736 million.

Chief of Naval Operations Adm. George W. Anderson said although Russian counterparts of U. S. Polaris submarines are "at present limited, we must accept the fact that they will make considerable progress in this area within the next few years." Adm. Anderson said if the Fiscal 1963 budget requests are granted, the Navy will have 7,228 operating aircraft, 862 ships and 665,315 men.

In contrast to Gen. LeMay's testimony, both Secretary of the Navy Korth and Adm. Anderson said they were satisfied with the way their budget requests were handled by the Kennedy Administration.

NASA Attempts to Clarify Views On Rendezvous and Direct Ascent

By Evert Clark

Washington—Both rendezvous in space and direct flight to a target are essential to manned exploration of space and both are being pursued as part of one careful plan, despite an impression that the U. S. is developing rendezvous techniques at the expense of direct flight, a National Aeronautics and Space Administration official said last week.

Milton W. Rosen, director of launch vehicles and propulsion in NASA's office of manned space flight programs, said "the public should not expect one solution or the use of one tool." He said the pursuit of both techniques "is not a dual approach but is like having both algebra and geometry at our disposal."

NASA officials have stated many times that rendezvous in an earth orbit appears to be the quickest way to achieve the national goal of landing men on the moon in this decade. They also have said that direct ascent would be used for later missions. Apparently they have left an impression that NASA favored rendezvous to the detriment of development programs aimed at producing vehicles large enough for direct ascent on lunar and planetary flights.

Rosen, speaking to a meeting of the American Rocket Society's chapter here, said much more is involved in landing men on the moon than whether rendezvous or direct ascent is chosen as the method. If government, industry and science can be marshalled properly to do the job it will make little difference which method is used—but one difference it would make is time, Rosen said.

Estimates on the time to be saved by using rendezvous have ranged from six months (AW Jan. 1, p. 16) to NASA Administrator James E. Webb's estimate of two years.

Neither approach can be viewed just from the standpoint of going to the moon, Rosen said, but must be viewed from the standpoint of continued and expanding exploration of space.

Rendezvous must be developed "regardless of whether we use it to go to the moon," Rosen said. In spite of the reliability built into Astronaut John H. Glenn, Jr.'s Mercury capsule, a potential re-entry problem developed when it appeared that his heat shield might come loose unless the retro-rocket pack was retained (see page 18). Rosen cited this example and said he did not think manned space flight could go on forever without provision for repairing a disabled spacecraft in orbit in order to rescue the occupant.

"For this one function alone, I am—and I think all of us must be—strong supporters of the urgency of developing rendezvous capability," Rosen said. Other missions will include re-supply of men and material and repair of large, expensive manned spacecraft in order to get full utilization from them, and the practicality of assembling some vehicles in space when power is not available to launch such large payloads from the ground, he said.

Direct flight is a simpler operational method with fewer separate tasks to perform and therefore an increased chance of success, Rosen said. If rendezvous is favored for the lunar mission, the next step will be to build a substantial lunar base and direct flight appears to be the best way to lift the heavy loads involved in this, he said.

There also will be certain missions where assembly in orbit is not practical because the parts of the payload need to be checked out and assembled on earth, Rosen said.

Considering the lunar mission alone, rendezvous offers the advantage that part of the operation can be staged before the man is committed to it, Rosen said. The entire spacecraft might even be put into orbit and checked out before the men were sent up to enter it.

The time scale is important when rendezvous is considered for the lunar mission, Rosen said, "but unfortunately, most of these claims [that rendezvous is faster] have been based on earlier vehicle availability.

"I think we will be paced not by the availability of the vehicle but by development of the rendezvous technique itself," Rosen said. "If we can master rendezvous, there is no doubt that rendezvous will be faster because the launch vehicle will be available first. But I don't think the launch vehicle will be the critical part. . . .

"To restrict launch vehicle capability at this early date seems to me to be very imprudent if we are in this for the long pull," Rosen said. To choose rendezvous alone "assumes easy mastery of rendezvous, limits launch vehicle capability and ignores advanced missions," he said. To choose direct flight alone "would be even more shortsighted," ignoring mastery of rendezvous for rescue, resupply and the need for direct flight on subsequent missions.

Therefore, NASA is taking both approaches and they have "much more in common than there are differences between them," Rosen said. For the lunar mission, rendezvous calls for putting the Apollo spacecraft and a 100-ton escape stage powered by a single Rocketdyne J-2 liquid hydrogen-liquid oxygen engine into orbit on separate flights, using the advanced Saturn C-5 vehicle; joining them and sending them to the moon. The direct method would require joining the same two pieces on earth, putting them into an earth orbit together using one flight of the Nova and sending them on to the moon.

Both vehicles will use the Rocketdyne 1.5-million lb. thrust F-1 engine in the first stage. C-5 will use five F-1s, and Nova probably will use eight, but might use one more or less than that. Second stages of both vehicles will use hydrogen-fueled engines—C-5 will use five J-2s and the Nova will use four Aerojet 1.2-million lb. thrust M-1s.

The C-5 will be needed for direct flight in the early circumlunar missions, for rendezvous if a single rendezvous is used for the manned landing, and for "many unmanned missions," Rosen said. Nova may be needed for construction of the lunar base, more advanced lunar missions and planetary missions involving nuclear stages, he said. Whichever method is used for manned lunar landings, "you can be certain we will send a beacon to the moon to guide them in long before we send the man, and I would think we will send supplies ahead, too," Rosen said.

NASA to Hire Management Firm

Washington—National Aeronautics and Space Administration soon will employ an outside management analysis firm to review such major space agency decisions as whether orbital rendezvous or direct flight is the best way to reach the moon.

NASA Administrator James E. Webb told the House Science and Astronautics Committee last week that NASA will use profit-making firms for its management help rather than follow the Defense Department policy of relying heavily on non-profit corporations. "We have made the basic decision not to use non-profit corporations as devices for bringing people in to make decisions that should be made by officials of the U. S. government," he said.

The prospective contract and the one recently awarded to General Electric Co. for systems integration and checkout of the Apollo spacecraft (AW Feb. 19, p. 26) are designed, Webb said, "to supplement the very thin number of people capable of the most important decisions." He said the management analysis contract is in final negotiation. The firm chosen, he said, will provide "continuous over-all examination of the concepts under which we work."

The House space committee intends to study this management contract in detail, probably during subcommittee hearings this week on NASA's Fiscal 1963 budget.

House Armed Services Permanent Investigations Subcommittee also is interested in the management contract. It is preparing for hearings on Defense Department's use of non-profit corporations and individual consultants. Chairman F. Edward Hebert (D.-La.) has expressed fears that the military is relinquishing its decision making to these non-profit groups.

Mobile Missile Delayed

Development of Mobile Mid-Range Ballistic Missile by the Air Force has been delayed again by the Director of Defense Research and Engineering in order to re-evaluate critical guidance requirements for the NATO weapon system and because the effort may be downgraded to a planning study.

Industry is concerned over the possibility of having to perform further studies, since the system was treated comprehensively in earlier studies of a small, mobile intercontinental missile, then called Midgetman, under Study Requirement 17982 (AW July 18, 1960, p. 26).

MMRBM system project office, established recently at Air Force Systems Command's Ballistic Systems Division, has asked industry to submit information on the number and duration of these earlier studies and the approximate amount spent for these. Against this background, discussions were being held last week between Defense Department, Air Force and Aerospace Corp.

Kennedy's Comsat Plan Draws Strong Opposition in Congress

Washington—Three-way fight in Congress over ownership and operation of a world-wide space communications system developed last week.

The President's proposal for a publicly-owned, profit-making communications satellite corporation met opposition from two sides: Those who favor exclusive ownership by international communications common carriers and those who want government ownership.

Senatorial Resistance

Opening hearings before the Senate space committee made it clear that key senators on the committee, notably Sen. Robert Kerr (D.-Okla.), the chairman, and Sen. Stuart Symington (D.-Mo.), are adamant against the President's plan (AW Feb. 12, p. 26).

Kerr is the author of legislation which would put ownership of the corporation with the communications common carriers.

Meanwhile, another group of senators, led by Sen. Estes Kefauver (D.-Tenn.), introduced legislation establishing a government-owned communications satellite authority. The main reasons for government ownership, Kefauver said, are that "only the government can launch the space satellites . . . only the government can negotiate with foreign governments for a single world-wide system . . . the government will have to regulate any system . . . and the government will be one of the principal users of the system."

Engstrom's Views

The target of the senatorial attacks at the space committee sessions was Dr. Elmer W. Engstrom, president of Radio Corp. of America and the lead-off industry witness, who initially—in his prepared statement—endorsed the President's legislation. After prolonged and harsh questioning, Dr. Engstrom modified his position. He suggested that it would be advisable to postpone a decision on the management organization for the satellite system for about a year. By that time, he noted, technical development work would be advanced, and companies would be better able to judge whether or not to invest in a privately-owned system.

Senators criticized Engstrom for declining to commit RCA to an investment in the corporation proposed by the President. Engstrom said that hundreds of millions of dollars would have to be spent on the system before it started making profits by about 1970. Noting Engstrom's initial endorsement of the corporation, Sen. John O. Pastore (D.-R. I.) commented that "you said you are for something you are really against and you have us all confused."

Symington developed in questioning that the corporation, as proposed by the President, probably would be government dominated: the President would appoint the original incorporators, who would appoint the original board of directors, who would file the articles of incorporation. This original management, Symington observed, could only be changed through the initiative of holders of Class A stock, which would have a wide public distribution. It could be purchased by anyone, including the communications common carriers, up to a maximum of 25% of the total outstanding stock. Holders of Class B stock, available only to the common carriers, would have no voting rights to elect corporate directors.

Development Timetable

Dr. Hugh Dryden, deputy administrator of National Aeronautics and Space Administration, and Morton J. Stoller, acting director of NASA's office of applications, presented the committee with this 1962-65 development program for a commercial space communications system:

- **1962:** One launch of Echo 2 passive satellite, two launches of American Telephone & Telegraph Co.'s Telstar low-altitude active repeater satellite, and two launches of RCA's Relay low-altitude active repeater satellite. Echo 2 will weigh 500 lb., compared with 135 lb. for Echo 1, and will have improved surface characteristics. Relay will weigh 125 lb., go into a 900 to 3,000 mi. elliptical orbit, and be launched by a Delta vehicle.
- **1963:** Two more Relay launches, two launches of Hughes Aircraft Co.'s Syncom synchronous orbit satellite, and one Rebound launch, which will embody the multiple-launch concept. Syncom will weigh 55 lb., go into a 22,300 mi. inclined orbit, and be launched by a Delta vehicle. The contract for the Rebound spacecraft has not yet been awarded.
- **1964:** One more Rebound launch, three advanced Relay launches, and two advanced Syncom launches. Advanced Relay will weigh 600 lb., go into a maximum 12,000 mi. circular orbit, and be launched by an Atlas-Agena B vehicle. Advanced Syncom will weigh 500 lb., go into a 22,300 mi. equatorial orbit, and also be launched by Atlas-Agena B.

British Cancel Rotodyne After Spending $30 Million on Program

London—Ministry of Aviation last week canceled the Westland Rotodyne VTOL transport after spending more than $30 million on its development in the past six years.

Decision to end Rotodyne work followed a review of its military potential for Royal Air Force and civil use by British European Airways, according to Minister of Aviation Peter Thorneycroft.

Cancellation came when BEA, which is considering buying the Vertol 107, told Thorneycroft that commercial prospects of the Rotodyne on its routes did not justify heavy costs of a production order. A single prototype, powered by Napier Eland engines, has made 455 test flights. A Rotodyne-Z version for BEA would have been powered by Rolls-Royce Tyne engines (AW Sept. 18, p. 41).

Thorneycroft said there would be no serious financial loss to Westland Aircraft, the builders. The government probably will pay the manufacturer about $5 million in termination fees.

The Tyne-powered version had a development contract limitation of about $12 million although not all the money has been spent. About $20 million was spent on the Eland phase of development.

Westland Aircraft said that without the RAF and BEA orders, it did not feel justified in continuing the project as a private venture, despite letters of intent from abroad. Kaman Aircraft Corp. is the U. S. licensee.

The company added that the Rotodyne could not have contributed to profits for at least five years and thus the cancellation will have no adverse effect on its profit earning capacity for that period.

In addition, Westland said it will receive certain payments from termination and will be able to release considerable sums previously written off. Several million dollars previously earmarked for future Rotodyne development also will be freed for other purposes.

The end of the Rotodyne leaves the convertiplane field to the Russian aircraft known as the Hoop and first seen at the Tushino air display (AW July 17, p. 28). There is no similar U. S. machine.

The Rotodyne originally was designed by Fairey Aviation, whose helicopter interests were merged into Westland in February, 1960. The prototype was developed under government contract which ended in December, 1957 and Fairey continued the project as a private venture. Maiden flight was Nov. 6, 1957.

Meanwhile, D. Napier & Son, builders of the Eland, have dropped the engine as a commercial proposition after a review of sales prospects. The engine powers the Canadair-Convair 540, some of which are in service with Royal Canadian Air Force. Any future development, Napier said, must come from military funding.

Atlas E Launched

Air Force-General Dynamics/Astronautics Atlas E ballistic missile was successfully launched from the coffin launcher operational system test facility at Vandenberg AFB, Calif. last week.

It was the second try and the first successful launch from the horizontal, semi-hard, coffin-type launch complex. The missile was prepared, erected to the vertical position and launched in a joint operation by personnel from General Dynamics/Astronautics, 6595th Aerospace Test Wing of Air Force Systems Command, and the 1st Strategic Aerospace Division of Strategic Air Command. Unlike earlier Atlas ICBMs, the E version is equipped with all-inertial navigation and its engines develop 390,000 lb. thrust rather than 360,000 lb. thrust.

Boeing 1961 Sales Up; Douglas Reports Profit

New York—Douglas Aircraft Co. showed a profit during Fiscal 1961 for the first time since 1958 and The Boeing Co. increased both profits and sales over the previous year, annual financial reports of the two companies have revealed.

Douglas reported a net profit of $5,957,000 or $1.56 per share for Fiscal 1961, which ended last November 30. This compares with a loss of $19,429,000 or $5.09 per share for 1960.

The company reported sales of $791,312,000 in Fiscal 1961, compared with $1,174,041,000 in Fiscal 1960, and had a year-end backlog of $759,308,000 compared with $1,030,177,000 at the end of Fiscal 1960.

Boeing Co. sales revenue for Calendar Year 1961 totaled $1,800,910,000, compared with sales of $1,554,573,000 for 1960. Net earnings for the year were $35,661,000, representing a return of 1.98% on sales and equal to $4.47 per share. Earnings in 1960 were $24,462,000 or $3.07 per share.

Year-end backlog at Boeing totaled $1,868,700,000.

Apollo Attitude Control

Los Angeles—Marquardt Corp., Van Nuys, Calif., has been selected by North American Aviation's Space and Information Systems Division to design and build the reaction control rocket engine for attitude control of the NASA Apollo spacecraft.

The installation, part of the over-all stabilization and control system to be supplied for Apollo by Minneapolis-Honeywell, will operate for the Apollo service capsule in the trajectory from earth to moon and return, and for the command capsule during re-entry to earth's atmosphere after the service capsule is jettisoned. Contract for the reaction control system will be in excess of $1 million.

B-58 Ejection Pod Makes Manned Test

First manned flight test of Convair B-58 crew ejection capsule was made successfully last week near Edwards AFB, Calif., with the supersonic bomber traveling at 565 mph. at 20,000-ft. altitude.

Two rocket motors, providing some 10,000 lb. thrust, boosted the Stanley Aviation Corp. fully-enclosed capsule, containing USAF parachute tester Chief Warrant Officer Edward J. Murray, about 250 ft. clear of the cockpit.

After a 26-sec., 5,000-ft. free fall, a barometric device opened the 41-ft. main chute that lowered the capsule to the ground, touchdown being eight minutes after ejection.

The 490-lb. Stanley crew escape capsule will be fitted to all three crew positions in operational B-58s following additional tests at higher altitudes and supersonic speeds.

Teamster's Sikorsky Victory Is Voided

New York—National Labor Relations Board has upheld an Independent Aircraft Guild-Sikorsky Aircraft Division of United Aircraft Corp. appeal against the Teamsters Union's Dec. 19 election victory at Sikorsky.

Competing with the Guild for representation of Sikorsky's 5,000 hourly rated production, inspection and maintenance employes at Sikorsky's Stratford and Bridgeport, Conn. plants, the Teamsters won the election with a 93-vote plurality (AW Dec. 25, p. 22).

Both Sikorsky and the Guild filed an appeal with NLRB Regional Director Ivan C. McLeod contending that the Teamsters had been guilty of misrepresentation prior to the election and asking that the results be voided.

Webb Sees U.S. Lunar Landing in 1968

Washington—Relying on orbital rendezvous rather than on direct flight to reach the moon promises to save two years and may result in a lunar landing as early as 1968, the head of the National Aeronautics and Space Administration said last week.

NASA Administrator James E. Webb also told the House Science and Astronautics Committee that his agency expects to spend about $35 billion over the next 10 years with $20 billion of that going for manned space flight. For Fiscal 1963, NASA is asking Congress for $3.8 billion, and $2.3 billion of that amount is earmarked for manned space flight (AW Jan. 22, p. 29).

Webb said the 1968 lunar landing could be made if all went well in the Apollo program over the next few years. If formidable difficulties are encountered, he said the lunar landing would be made about 1970. He stressed that the space agency has not abandoned the Nova program (see p. 24) but currently felt that the orbital rendezvous technique "is the most inexpensive means of accomplishing the lunar landing. It offers also the capability of saving something like two years of time."

House space committee hearings on NASA's Fiscal 1963 budget continue this week before special subcommittees established to consider specific portions of NASA's budget.

These were major points made by Webb and Robert C. Seamans, Jr., NASA associate administrator, at last week's hearings:

• **Solid propellants.** NASA currently is discussing with Defense Department officials the solid motors over 120 in. in diameter which will be needed for the space program. Webb said that NASA eventually will need solid motors from 240 in. to 280 in. in diameter (see p. 29). Seamans said NASA will use Defense developments in solid motors "where required in our program."

• **Additional astronauts.** Webb said NASA expects soon to make "some additions" to the present group. He said the agency is studying ways to assure that trained scientists participate eventually in space flights. Robert R. Gilruth, director of the Mercury project, said "equal consideration should be given to training test pilots in scientific observations."

• **Gemini.** Webb said the vehicle will be flying with two men in it "the summer of 1963." Seamans said the program in Fiscal 1963 will cost $207 million, compared with $13 million for Mercury and $644 million for Apollo.

• **Scout.** Seamans said it is "essentially through initial development" but a program is under way to increase its payload from 150 lb. to 240 lb. and to provide greater injection accuracy. Improved vehicle should be available in 1963. Modifications will cost $8.9 million in Fiscal 1963.

• **Orbital solar observatory.** Four flights are planned for 1962 and 1963 (AW Feb. 26, p. 55). Flights of the orbiting astronomical observatory will come in late 1963 and 1964.

• **Electric Propulsion.** Seamans said if Snap 8 experiments are successful, "we will proceed with development of electric engines in the million watt size." Snap 8 is being designed to provide 30 to 60 kw. of electrical power, with the 30 kw. units slated to undergo preliminary flight tests in 1965 or 1966. Seamans said long life ground tests involving 10,000 hr. of continuous running should be completed in 1966 or 1967 after which Snap 8 will undergo long duration flight tests.

• **Aircraft research.** Supersonic transport will continue to be NASA's largest aircraft effort. The agency also is working with Defense on aircraft configurations designed to fly fast at low altitudes for close support of ground troops.

Apollo Fuel Cell Contract Imminent

Los Angeles—Selection of a contractor to develop the fuel cell power system for the National Aeronautics and Space Administration's Apollo spacecraft may be made this week by North American Aviation's Space and Information Systems Division, principal contractor for the Apollo project. Contenders in the competition are Pratt & Whitney, General Electric, Allis-Chalmers, and the team of Ionics, Inc. and Tapco. The system is expected to be projected for a two-week operational period, but this requirement may be extended to 30 days.

Pratt & Whitney is developing a Bacon-type fuel cell under sublicense, limited to military and space applications, from Patterson-Moos Division of Leesona Corp., Jamaica, N. Y. The development uses hydrogen as a fuel and is a high-temperature, high-pressure unit involving double porosity electrodes in an aqueous electrolyte.

The General Electric development is a low-temperature, low-pressure hydrogen-oxygen cell of the ion exchanger membrane type. General Electric also is working under contract with Air Force Systems Command's Aeronautical Systems Division for development of a 500-watt system with a 30-day operational life, probably in an earth-orbiting vehicle, to prove feasibility of fuel cell application.

Allis-Chalmers' development work is directed toward use of an electrolyte, probably potassium hydroxide, retained in a bed of inert material between the electrodes.

The Ionics cell is a hydrogen-halide type, perhaps hydrogen-bromide, since considerable effort has been funneled in this direction.

GE Unit Centralizes Defense Operations

Washington—General Electric Co. has established a Defense Programs Operation with headquarters here to provide a single contact point for its customers in the aerospace and defense fields and to increase its activity in these fields.

Robert J. Brown, former general manager of GE's Heavy Military Electronics Department at Syracuse, N. Y., will head the new office. It will have the status of a division within the company, and will report to J. S. Parker, GE vice president and group executive for the Electronic and Flight Systems Group, which includes the defense electronics, flight propulsion and electronic components divisions.

The Defense Programs Operation will have six regional offices. Heads of these offices will have the status of department managers. One will be located here. Another will serve the "NASA crescent"—the area around the Gulf of Mexico coast embracing National Aeronautics and Space Administration installations from Tulsa, Okla., and Houston, Tex., to Huntsville, Ala., and Cape Canaveral, Fla.; and one will serve the West Coast aerospace companies.

The new organization will attempt to consolidate field activities of research laboratories, development facilities and manufacturing complexes employing about 75,000 people, including 10,000 engineers and scientists.

Three main purposes of the new organization are to provide better customer-company contact; provide better customer servicing, including a systems management service and on-the-spot servicing in the field; and to increase GE's share of the aerospace and defense market, Brown said.

Washington was chosen as the location for the headquarters, which will consist of less than 150 to 200 people, more because it is convenient geographically to GE facilities at Lynchburg, Va., Cincinnati, Ohio, Philadelphia, Pa., etc., than because government agencies are located here, he said.

RAF to Reduce Aircraft Types From 22 to 4-5 in Next Decade

By Herbert J. Coleman

London—Royal Air Force will reduce its aircraft types from the present 22 to four or five within the next decade, with each type capable of multi-missions for RAF, Navy and Army.

New procurement policy was revealed in the Annual Memorandum to the Air Estimates and submitted to Parliament by Air Minister Julian Amery.

RAF's future will follow these trends:

• **Manned aircraft** will be used to fulfill the nuclear deterrent role, thus reversing the 1957 Defense White Paper which abandoned this attack role for ground-based missiles.

• **Douglas Thor bases** eventually will be phased out, when the Avro Blue Steel and the Douglas Skybolt are delivered to the British V-bomber fleet. Amery said Blue Steel has recently been fired twice at Woomera and has impacted in the target area both times. The memorandum contended Britain is too small and vulnerable to be suited to deployment in future of strategic missiles.

• **Skybolt will work** a revolution in bomber tactics although future developments will be in the missiles, rather than in the V-bomber fleet.

• **Royal Air Force will study** the military uses of space, primarily in the communications field, and in the manned orbital aircraft, such as Dyna-Soar.

Development now will center on design of combination-role aircraft, which could be used in the bomber, transport and maritime reconnaissance roles. Need for inter-service aircraft was pointed out in the 1962 White Paper (AW Feb. 26, p. 36), with emphasis placed on the VTOL and STOL roles.

Following through with this policy, the RAF could replace six types with one, dropping the Avro Vulcan, Handley Page Victor and Vickers Valiant V-bombers, the de Havilland Comet and Vickers VC.10 jet transports, and the Avro Shackleton maritime reconnaissance aircraft.

The move probably means an acceleration in the design of variable geometry wings and laminar flow, both of which have received steady, although relatively small, government funding in the past eight years. The memorandum noted that the new aircraft should have the largest practicable ferry range and radius of action and that new techniques should enable industry to meet these requirements.

Net RAF Spending

Net spending for Royal Air Force in 1962-63 will be $1.6 billion, an increase of $15 million over the preceding year. About one-tenth of this earmarked for V-bomber and Thor bases.

Other points raised in the Air Ministry memorandum are:

• **Production orders** are being placed for the de Havilland Red Top infrared air-to-air missile for installation on the English Electric Lightning Mk.3 version. The Canberra force will be armed with Nord AS.30 missiles, mostly in overseas bases, but none will have nuclear warheads.

• **First TSR.2** supersonic strike aircraft will fly next year.

• **Program for modifying** the Vulcan Mk.2 bomber for Skybolt is making good progress.

• **Two squadrons of Hawker Hunters** will be assigned to No. 38 Group, land warfare specialist unit, in line with inter-service cooperation policy. The Hunters will be used for ground attack missions.

• **Strength of Royal Air Force** dropped from 158,000 to 148,000 in the last year.

• **Ballistic Missile Early Warning** System station now under construction at Flyingdales will come into operation early next year.

Army Estimates

In the Army estimates, the accompanying memorandum said the British Army will adopt the Radioplane SD-1 surveillance drone, which is radio-guided and fitted with cameras for photographing enemy areas.

British Army first ordered 32 SD-1s in 1961 for evaluation.

The Army also is cooperating with U. S. Army on development of infrared sensing devices to enable infantrymen to fire at targets up to 150 yards distant in total darkness.

The memorandum's only reference to the Blue Water missile is that it will be air transportable and relatively easy to maneuver.

Total Army estimate for 1961-62 is $1.5 billion, an increase of about $48 million from the previous year. Regular Army strength is 209,207.

Navy estimates call for equipping the Sea Vixen and Scimitar fighters with Martin Bullpup missiles, confirming an AVIATION WEEK report (AW Feb. 19, p. 23).

The Whitworth Gloster Seaslug ship-to-air missile is being considered for a surface-to-surface role.

Helicopter Armament

In addition, Navy plans to equip its Westland Wessex helicopters with the Nord SS.11 anti-tank missile. Follow-on Wessex, now being developed, will include a gun package in addition to the missiles, although its primary role will be as a commando carrier.

Studies of underwater detection devices also will include research into helicopter-borne anti-submarine detection equipment.

Navy will spend $1.2 billion in 1962-3, an increase of about $26 million over last year. Strength will be held to the present level of 100,000 personnel.

SAC Considering Missile Contest

Strategic Air Command is considering a contest among its missile crews, similar in concept to SAC's annual combat competition for bomber and tanker units and crews.

Exact nature of a missile competition, who would compete or rules and scoring guidelines for such a meet have not been determined. If the idea is approved, crews at SAC intercontinental ballistic missile sites probably would be scored on ability to prepare their missiles for launch within a compressed "alert" period.

Meanwhile, the command has altered its aircraft competition, tentatively scheduled this year for early September (AW Dec. 18, p. 23). This year, crews selected in eliminations among SAC's numbered air forces in the United States will fly their command contest missions from their home bases instead of staging from a single SAC airfield, as in the past. Staging from home fields is a move designed to reduce cost of the competition by avoiding payment of temporary duty expenses to crews and eliminating the need for special facilities at a single base.

All crews will fly a standard mission profile over the same areas of the continental U. S. Bombers will be scored on reaction to a no-notice alert scramble, radar-monitored runs on simulated target complexes, use of electronic countermeasures equipment, a navigation leg and an aerial refueling.

Tanker crews will be judged on a scramble takeoff, the refueling and a navigation leg.

Individual crew and unit trophies will be awarded in bombing, navigation and air refueling.

Speeded Development of Large Solid Motors Urged by NASA

Washington—National Aeronautics and Space Administration has suggested to the Defense Department that solid propellant rocket motors and cases above 120 in. in diameter be developed directly as flight weight hardware instead of boilerplate versions, in the hope that this will cut the cost considerably and make the motors available for space flight much earlier if the development work is successful.

This suggestion, contained in a letter signed by NASA Associate Administrator Robert C. Seamans, Jr., is considered to be the strongest top-level expression of interest NASA has yet made in the 156-in. dia. and 240-in. dia. motors that Air Force wants to develop under its large solid rocket program.

Although the letter does not mention specific diameters, 156 in. is the upper limit for motors that can be shipped by rail. Motors in the 240-in. class would be moved by barge.

The joint NASA-Defense Large Launch Vehicles Group, or Golovin Committee had recommended some weeks ago that any demonstration of a large solid motor be done with a usable item rather than a rough, boilerplate model. Proponents of large solid boosters for space vehicles have felt that NASA showed definite favoritism to liquid propellants and have been urging greater recognition of the potential of solids.

While the Seamans letter is not nearly as strong an expression of interest in the big motors as proponents of solids have advocated, it is the most positive step NASA has taken toward recognition that the large solids might be competitive with liquids in the relatively near future.

There is some question as to whether Air Force, which has felt that a 156-in. motor could be demonstrated much earlier than a 240-in., would be able to develop demonstration models of both rapidly with the funds now allocated to the solid development program.

Aerospace Corp., technical adviser to Air Force Systems Command, has had work statements prepared for some time for the 156-in. and 240-in. motors as possible follow-on efforts to the 120-in.-dia. motor development now up for industry bids. These statements have projected the 156-in. size as a full hardware development program and the 240-in. as a study program involving a feasibility demonstration firing.

In the current competition for the 120-in. motor for the Titan 3 boost vehicle, AFSC's Space Systems Division will look favorably upon any contractor's proposal which establishes an ability to accelerate the delivery schedule to meet a launch date just after availability of a universal-type pad, in January, 1964, at Cape Canaveral, Fla., where research and development flights will be conducted. Motor storage and assembly facilities at Canaveral are projected for availability as early as October, 1963.

Probably not more than three research firings for the 120-in. motor will be conducted from the universal-type pad. Remainder of the flight test program will be conducted from the Titan 3 integration, test and launch (ITL) complex, for which the space systems division has awarded a contract to the Ralph M. Parsons Co. (see box).

First pad at Edwards AFB for static testing of the 120-in. motor is programed for completion next February. Additional facilities are expected to be available about three months later.

Titan 3 Test Complex

Air Force has awarded the Ralph M. Parsons Co. a contract for architect and engineering services for an integration, test and launch (ITL) complex for the Titan 3 boost vehicle. The complex will be built at Cape Canaveral, Fla. and will cost between $60 and $100 million. It will be equipped to handle various configurations of Titan 3 and undoubtedly will be designed to accommodate larger boost vehicles, such as those envisioned under Phoenix project studies (AW Mar. 27, 1961, p. 50).

RAF STOL Transport

London—British government is reviewing development costs, performance and delivery dates of a proposed Royal Air Force STOL tactical transport, details of which were first reported by Aviation Week (Sept. 18, p. 43).

However, Minister of Aviation Peter Thorneycroft told Parliament he could not say whether the operational requirement, as laid down by RAF, will be confirmed. He described it as a substantial and costly project and said it should be very carefully examined before it is finally approved.

Decision, expected since last November, centers on the Bristol 208, the Armstrong Whitworth 681, the Short Belfast and a British-built Lockheed BLC-130 which would be built under license by British Aircraft Corp.

News Digest

Lockheed Aircraft Corp. has received a $1.5-million Navy contract to prove the concept of rigid rotor helicopters which the company has developed and is employing in a prototype vehicle. The project is funded jointly by the Army and the Navy.

North American Aviation, Inc., has formed a small subsidiary in Torino, Italy to maintain its Autonetics Division's NASARR all-weather fire control systems in F-104 fighters operated by European Air Forces.

Aerospace Corp., El Segundo, Calif., will acquire a nine-acre site at Cocoa Beach, Fla., for technical support of Air Force missile and space programs at the Atlantic Missile Range. Purchase is contingent on annexation of the Brevard County site by the city of Cocoa Beach and permission to construct an office and laboratory building.

Bristol Aeroplane and Westland Aircraft bid to take over the Fairey Co. (AW Jan. 1, p. 18) last week was turned down by Fairey stockholders.

Orbiting Solar Observatory direct radiation measurement satellite, scheduled for launch Feb. 27, was rescheduled for late last week when difficulties arose in the third stage. Retests of the stage required removal of the 450-lb. payload and Delta-satellite attachment ring.

USAF-Lockheed Discoverer 38 was successfully launched into a polar orbit from Vandenberg AFB, Calif., last week. An air snatch recovery was scheduled to occur within four days. Payload has not been announced.

American Airlines 707-123B that crashed in Jamaica Bay last week during takeoff from New York's Idlewild Airport rolled to the left almost on its back, then struck the water in a steep nose down position, according to witnesses that included passengers and crew of a Mohawk Airlines Martin 404. All 95 persons on board were killed.

Federal Aviation Agency abandoned efforts to save Mitchel Field, former Nassau County, N. Y., USAF base, for general aviation use because of inability to find a sponsor to operate the field.

Grumman Aircraft Engineering Corp. has been awarded a $21,986,000 follow-on contract by Navy Bureau of Weapons for the production of 48 AO-1B Mohawk battlefield surveillance aircraft.

Eastern Submits New Low Fare Formula

Lower New York-Miami price, elimination of some meals aims at economy, better traffic distribution.

By L. L. Doty

Washington—Eastern Air Lines last week proposed a new low-fare tariff formula which it hopes will be adopted by competing airlines as a means of generating new traffic and providing more economies for the trunkline industry.

The new fares would slice the present New York-Miami round-trip jet day coach fare by more than one-half during certain seasons. In addition, the formula, which was presented to the Civil Aeronautics Board as a tariff package, would eliminate use of low jet night coach fares on some routes and the serving of meals on all coach flights between New York and Miami.

The main purpose of the tariff is to lessen the imbalance between low-peak and high-peak travel periods. Because the formula was developed on the basis of experience with previously tested promotional fares, it is attracting close industry attention. The package does not contain many experimental type rates which met with such little success late last year.

Here are the principal features of the new tariff:

• **Round-trip excursion fares** between major northern cities and Florida, to apply four days each week—Monday through Thursday—will be introduced. Excursion rates, applicable to both jet and propeller flights, will be one-way jet day coach fares plus 10% between Apr. 30 and June 15 and between Sept. 1 and Dec. 14. During the period between June 16 and Aug. 31, excursion rate will be one-way jet day coach fare plus 35%. Fares will be available only on round trips completed in not less than seven days nor more than 30 days.

• **Jet night coach fares** between these points will be discontinued and all jets will provide both first-class and coach service at existing rates regardless of departure time. However, the New York-Miami jet day coach fare will be reduced by 78 cents because of the elimination of meals.

• **Existing New York-Miami** no-reservations Air-Shuttle tariff will be extended through Dec. 13 and the service will be available at a fare $10 less than the regular reserved-seat round-trip excursion rate.

• **To encourage more family** vacation travel by air, and in a major move aimed at diverting traffic from the private automobile, age limit for half-fare travel would be raised from the present 12 years to 17 for children accompanied by adults.

The new excursion rate would be for a $70 round trip between New York and Miami on the Air-Shuttle and $80 on reserved-seat coach flights. Present New York-Miami round trip jet day coach fare is $146.10 and the jet night coach is $113.30, all fares excluding tax.

In a letter to the CAB, Eastern President Malcolm A. MacIntyre emphasized that the airline "intentionally filed this proposal on sufficient notice to permit Eastern's competition to match the proposal, and make the necessary scheduling adjustments for the summer season." He added:

"Eastern is not seeking a competitive advantage—we hope that the competition will adopt the complete package, for we believe that it is based on sound scheduling economics and will provide optimum utilization of aircraft and facilities, and best serve the traveling public." MacIntyre also urged that the industry return all coach service to its original no-meal status.

MacIntyre said the reduced fares will stimulate traffic enough to smooth out seasonal variations which have always existed in travel between the Northern U. S. and the Florida resort market. He also said that, by confining the excursion rates to mid-week periods, weekend travel peaks will be leveled off.

He noted that previously tested promotional fares had failed to correct these imbalances. Experiments with a substantially reduced night coach fare, offered last summer during midweek periods, merely diverted more daytime travelers to night coach than weekend passengers to weekday travel, he said.

MacIntyre said it was not possible to schedule enough service during the two or three hours after 10:00 p.m. to meet the demand. As a result, Eastern decided to offer the new excursion fares 24 hr. a day during the four-day period in order to spread the demand throughout the day, and thus obtain higher utilization of aircraft, personnel and facilities.

Eastern divided its summer season rates into three distinct parts to reflect present travel patterns to the Florida area. The airline found that this breakdown corresponds to experiences of the Florida hotels.

In raising the age limit for children flying at half-rate, MacIntyre said that the requirement that children must be accompanied by an adult "distinguishes this proposal significantly from the youth fares which some carriers attempted last fall." He stressed that the excursion fares are comparable to or lower than driving costs for a party of one or two and that "this is the first time that low-cost coach excursion fares have been made available between the Midwest and Great Lakes areas and Florida."

Eastern has urged the CAB to view the tariff proposal as a "package" to achieve the specific purposes of stimulating more traffic and attaining higher aircraft utilization.

"It is the view of Eastern's management that these changes are so interrelated that no carrier should be allowed to duplicate some of them without duplicating all of them," MacIntyre said. "As for Eastern's own program, Eastern offers it to the Board and the public as a unit. We trust that it will be allowed to take effect in that manner."

In a recent survey, Eastern found that 17% of its Air-Bus passengers were taking their first trip by air and that 31% would have traveled by surface means had the Air-Bus service not been available. Air-Shuttle operations on Eastern's Boston-New York-Washington route are generating load factors in the approximate area of 55% and, according to MacIntyre, are proving profitable.

The Air-Shuttle concept was introduced on the New York-Miami route early last month and the airline contemplates further expansion of the service within the next few months. The carrier's Air-Commuter program is designed to provide turbojet and turboprop flights on relatively short-haul routes to encourage same-day round trip flights in major markets by business travelers.

Control Ruling Protest

Washington—Pan American World Airways has asked Civil Aeronautics Board to modify or reconsider restrictions imposed when the Board granted approval of its control of LACSA, the Costa Rican flag carrier (AW Feb. 5, p. 40).

CAB imposed a series of restrictions designed to ensure a separate identity for LACSA after approving Pan American's control, which it granted to forestall any Communist ambitions toward commercial aviation in Costa Rica.

Pan American said it had never considered itself in control of LACSA, but would not re-argue the point with CAB. It did say that certain LACSA officials once employed by Pan American had left, thereby removing much of the cause of CAB's concern over LACSA's independence. Pan American said that since it did not control LACSA, it would have no way of complying with many of the Board's requests for filing of separate traffic and financial information.

Plans Outlined for Implementing Project Beacon Recommendations

By Ward Wright

Washington—Groundwork for converting Project Beacon proposals into a unified national air space utilization system was outlined here last week at a Federal Aviation Agency Symposium on airborne equipment.

FAA held the symposium to acquaint pilots, aircraft owners and manufacturers of airborne equipment with basic principles underlying implementation of Project Beacon (AW Nov. 13, p. 34).

FAA Administrator N. E. Halaby told the symposium to notice that he did not call the goals of Project Beacon an air traffic control system. He said the FAA program to implement Beacon is designed to systematically integrate people, equipment, rules and standards into one cohesive, unified national air space utilization system.

Halaby outlined three principles as basic to development of such a system:

• **Airborne and ground elements** will constitute the utilization system. Present FAA thinking calls for an extensive future increase in Vortac and ILS (instrument landing system) installations.

• **Standardization of ground** subsystems with the goal of reducing the amount of navigation and communication equipment which aircraft now must carry, but operators must equip aircraft with avionic devices compatible with ground systems.

• **Airborne equipment** performance standards must be established to ensure harmony between ground and air elements on which the national air space control system will be based. Halaby indicated he expected these performance standards to replace dependence on FAA's Technical Standard Orders (TSO)—currently affecting airline operations only—and become applicable to general aviation aircraft over 12,500 lb.

Halaby said the air space system would include the national airport system, the national weather data system, the national aviation navigation and communications net and would be tied together by federal regulations. He said that if the system were supported by adequate labor and management—advancing at the same pace as the growth of technology, not behind as in the past, nor so far ahead as to be uneconomical—the system will become a reality.

Halaby said the recently created regulatory council would act as a forum for FAA's rule-making process when system recommendations reach that stage.

Another symposium speaker, Joseph D. Blatt, director of FAA's research and development service, said present plans for air navigation systems under the new system call for converting the 422 VOR facilities now in commission into Vortac facilities and to continue to add ILS' to airports whose traffic growth warrants it.

Blatt said the present 293 Vortac facilities, 216 ILS installation and existing VOR stations represent an initial investment of $230 million. Planned expenditures for new Vortac and ILS facilities will cost an estimated $492 million during the next five years, he said. In addition, he said, $10 million will be needed each year for flight inspection activities required to ensure that air navigational aids are operating at prescribed standards.

As for aircraft equipment, Blatt said, national standards for airborne equipment compatible with ground system or consistent with their accuracy—±1¼ deg. on the radials of 94% of Vortac installation—have still not been established.

The result, Blatt said, is that maintenance of non-standard ground facilities to accommodate users of older types of navigation equipment, such as automatic direction finder and low frequency radio range receivers, costs taxpayers millions of dollars a year.

In the cockpit, Blatt said, the mixture of types of navigational equipment is a problem to the aircraft designer and a drain on the buyer. The value of a clear-cut standard system of Vortac and ILS would allow pilots and owners to make effective plans as to what equipment they will need and allow designers and manufacturers to operate more efficiently.

Blatt said that users of Vortac and ILS equipment, which meets accuracy requirements consistent with route and approach criteria, could look forward to "ever improving service in years to come." Such operators need have no concern that their flights would be hampered anywhere in the navigational system as far as equipment was concerned. Such operators can be assured that Vortac and ILS equipment will be necessary if they should install a cockpit pictorial display.

On air-ground communications, Blatt said one of FAA's principal objectives will be to hold the VHF-UHF channelization requirement at 360 channels. This task, though difficult, would be accomplished by reducing the required air-ground communications and critically analyzing present criteria for assignment of channels to ground stations.

Ideally, such criteria for a ground station would ensure that each assigned channel would carry an efficient traffic load. Blatt said that the agency also had hopes of establishing a more orderly frequency deployment scheme to allow users to better anticipate the frequencies used for various air traffic control and flight service functions.

Present plans for frequency management will allot to civil aircraft all the VHF channels between 118 mc. and 136 mc. with 50 kc. spacing. The present VHF net of towers, centers and flight service stations will be completely modernized to this capability within the next five years.

Air Traffic Control Radar Beacon System (ATCRBS), another aspect of the air space utilization system, is slated for $164-million expansion and improvement program during the next five years, Blatt said.

FAA plans to extend additional positive air traffic control over substantial portions of the U. S., Blatt said. In such areas, airborne transponders—to provide identification to ground radar controllers—would become mandatory equipment.

Blatt outlined what the future holds for operators of equipment with or without non-standard navigational and communications equipment:

• **Operators of aircraft** not having Vortac and ILS equipment could look forward to limited and decreasing service as non-standard ground facilities are decommissioned.

• **Operators without radio** equipment may eventually be limited to airspace reserved for VFR operations.

• **Operators having non-standard** VHF equipment can expect limited but useful service for the next five years. After that, they may be unable to get IFR service in some localities due to lack of appropriate frequencies, or because non-standard equipment disrupts other communications.

Southern Probe May Shape U.S. Role in Airline Labor Disputes

By Robert H. Cook

Washington—Precise guidelines for the maximum use of federal powers in settling airline labor disputes may result from the 20-month-old pilots' strike at Southern Airways, now being investigated by a special presidential labor authority.

Prof. Nathan B. Feinsinger, whose three-member commission has received strong Administration support on its recommendations to settle the crew complement dispute between trunkline pilots and flight engineers, has formulated the Southern hearing agenda around several basic points which could have a far-reaching effect on the entire airline industry.

Critical Scrutiny

Labor and management alike are being subjected to a close, critical scrutiny designed to answer these questions:

- **Should a local service** carrier be paid subsidy which might be used to offset the effects of a strike?
- **Should an airline** continue to receive subsidy if it has a history of labor problems and the unions are found not to be at fault?
- **Should such a record** be taken into consideration by government agencies awarding new routes or contracts?
- **Does an airline** have the right to change existing work contracts during the course of a legal strike by a representative union?
- **Are any special labor,** safety or economic policies involved which should prevent a carrier from replacing striking employes? If not, should the Federal Aviation Agency and the Civil Aeronautics Board take precautions to assure compliance with safety and operational procedures by the replacements?
- **Are carrier payments** to a struck airline, under Mutual Aid Pact, justified?
- **Should airline refusal** of government arbitration result in a curtailment of its subsidy, or union refusal cost it the loss of its rights as a bargaining agent?
- **Does the government,** under existing authority, have sufficient powers to avoid the risk of continuing subsidy payments to a carrier ultimately found to have been at fault? Should the government recover these payments, should they be suspended pending settlement of a complaint and should the CAB act independently or only when a complaint is filed?
- **Would any of these points** have a bearing on trunk or international airline labor issues?

Considering the broad scope of the hearing, Feinsinger does not expect to arrive at any specific conclusions in the near future and emphasizes that he must first obtain "all the facts from all the parties." After the Southern hearing, he plans to investigate Western Air Lines' refusal to rehire striking flight engineers, despite the personal pleas of Labor Secretary Arthur Goldberg.

While the Southern hearings are being conducted before Feinsinger, the CAB is investigating an Airline Pilots Assn. request to revoke the carrier's operating authority on grounds that Southern's failure to rehire striking pilots is an indication that it intentionally failed to "bargain in good faith" as required by labor provisions of the Railway Labor Act.

The pilots' union is also awaiting the outcome of a $1-million suit filed against Southern in the U. S. District Court at Nashville, Tenn. The suit, filed in November, 1960, makes the same complaints as those lodged with CAB and asks that the airline be directed to comply with the Federal Aviation Act and the Railway Labor Act, and conclude an agreement with the striking pilots.

The primary issue in the strike is that ALPA contends Southern refused to grant the strikers their proper seniority positions, as a condition to rehiring. The union has pointed out that Southern hired non-union pilots, who are still employed, and refused to grant ALPA's seniority requests even after general terms of wages and working conditions had been agreed to by both the union and company.

Southern has contended that it was necessary to hire the non-union pilots during the contract deadlock in order to maintain its operations. Since these men helped the company when it was in trouble, the airline has stated that it has an obligation to avoid either dismissing the non-union pilots or placing them in a lower seniority category than returning strikers.

Acceptance of the Southern terms, ALPA contends, amounts to a "punitive action" which would affect members' seniority, pay and general working benefits.

The hearings were bitterly protested by Southern attorney Erle Phillips. During a pre-hearing conference, Phillips claimed that the hearings would interfere with both the CAB case and the Nashville law suit. "We regard this as a forum to try us in the press and before the public," he said.

Congressional interest in the outcome of the hearing was underscored in a telegram sent to Feinsinger from Rep. Frank Kowalski (D.-Conn.). He expressed his deep concern and said, "I believe that the government must be wholly impartial in the field of labor disputes. To find that federal funds are in essence being used to support one side in such disputes shows that the government is not being impartial."

He urged a careful reappraisal of the whole area of federal subsidization. "If an industry is involved in a labor dispute such that it incurs losses directly attributed to this dispute, under no ordinary circumstances should the government allow public funds to be used to underwrite these losses," he said. "Only in the event of a national emergency should the taxpayers' money be used for such purposes."

Kowalski is understood to be preparing legislation which would require subsidized airlines to use all available federal procedures to resolve labor disputes, as a condition to continuing their collection of subsidy.

National Case Cited

Henry Weiss, attorney for ALPA, called attention to past CAB orders finding that subsidy payments had been used to offset strike losses, and demanding their repayment. In one case, he said, National Airlines was ordered to repay more than $400,000 collected during an ALPA strike in 1947. The strike was called because of National's refusal to submit the dismissal of a pilot to arbitration, he said. The airline also employed non-union pilots during the strike period, he said.

Breakdown of the National subsidy attributed to strike costs, the union said, was $145,000 for mileage not flown; $170,077 for additional salaries; $21,982 for guard service and $63,253 for legal fees, arbitrator fees, etc.

A significant portion of $2.2 million in subsidy which CAB has ordered Pan American World Airways to repay (AW Feb. 19, p. 49), was accounted for by disallowances for payments made in the Mutual Aid Pact, plus payments incurred by American Overseas Airlines for a 1947 pilots strike.

Wording of the Board's decision in the 12-year-old case notes that while CAB has never before passed on the validity of this type of expense for subsidy purposes, the $607,000 paid by Pan American to other mutual aid members was, "in effect insurance payments against possible strike losses, whether or not the fault of PAA management."

Referring to the American Overseas Airline situation, the Board found that the strike losses were not a part of the carrier's need "under honest, economical, and efficient management." Labor-management talks in the case were hampered by the airline, which also failed to take appropriate measures necessary to settle the strike, the order stated.

Airline Traffic—December, 1961

	Revenue Passengers	Revenue Passenger Miles (000)	Passenger Load Factor %	U.S. Mail Ton-Miles	Express Ton-Miles	Freight Ton-Miles	Total Revenue Ton-Miles	Over-All Revenue Load Factor
DOMESTIC TRUNKS								
American	622,384	493,583	60.6	3,423,318	1,303,768	12,717,310	64,650,525	57.2
Braniff	183,742	93,137	57.7	557,052	223,735	1,151,412	10,846,042	48.5
Continental	116,040	84,466	53.4	397,937	152,193	710,811	9,361,282	44.4
Delta	294,395	193,074	58.6	1,049,763	416,461	1,975,160	21,971,107	50.7
Eastern	683,503	370,056	52.9	1,893,475	627,009	2,732,199	40,874,017	41.2
National	159,767	123,614	55.2	716,424	125,070	1,484,932	14,256,123	46.2
Northeast	114,700	60,570	49.5	228,090	65,387	268,932	6,375,136	42.0
Northwest	145,252	99,211	49.1	977,871	306,605	1,683,459	12,480,880	45.2
Trans World	392,948	365,853	56.4	2,207,152	896,847	6,077,115	44,199,952	48.6
United	853,176	558,193	56.4	4,942,258	1,401,357	9,483,249	69,182,645	51.9
Western	152,519	93,208	54.0	530,005	126,318	460,401	10,028,572	44.7
INTERNATIONAL								
American	8,336	8,808	54.5	10,203	506	219,912	1,146,311	61.3
Braniff	8,548	12,049	49.7	69,556	----	250,078	1,593,703	46.4
Caribbean Atlantic	40,941	2,970	67.6	4,358	----	15,740	298,889	66.5
Delta	1,213	1,561	30.8	1,555	----	17,035	184,802	29.6
Eastern	38,851	55,320	55.6	219,491	9,461	352,668	6,040,229	52.4
Mackey	8,035	1,438	31.7	----	329	6,838	148,290	29.2
Northwest	16,086	28,732	41.6	2,636,375	5,396	1,060,177	6,850,714	55.8
Pan American								
Alaska	4,151	4,113	40.2	75,666	5,660	211,349	724,563	47.1
Atlantic	120,787	180,349	48.5	4,703,403	----	5,284,658	28,905,421	50.5
Latin America	124,493	166,587	61.7	825,174	5,278	5,232,443	23,386,451	63.5
Pacific	39,676	149,845	57.5	5,509,210	21,401	3,603,559	24,702,380	58.9
Panagra	11,827	21,179	68.8	129,661	----	776,559	3,204,640	66.0
South Pacific	219	598	38.4	1,214	----	1,602	63,809	38.1
Trans Caribbean	8,164	12,454	59.9	----	4,738	218,259	1,276,432	57.8
Trans World	20,027	65,196	48.9	3,069,025	----	2,084,933	11,929,987	57.3
United	13,718	34,162	52.6	619,243	10,027	212,406	4,317,750	50.0
Western	7,172	11,134	70.7	18,373	----	34,153	1,197,028	61.2
LOCAL SERVICE								
Allegheny	64,929	13,839	43.2	37,417	53,900	91,986	1,504,818	48.4
Bonanza	27,856	7,323	51.8	13,197	3,058	14,366	733,432	53.3
Central	23,939	4,885	35.6	24,462	9,713	27,740	529,408	35.0
Frontier	28,575	8,231	37.2	36,998	12,125	66,319	903,458	40.1
Lake Central	29,413	4,638	33.4	27,599	25,791	23,321	309,333	36.1
Mohawk	68,465	13,878	44.5	33,167	36,924	53,410	1,443,970	44.1
North Central	75,270	13,805	40.5	70,007	61,591	81,974	1,525,114	43.8
Ozark	44,183	8,169	43.9	29,390	31,744	42,053	883,456	49.3
Pacific	32,148	7,871	47.5	22,323	5,617	10,188	789,323	48.6
Piedmont	38,402	8,457	45.0	25,599	21,065	29,326	886,029	47.7
Southern	30,737	5,617	31.2	28,530	18,786	24,397	609,617	32.3
Trans-Texas	25,498	6,117	36.3	27,906	13,434	42,159	669,853	38.0
West Coast	29,201	7,268	41.9	22,279	5,380	23,324	744,920	42.9
HAWAIIAN LINES								
Aloha	27,482	3,944	59.7	5,907	----	5,321	328,398	51.9
Hawaiian	40,415	5,925	56.5	9,464	----	169,478	655,262	58.5
CARGO LINES								
Aerovias Sud Americana	----	----	----	----	----	269,283	269,283	62.4
Flying Tiger	56	292	33.2	26,116	55,701	18,312,327	18,423,313	81.4
Riddle	85	172	67.2	29,042	45,572	5,412,801	5,504,584	62.5
Seaboard World	755	3,066	99.2	466,876	----	6,616,707	8,505,398	66.9
Slick	1,558	8,833	84.9	----	----	5,937,007	6,803,918	87.3
HELICOPTER LINES								
Chicago Helicopter	17,316	301	39.7	2,141	----	----	30,879	35.4
Los Angeles Airways	2,282	81	50.1	4,056	2,382	----	14,246	62.8
New York Airways	10,858	222	52.9	1,472	877	355	23,918	50.3
ALASKA LINES								
Alaska Airlines	6,198	5,972	40.9	97,652	2,226	379,368	1,081,802	61.2
Alaska Coastal	2,842	319	56.2	5,783	----	5,498	43,651	71.6
Cordova	1,481	206	37.8	8,814	----	22,295	52,077	49.0
Ellis	3,575	169	47.1	2,752	----	2,036	22,042	61.3
Kodiak	504	26	42.6	633	----	626	3,934	49.7
Northern Consolidated	1,538	444	28.2	65,982	----	50,285	166,209	57.0
Pacific Northern	9,145	8,220	44.8	278,017	11,915	457,543	1,638,920	64.6
Reeve Aleutian	822	842	32.1	98,059	----	51,911	243,448	57.4
Western Alaska	442	24	52.0	949	----	1,636	4,834	57.0
Wien Alaska	2,003	551	27.7	551	66,926	77,246	201,528	49.2
Avalon	2,750	146	35.8	785	----	240/1	14,867	38.5

Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board. 1/ Includes excess baggage

AIRLINE OBSERVER

► Seven major airline unions at Trans World Airlines have formed a Council of Air Transport Unions, pledging mutual support of any striking member. Representing an estimated 10,000 employes, the council includes the Air Line Pilots Assn., Air Line Dispatchers Assn., Flight Engineers International Assn., International Assn. of Machinists, Air Line Employes Assn., Air Line Navigators Council and the Air Line Stewards and Stewardesses Assn. Four years ago a similar council was formed at Eastern Air Lines by FEIA, ALSSA and IAM.

► **Eastern Air Lines will test a new series of radio programs designed to provide air travelers with information on current weather, traffic and other conditions which affect airline operations. Initially, the 60-sec. programs will be broadcast over local radio stations in Washington, New York and Miami at 6, 7 and 8 a. m. and 10, 11 and 12 p. m.**

► Aeroflot has indicated that later models of the twin-jet Tu-124 medium-range transport may carry as many as 70 passengers. Reference may be to the recently-announced Tu-124A, which is slated to go in service next year (AW Feb. 19, p. 52). None of the cabin configurations of the Tu-124 hitherto revealed has a 70-seat capacity.

► **Maryland interests are making renewed attempts to prevent a heavy aircraft traffic diversion from Baltimore's Friendship Airport to Washington's new Dulles International Airport, now under construction at Chantilly, Va. Latest move is being made by Rep. Daniel B. Brewster (D.-Md.) who will introduce legislation that would relieve the Federal Aviation Agency of the responsibility of operating Washington National and Dulles airports. Brewster charges that traffic at Washington National has been operating at absolute peak and under conditions which FAA would not tolerate elsewhere.**

► FAA will require new or materially altered aircraft introduced into service by supplemental air carriers to fly 100 hr. in proving tests. In the past, supplementals have been exempted from this requirement enforced upon scheduled carriers on grounds that most aircraft brought into use by supplementals had already been operated by scheduled airlines. FAA is revising the rule because certain supplemental carriers recently have put into service newly certificated or substantially modified used aircraft.

► **American Airlines experience with electronic data processing has brought out these facts, according to William J. Hogan, the airline's executive vice president-finance: application development time will be longer than indicated by first estimates—perhaps by second and third estimates; clerical savings rarely come up to expectation; and unrealistic demands upon the equipment by operators, if not stopped quickly, can result in substantially increased development and machine costs.**

► Russia and the Republic of Guinea have signed an agreement providing for the establishment of air service between the two countries. A pact between Aeroflot and Air Guinea calling for reciprocal services was signed at the same time.

► **Justice Department has told the Civil Aeronautics Board that the proposed International Air Transport Assn. North Atlantic group fares (AW Feb 12, p. 38) raise "such substantial questions affecting the public interest" that there is a need for full evidentiary hearings before approving the lower rates. Justice said that since group fares are not "across-the-board," the possibility exists that such fares are discriminatory.**

► IATA will strengthen policing of rules governing accredited travel and cargo agents. New procedure will enable IATA to cancel accreditation of an agent found guilty of infractions within 60 days after a complaint has been lodged. Previously, it has taken as long as six months to process even minor complaints. Effective June 1, an agency compliance committee will be empowered to cancel an agent's authority if it is found that the agent has made an improper rebate, improperly split commissions with other persons or made misrepresentations in applications for reduced rate transportation.

SHORTLINES

► **American Airlines** reports it flew 533.1 million passenger miles in January—a 7% increase over January, 1961. Air cargo flown during January totaled 11 million tons miles—a 26% increase over the same month last year.

► **British Overseas Airways Corp.** will supplement its Comet 4 jet services in Asia with Rolls-Royce powered Boeing 707 aircraft late this month. Boeing 707s will leave London twice weekly for Hong Kong via Beirut, Teheran, New Delhi and Bangkok.

► **Delta Air Lines** reported a net income of $410,000 for January, compared with $351,000 for January, 1961. Operating revenues for the same two months, respectively, were $14.3 million and $12.8 million.

► **Flying Tiger Line** reports CL-44 turboprop airfreighters are airlifting an average 30 tons of cargo between Travis AFB, Calif. and Tachikawa, Japan in 18 to 19 hr. Flying Tiger said, by contrast, its 1049H Constellations are carrying 20 tons with a flying time of 25 to 26 hr. on the same route.

► **International Air Transport Assn.** reports passenger traffic over the North Atlantic has doubled during the last five years. Passengers totaled 2.1 million in 1961, compared with 1 million in 1957. During the same period, air cargo shipments have tripled.

► **North Central Airlines** grossed more than $1.2 million in cargo revenue—including freight, express and mail—during 1961, the company reports. North Central claims it is the first local service carrier to top $1 million in annual cargo revenue.

► **South Pacific Air Lines** will begin scheduled service to Samoa on Mar. 14. Samoa will be served on the return leg of SPAL's Honolulu-Tahiti route on a bi-weekly basis. First-class fare from Honolulu to Samoa via Tahiti will be $469 and economy class will be $332. SPAL will continue to operate its Honolulu-Tahiti service on a weekly basis.

► **Trans-Texas Airways'** "round dollar" fare plan (AW Feb. 5, p. 47) went into effect late last month with Civil Aeronautics Board approval. The plan allows the airline to round off its new fares, which reflect the recent 3% increase, to the nearest lower dollar. Under the plan a $33.58 fare would become $33.

LOH/HUGHES—just what the commander ordered

The Army's Light Observation Helicopter will bring the latest state of the art to front-line reality. Men who must depend on the LOH will value the advancements the Hughes HO-6 provides — reliability throughout the mission spectrum from combat recon to logistic support. Greater performance and larger useful load capacity at a lower over-all cost. ■ The HO-6 rests on sound concepts which take full advantage of Hughes modern techniques. These have been developed during the long partnership in progress between the U. S. Army and the Hughes Tool Company. ■ When deliveries are made, the Hughes HO-6 will prove itself — the optimum result of experience, imagination and outstanding production capability.

HUGHES TOOL COMPANY—Aircraft Division, Culver City, California

A salute to the 20th Anniversary of Army Aviation—June 6, 1962

Hughes has one of the industry's largest production facilities—now in volume production of the commercial 269A.

Hughes HO-6 blades quickly fold for easy concealment.

Compact size and small rotor diameter permit the Hughes HO-6 to operate from tight quarters.

Lunar Altitude Measuring System Devised

By Philip J. Klass

Utica, N. Y.—Simple, lightweight system to enable a lunar vehicle to accurately measure its height above the moon's surface at altitudes out to 200 mi. or more for precision lunar orbits and landing trajectories, has been devised here by General Electric's Light Military Electronics Dept. (LMED).

Company studies indicate that the technique, dubbed "Mark Twain," offers important advantages over conventional radio/radar altimeters in accuracy, operating range, size, weight and power consumption. These studies suggest that the system can measure selenographic (lunar) altitude with an error of only several feet at altitudes of 200 mi.

General Electric recently presented the concept to the National Aeronautics and Space Administration in an effort to obtain government support for continued studies. Work to date has been company funded.

Basic Principle

The basic principle used in Mark Twain is an adaptation of one employed in the radio guidance system developed by GE for the early Atlas ballistic missiles.

In the Atlas radio command guidance system, a signal is transmitted from the ground to a transponder in the missile. Because of the missile's velocity with respect to the terrestrial transmitter, the frequency of the signal as received by the missile differs from the transmitted signal frequency by the amount of the Doppler shift.

The missile transponder then doubles the received signal (or shifts it by some other multiple) and transmits back to the ground. Upon its arrival there, the missile-transmitted frequency has undergone an equivalent Doppler shift.

By comparing the received signal frequency with the original transmitted frequency, and making allowance for the transponder multiplication, the ground station can compute the Doppler shift and from this determine the missile's velocity.

By integrating the rate of change of missile velocity from time of launch, the ground station computer also can determine the total distance traveled by the missile, or its altitude.

In the Mark Twain system which GE proposes, a simplified miniature version of the Atlas ground equipment would be installed in the lunar vehicle. The counterpart of the transponder carried in the Atlas missile would, in this new application, be carried initially aboard the space vehicle and later would be ejected in the vicinity of the moon.

Depending upon the vehicle's intended mission, the tiny transponder beacon can be ejected so as to follow a ballistic trajectory and impact on the moon's surface, or to follow the vehicle's original orbit/trajectory to serve as a reference marker for vehicle guidance.

In either case, the vehicle-borne equipment integrates the rate-of-change of Doppler shift to determine change of altitude between vehicle and the beacon.

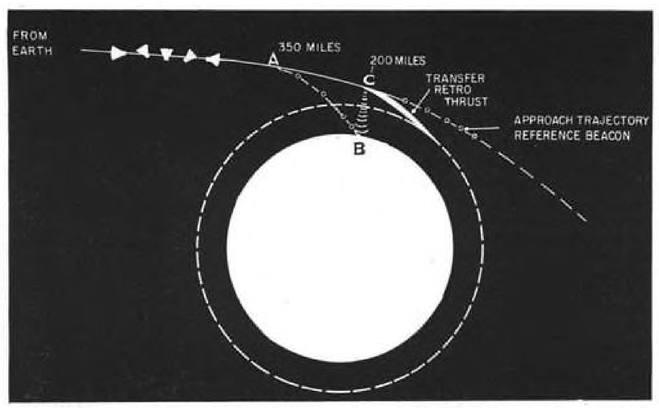
If the beacon is ejected so as to impact on the moon, the vehicle will determine change of altitude until the instant of impact, when the beacon would be destroyed, giving the crew an indication of its altitude above the moon's surface. If the beacon is ejected so as to remain in the vehicle's present orbit, the vehicle can take up a new orbit or initiate a landing maneuver, using the orbiting beacon as an altitude reference.

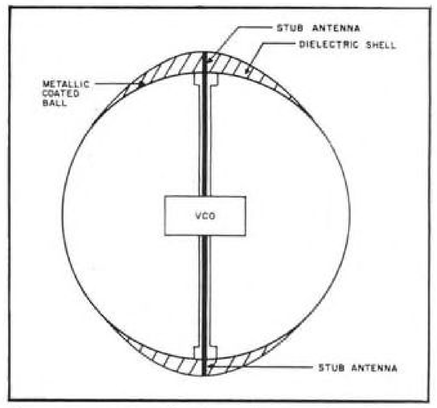
A vehicle making a lunar landing could plant a beacon on the lunar surface and use it to determine vehicle altitude during the return-to-earth phase of the mission.

The GE studies assume that the lunar vehicle will be equipped with a small digital computer for mid-course guidance which also can be used to perform the required geometric-trigonometric relationships from data supplied by the ejected beacon.

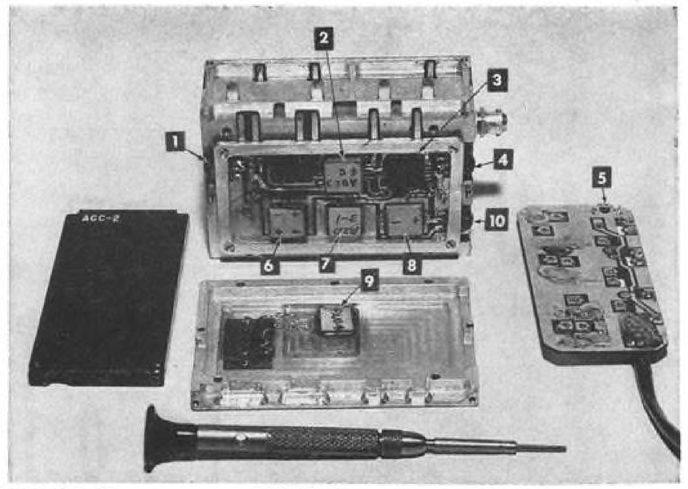
Weight of Device

On this basis, GE's William Muntz estimates that the vehicle-borne transmitter-receiver and indicator will weigh only 4 lb., not including power supply. Weight of the beacon to be ejected from the vehicle is estimated at between 3 lb. and 4 lb., depending upon whether it is intended to impact on the moon's surface and needs only short-lived battery supply, or whether it must function for an extended period in orbit.





"MARK TWAIN," new lightweight, simple technique to enable lunar vehicle to determine its altitude above the moon's surface, or change in altitude from original trajectory, uses small continuous-wave radio beacon ejected from space vehicle. Beacon can be ejected (A) so as to impact on lunar surface (B), enabling vehicle to measure its own altitude, or beacon can be ejected at (C) so it will remain in vehicle's original trajectory while vehicle begins descent or transfer into lunar orbit. Ejectable beacon, (right), containing phase-locked transmitter, would be housed in spherical container. Metallic coating and two stub antennas would provide nearly omnidirectional coverage. Studies indicate Mark Twain system offers significant advantages over conventional altimeters.



Molectronic AN/ARC-63 Emergency UHF Receiver Built

Molectronic AN/ARC-63 emergency UHF receiver, built to demonstrate use of molecular electronic techniques, weighs 0.46 lb., 90% less than standard ARC-63 receiver, and occupies only 9 cu. in., $\frac{1}{8}$ the volume of a standard model. Power consumption is 2.2 watts vs. 24.5 watts for conventional ARC-63. The receiver, built by Westinghouse Electric under Aeronautical Systems Division contract, is a fixed-tuned AM double-sideband, double conversion set. The RF and first IF stages use conventional miniature components, while the rest of the set utilizes molectronic units. Where standard ARC-63 uses 219 components, the new version uses only 82 standard components and nine molectronic units. Device is composed of (1) AGC-1 level set control, (2) differential AGC amplifier, (3) two stage AGC amplifier, (4) squelch control, (5) AGC-2 level set control, (6) 1.0 UF coupling capacitor, (7) audio amplifier, (8) 0.47 UF coupling capacitor, (9) audio power amplifier, (10) volume control.

Using phase-lock techniques, and assuming a 10 db. noise figure both for the vehicle-borne and ejected beacon receivers, Muntz says that 100 milliwatts of transmitter power should provide operating ranges up to approximately 200 mi. with a 6 db. signal-to-noise ratio.

Prior to beacon ejection, its voltage-controlled oscillator would be phase-locked to a crystal controlled oscillator in the vehicle's receiver. The vehicle might, for example, transmit a continuous wave signal at a frequency of 1,125 mc. Upon receipt of this by the beacon, it would be heterodyned down to 125 mc. (plus Doppler shift) and used to control the beacon's oscillator whose output would be multiplied by a factor of eight and transmitted back to the vehicle at roughly 1,000 mc.

Omnidirectional Radiation

The ejectable beacon could be potted in a spherical form with a diameter estimated at approximately $3\frac{1}{2}$ in. It would be metallic coated to provide a ground plane for two stub antennas which would provide nearly omnidirectional radiation. The number of such beacons carried by a lunar vehicle would depend upon its intended mission.

Both the beacon and the vehicle-borne companion equipment would be fully transistorized. Muntz estimates the power consumption of the beacon at around 20 watts, with a figure of about 25 watts for the vehicle equipment.

Muntz claims the Mark Twain approach to determining selenographic altitude has a marked advantage over conventional radio/radar altimeters on such important factors as range, accuracy, size, weight and power consumption.

Altimeters Compared

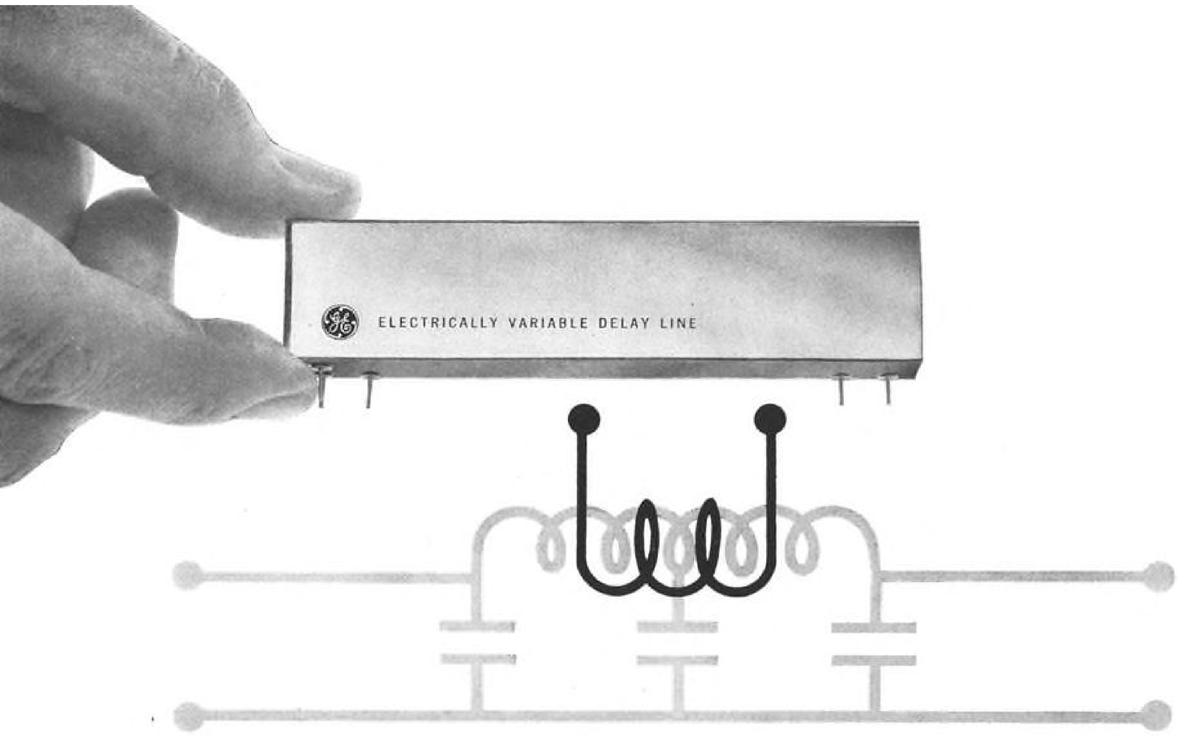
For example, one existing radar altimeter built for airborne use weighs 33.5 lb., requires 270 watts of power, is designed for maximum altitude of only 12 mi. and has a quoted accuracy of 25 ft. plus 0.025% of altitude. Compared with the airborne radar altimeter volume of 1,300 cu. in., Muntz estimates the vehicle-borne portion of Mark Twain can be built in a volume of 50 cu. in.

Potentially, Mark Twain should be more reliable, Muntz says, because it is considerably less complex than a conventional radio/radar altimeter. Because of its small size and volume, duplicate equipment could be carried to afford back-up protection.

In the recent presentation to NASA, representatives of GE's Light Military Electronics Department indicated that the company could conduct the detailed study of the use of such a system for lunar orbit transfer, landing and takeoff, and make a preliminary design of the required hardware in six to nine months.

Estimated Shipments of Electronic Components

Category	Second Quarter, 1961 Quantity (Thousands of units) Military	Total (Military plus non-military)	Value (Thousands of dollars) Military	Total (Military plus non-military)
Capacitors	35,893	362,873	$21,628	$71,135
Connectors	15,316	28,269	30,896	47,093
Quartz crystals	560	1,706	1,443	6,727
Relays	1,650	6,739	18,217	40,296
Resistors	63,786	637,660	27,160	69,656
Transformers and reactors	1,427	8,264	16,910	43,969
Power and special purpose tubes	707	1,909.5	46,096	68,593
Receiving tubes	5,853	98,970	10,737	84,294
Semiconductor devices	31,584	122,868	50,202	127,905
Total	.....	.....	$223,289	$559,668



SIMPLIFIES THE CIRCUITRY NEEDED TO CONTROL DELAY

Electrically Variable Delay Lines from General Electric offer Design Engineers all the cost, time, space, and reliability advantages that accrue when a circuit design requirement can be greatly simplified. This unique device offers a new approach to pulse positioning and phase control, and features the advantages of controlling delay by electrical rather than mechanical means.

For such equipments as radar, computers, mobile communications, Electrically Variable Delay Lines are a superior method for the solution of problems in transmission time control, pulse control and shaping, high-frequency phase control, pulse time modulation, and phase or frequency modulation. These devices are available for either carrier or pulse type applications, and can be produced within a wide range of operating characteristics.

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- ☐ radar ☐ computer ☐ communications
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- ☐ for use with transistorized circuitry
- ☐ environmental (extreme humidity, vibration, shock)
- ☐ delay (variation) x bandwidth
- ☐ Please send me information on the following integrated electronic devices available from G.E.
- ☐ Ferrite Core Memory Planes (fully encapsulated or open)
- ☐ Sonic Delay Lines (completely passive)
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- ☐ Digital Readout Device (best combination of readability, flexibility, reliability)
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SPECIALTY DEVICES OPERATION

GENERAL ELECTRIC

Defense Electronics Division

Mobile Traffic Control System Studied

By James D. Hendricks

Hanscom Field, Mass.—Prime contractor will be selected this spring for USAF's 482L Emergency Mission Support System—a compact, air-transportable collection of air traffic control equipment designed to assist in airlift and limited war operations at landing strips in remote areas of the world.

Air Force Systems Command's Electronic Systems Division here currently is paring original industry proposals to a group of finalists (AW Jan. 15, p. 23). These companies will be invited to offer bids toward a contract award in late April or early May.

No dollar estimate is available on the contract, but Lt. Col. Victor K. Syphers, acting director of ESD's 482L System Program Office, said it will call for production of three complete systems to be tested simultaneously at a site near the prime contractor's facility. If tests are successful, Air Force plans to order 19 system packages.

The 482L system is scheduled to become operational next year, and eventually USAF will locate 482L equipment at bases around the world. This dispersal would enable Air Force to deploy a 482L system into a remote trouble spot quickly, probably within a matter of hours.

System Concept

System concept specifies six main vans containing radar and communications gear to be airlifted aboard two C-130A transport aircraft. Load dimension limits of the C-130A restrict each van to maximum height and width of 7 ft. and a length of no more than 15 ft.

Support equipment and personnel probably would be carried in other aircraft. The vans would be unloaded from the C-130As onto prime mover truck beds and positioned near the landing strip.

Other system requirements include:

- **Operation under extreme** climatic conditions.
- **Self-sustained operation** for at least 30 days.
- **Minimum maintenance,** since remote airstrips could make frequent shipments of spares and maintenance personnel prohibitive.
- **Operational minimums** of 100-ft. ceiling and ¼-mi. visibility, although setting of limits will be left to the discretion of the local commander.
- **Capability for handling** various aircraft types, from supersonic jets to subsonic piston-engine or VTOL vehicles.
- **Landing rate** of one plane every 2½ min. System development officers point out, however, that a one per minute rate is possible over short periods with aircraft of similar approach and landing speed characteristics.
- **Simultaneous control capability** for as many as 20-24 aircraft.

Additionally, ESD has specified that individual 482L components must be capable of independent operation if necessary. For example, should an airfield in the United States or overseas lose its traffic control facilities, in part or whole, 482L gear could be deployed to the field to provide emergency support until regular facilities are restored.

To meet this requirement, ESD has maintained close liaison with Federal Aviation Agency to assure that 482L will be compatible with air traffic control techniques and equipment under development by FAA for civil air operations.

Program Background

The 482L program is an outgrowth of two earlier efforts of a few years ago, Projects Two Wheels and Four Wheels. Those programs had the same general objectives, but consisted of a rough arrangement of equipment then available. Field tests conducted by Convair in 1959 showed that the earlier systems were unwieldy and offered a poor landing rate.

Last September, Air Force issued an operations requirement for a mobile, compact and advanced emergency air traffic control system and created the 482L SPO.

A preliminary ESD estimate calls for approximately 22 personnel to operate a 482L system at full capacity.

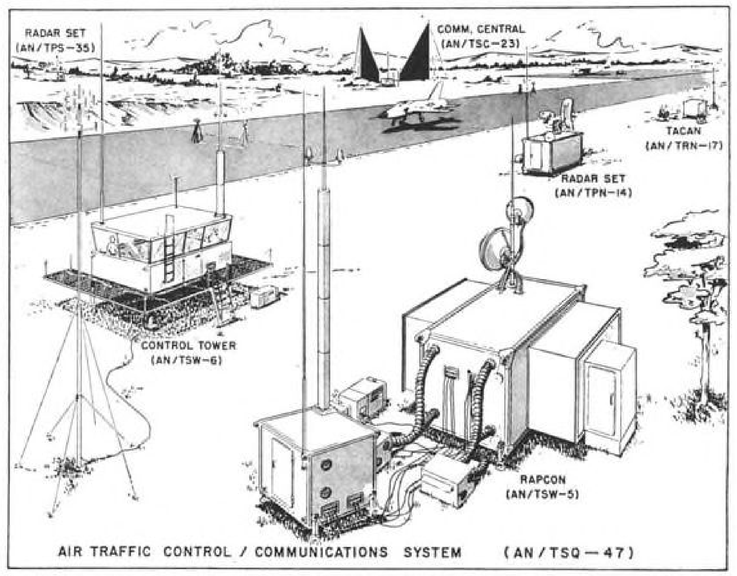
Edward Segal, deputy SPO director, stressed that USAF wants a system that can be manned by "average technical personnel. We don't want to have to carry a lot of tech reps along on an operation."

Segal said companies that submitted proposals have been told "we want no more and no less than our specifications indicate. We can't accept anything less, and anything more might be too heavy or too expensive to be practical."

System Components

No breakthrough in equipment development is believed to be necessary for the 482L system. Designated the AN/TSQ-47, the system is to include six basic components:

- **Search radar van (AN/TPS-35),** containing an L-band radar with nominal scan of 80 mi. at 45,000 ft., a radar transmitter-receiver, search display set for maintenance and independent use, and one UHF radio channel. The van would be 12 ft. long with one operator.
- **Communications van (AN/TSC-23),** primarily for use by the base or theater commander, would have long-range point-to-point communications gear to link the site with USAF's world-wide 480L Air Communications System, now under development. Equipment would include five teletype machines and various long-range antennas for receipt and

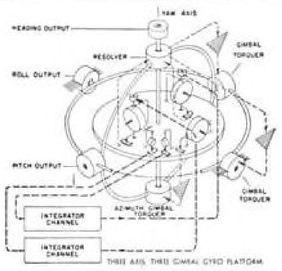


POSSIBLE ARRANGEMENT of 482L Emergency Mission Support System vans and equipment is shown in artist's concept. In actual use, vans might be more widely separated.

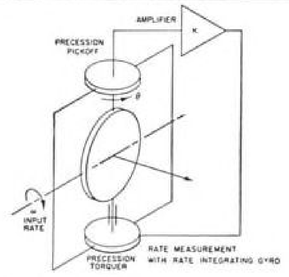
kearfott technical information report

GYROS

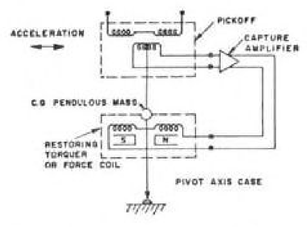
This 60-page reference book describes the theory, application and testing of gyros, platforms and accelerometers. It also discusses, with some reservation to protect our proprietary interest, several sophisticated concepts now being developed at Kearfott. It includes, for your convenience and ours, a tabulation of the equipment we produce in these various product areas. A copy of this book is available to you free of charge. Just drop us a note, requesting your copy.



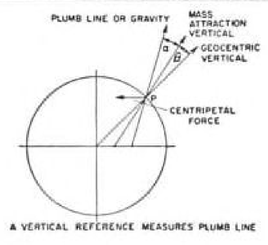
Stable Platforms. Essentially a cluster of gyros mounted within gimbals and utilizing acceleration sensing components, stable platforms perform the important function of having the gyro out-puts control the gimbals by means of a servo loop. By manipulating various arrangements of gimbals and gyros, a variety of platform types can be produced. They are used as reference elements and to stabilize accelerometers, star trackers, and similar devices in space.



Floated Rate Integrating Gyros. Floated Rate Integrating Gyros are used where exceptionally high-level performance is required. Should the rotor mass of a gyro wheel having an angular momentum of 1.0×10^6 gm. cm.^{2}/sec. shift by as little as one micro-inch, a drift of 0.1°/hr. could result. The difficulty in achieving ultra-high precision and accuracy is apparent, and the necessity for obtaining low drift gyros is of paramount importance.



Inertial Accelerometers. A typical force balance pendulous accelerometer utilizing a differential transformer pickoff, a high gain capture amplifier, and a DC permanent magnet force coil is illustrated. This type of accelerometer, together with its amplifier, is a high-gain null-seeking servo in which the current flowing through the force balance coil, measured as voltage across a resistor in series with the coil, is directly proportional to the acceleration applied.



Vertical Sensing Elements. The Vertical Sensing Element is essentially a high accuracy single or two axis electrical plumb bob providing an electrical signal proportional to its displacement from the local gravity vertical. Effectively a form of accelerometer, it is suited for applications not affected, to a major extent, by external accelerations acting upon it. Since it is a first order open loop device, unless stabilized within a gimbal structure, it will sense lateral accelerations, producing a signal representing the resultant of gravity and these spurious forces.

Inertial Reference Platform. Designed for ballistic missiles, the three-gimbal configuration of the SD510 Platform has undergone rigorous flight and sled tests, thoroughly proving its accuracy and ruggedness. Three Kearfott inertial navigation gyros (KING) form the core of a velocity servo-mechanism which provides dynamic isolation of the inertial reference from external inputs. Three inertial-quality accelerometers are mounted on the isolated inner cluster. The resulting platform is a hermetically sealed cylinder 10 inches in diameter by 14 inches in height.

King Floated Rate Integrating Gyros. Designed primarily for missile system applications, the gyro makes possible the superior performance of the SD510 platform. Distinguished by outstanding mass stability, eliminating the need for daily trimming, and an extremely low drift rate of 0.003°/hr., this gyro has all capability of being torqued at rates up to 22,000°/hr. An optimum combination of characteristics permits tight gimbal control. A low impedance pick-off and DC torquer virtually eliminate noise problems.

Inertial Single Axis Accelerometer. This single axis, fluid damped accelerometer is a DC torquer-restrained device possessing a useful dynamic measuring range of greater than twenty g's. The sensitive element consists of a symmetrically-located differential transformer pick-off and a pair of force coils mounted in common on the instrument measuring axis. The high degree of symmetry of both force coils and pick-off coils minimize the resultant errors which might otherwise occur during vibratory inputs. Transistorized amplifiers, such as the Kearfott type S3503-03A, are available.

Typical characteristics include: Range of measurement . . . 20 g when using S-3503 amplifier . . . Bias and Zero Stability . . . 0.00002 g day to day . . . Threshold . . . 2×10^{-7} g . . . Natural Frequency . . . 220 cps.

Vertical Sensing Element. A frictionless, wire-suspended pendulum acts as the moving portion of two orthogonally mounted differential transformers to provide phase-sensitive ac output signals proportional to the tile angle. A typical application is initial alignment of a gyro platform. The unit has exceptional repeatability to vertical, high sensitivity, and low null voltage.

Design features include a balanced signal generator for minimum null shift with temperature or excitation – and for fluid filling for damping and resistance from shock or vibration.

Typical characteristics include: Linearity . . . 5% of 3 arc minute – Threshold . . . 0.5 arc seconds max., Null Repeatibility (long term) . . . Within 2 arc seconds.

KEARFOTT DIVISION | GENERAL PRECISION INC., LITTLE FALLS, NEW JERSEY

GENERAL PRECISION

your map
in a **UNIVERSE**
of AIRCRAFT PUMPS

This new engineering bulletin leads you right to the hydraulic pump designs you may be looking for. Here, passing on parade, are high performance gear pumps made to the measure of the next generation in aircraft, missiles, spacecraft, and support equipment.

Many of these units are the product of ready-made, mass-produced components that can be teamed into the precise configuration you need. Custom-designed pumps are also available.

All have in common these classic Eastern hydraulic pump characteristics:

SMALL SIZE: Eastern gear pumps are the smallest, lightest made. Airborne servo system pump shown delivers 1.5 gpm @ 1500 psig — measures only 1⅞" x 1⅞" x 2¾", weighs 9 oz.

WIDE PERFORMANCE RANGE: pumps available have theoretical displacement from .0016 to 1.30 cu. in. per revolution — flow from .025 to 9.6 gpm, pressures from 0 to 2000 psig, at speeds to 24,000 rpm. Weights with motor range from 1.5 to 8.5 lbs.

UNAFFECTED BY EXTREME ENVIRONMENTS: rugged, reliable Eastern units take loads to 50g in stride — shrug off temperature differentials to meet MIL specs.

Eastern AVIATION PRODUCTS

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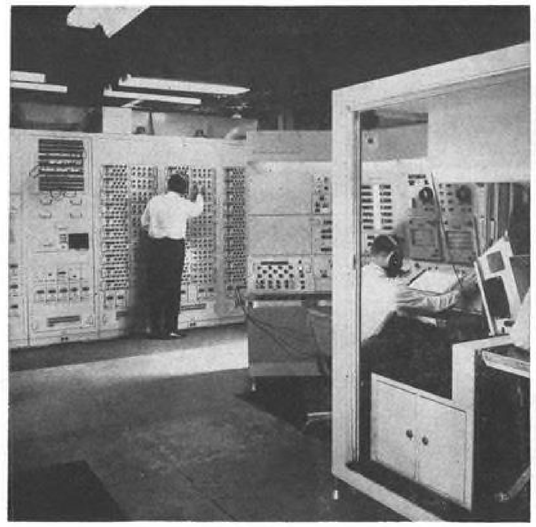
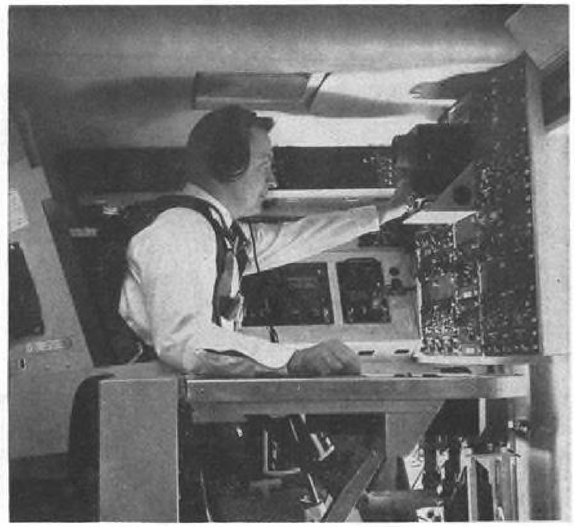
Other Eastern products:
- hydraulic motors
- servovalves, amplifiers, actuators and systems
- pressurization/dehydration packs
- quick-disconnect couplings
- electronic tube cooling units





B-52 Electronic Countermeasures System Simulator Shown

B-52 electronic countermeasures simulator for training ECM officers is able to simulate wide variety of enemy radar signals which airborne ECM operator must be able to jam or spoof. Simulator uses punched card system to select simulated enemy radar antenna characteristics and other parameters of the radar, such as location, pulse, repetition frequency, pulse width and reaction to B-52 jamming. During simulated training flight, signal activity occurs automatically. Equipment provides a printed record of student performance. The new simulator was built by Reflectone Electronics, Inc., subsidiary of Universal Match Corp., under $11.8 million Aeronautical Systems Division contract. Close-up of student's position, which closely resembles B-52 ECM station, is shown at right.

transmission of weather information, operations plans and support data. The van would be 13 ft. long and possibly manned by five operators.

• **Tower van** (AN/TSW-6), 12 ft. long, would have full traffic tower capability with two controllers and a data handling operator. The van would include 10 air-ground-air channels (5 UHF, 4 VHF and 1 HF), a Servo Corp. of America GBD-11 Doppler direction-finding antenna mounted near the van, and light guns for signaling approaching aircraft. Construction concept shows a metal catwalk around the sides of the van up to four feet off the ground. During airlift, the catwalk would be folded upward to protect the tower windows.

• **TACAN van** (AN/TRN-17), 9 ft. long, containing a dual beacon transponder, dual monitors and automatic switchover capability for unattended operation. International Telephone & Telegraph Corp. already is building equipment of this type.

• **RAPCON van** (AN/TSW-5), 15 ft. long, manned by nine personnel. Equipment is to consist of two final approach display radars, three surveillance displays and one large horizontal display radar. A 6-ft. long annex van will contain 14 air-ground-air channels (7 UHF, 6 VHF and 1 HF) and a microwave link to receive data from radar vans.

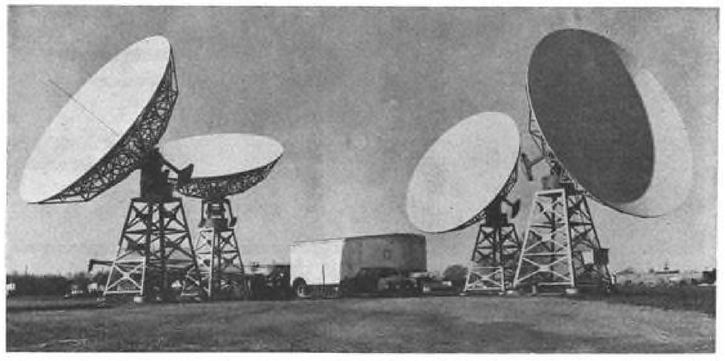
• **Final approach van** (AN/TPN-14), 12 ft. long, to contain a radar transmitter-receiver, a final approach display for emergency operation, two air-ground-air channels (UHF-VHF), and a microwave channel linking it with the RAPCON van. Cable communications can be used instead of the microwave gear if the final approach and RAPCON vans are not widely separated.

The entire 482L system will be powered by gas turbine engines weighing 400 lb. each, and capable of operation for 23 of 24 hr.

The turbines were chosen, Segal said, because they are easy to maintain and "will burn just about anything you can find."

Each van will carry an extra turbine as a backup.

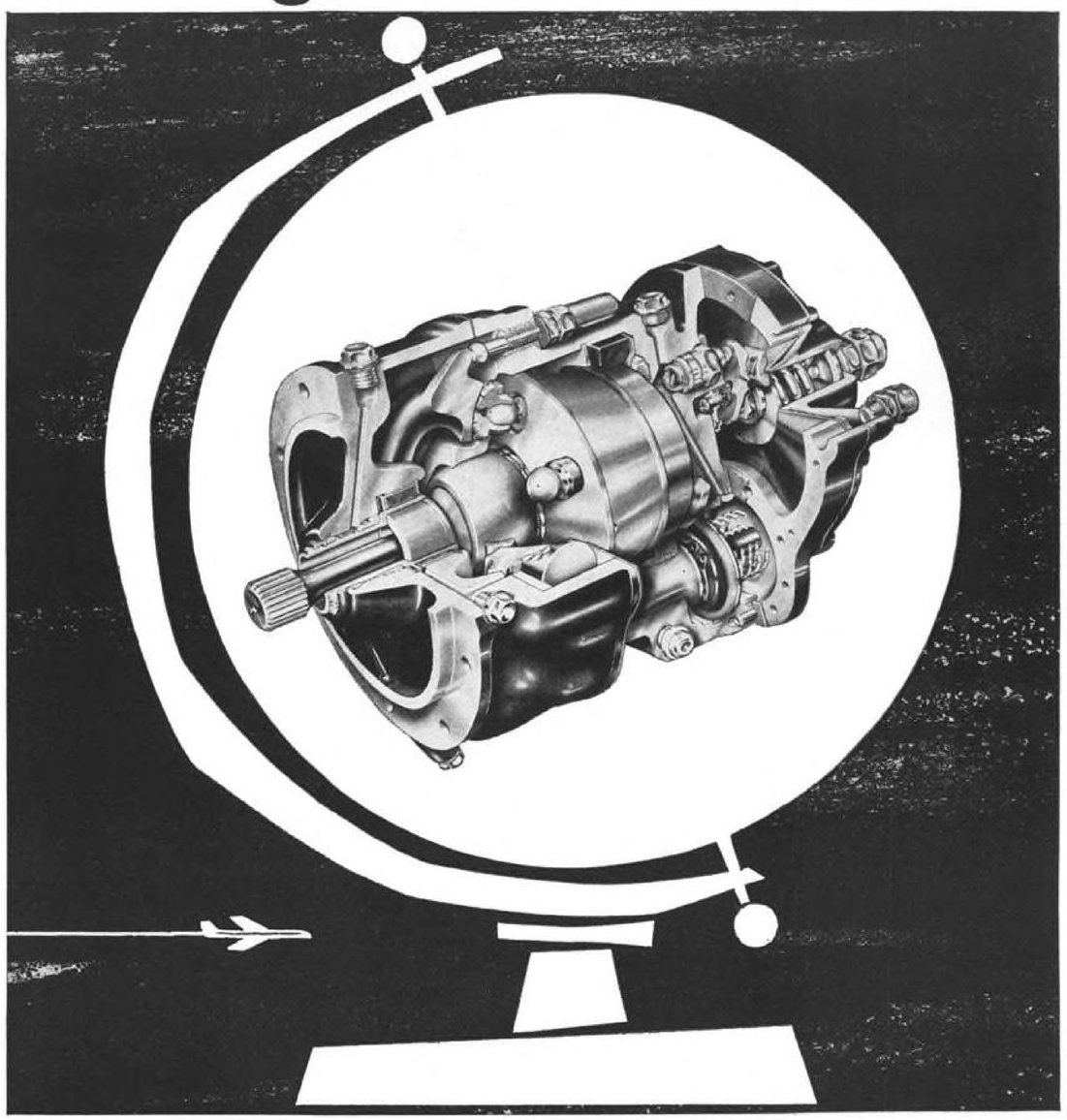
Thirty days' worth of spares will be stored internally in the vans. Another 60 days' supply may also be carried with each 482L system package. Four maintenance men will be on duty at each site.



Antenna System to Work with Echo II

Distributed aperture antenna system, consisting of four 30-ft. diameter parabolic reflectors, is designed to give performance equivalent to a single 60-ft. dish. Developed by Ohio State University's Antenna Laboratory, under Rome Air Development Center sponsorship, the array will be used in passive communication satellite tests with Echo II, 135-ft. sphere to be launched this spring. The distributed aperture antenna is expected to be less costly and permit operation over a wider frequency range. Initial tests will be conducted at 2,000 mc., where array is expected to provide 49 db. gain, but operation later will be extended into the 10-20 gmc. range. Each antenna is powered by a 10 kw. transmitter. Servo systems to keep four dishes synchronized were built by Antlab, Inc., Worthington, Ohio.

Throughout the world—



FROM LUCAS CARE STEMS LUCAS ACHIEVEMENT

In the finest aircraft, throughout the world, Lucas fuel pumps give outstanding performance. Over 100,000 of these fuel pumps are in operation in today's civil and military aircraft. The civil pumps have completed a total of 19,500,000 hours' operation. In many instances Lucas pumps on the North American continent are giving over 3000 hours' service between overhauls. Proof, that from the tremendous care Lucas takes in the manufacture of these pumps, stems the achievement of world-wide confidence.

Lucas Gas Turbine Equipment Limited, Birmingham, England.
Lucas-Rotax Limited, Toronto, Montreal, and Vancouver, Canada,
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Lucas-Rotax (Australia) Pty. Limited, Melbourne and Sydney, Australia.

LUCAS

FUEL AND COMBUSTION SYSTEMS FOR GAS TURBINE AND RAM JET ENGINES

USAF Orders Four Vocoder Prototypes

Dallas, Tex.—Contract totaling $370,000 for design, development and manufacture of four voice communications systems utilizing coded digital transmission technique has been awarded Texas Instruments' Apparatus Division by Electronic Systems Division, Air Force Systems Command.

The four prototype equipments will be field-tested by Air Force to determine performance goals and specifications for digital Vocoder systems for operational use.

Aimed at providing a high degree of speech compression and communications security, the Texas Instruments Vocoder system will have three modes of operation—1,200, 1,400 or 9,600 bits per second—to offer different degrees of bandwidth compression and quality and enhance compatibility with various available channel bit rates and operational requirements. The digital output of the system may be used as an input source to automatic speech pattern recognition being developed by Air Force Cambridge Research Laboratories' Communications Sciences Laboratory. A fully automatic means of locking two or more duplex terminals into synchronization will be incorporated.

Speech intelligibility, voice quality and talker recognition of the system will vary as a function of the data rate. Use of a voice-excited or hybrid technique will provide a quality of the 9,600-bit mode that is as good or better than toll telephone quality, firm says.

FILTER CENTER

► **Integrated Circuits for Growth Minuteman**—Extensive reliability improvement program to determine and improve the reliability of integrated circuits which would be used in the inertial guidance computers of growth versions of the Minuteman ICBM may be initiated soon by Autonetics, associate prime contractor for the ballistic missile's guidance and control systems. The program would be fashioned after a multi-million dollar Air Force/Autonetics effort which significantly boosted the mean-time-to-failure of individual, discrete avionic components now going into Minuteman (AW Dec. 12, 1960, p. 99; Oct. 19, 1959, p. 69). The likelihood that Autonetics will make this move is a reflection of growing Air Force confidence in these solid-state devices, their ultimate high reliability and low cost. Autonetics is preparing to send out bid packages to integrated circuit manufacturers to acquaint itself with their capabilities while its engineers are touring integrated circuit manufacturing facilities. More than one supplier currently active in the business probably would be selected if the program gets final Air Force approval. Likely prospective contenders for participation include Texas Instruments, Fairchild Semiconductor, General Electric, Motorola, Westinghouse and Pacific Semiconductors.

► **Slashing Navigation Equipment Weight**—Navy hopes to cut the weight of airborne Loran C receivers by an appreciable amount in a forthcoming program aimed at developing an experimental 30 lb. Loran C receiver. Weight reduction will have to be achieved through the use of one of the new techniques of microelectronics. Proposals for the Bureau of Weapons program are due on Mar. 9.

► **Channeling Lightning Strokes**—Air Force Cambridge Research Laboratories plans to attempt to draw lightning strokes to the ground in an effort to learn about lightning characteristics—radio frequencies generated, currents and energy of the stroke, possibility of coupling energy to the ionized channel created in the tests. The study calls for firing into thunderheads a rocket to which will be attached fine steel wire of high tensile strength. The discharge may follow the wire to the ground, vaporizing it and thereby cutting an ionized channel down which subsequent strokes could be channeled. The ionized channel could possibly serve as an antenna for VLF transmissions.

► **Lockheed Prepares TRIPOD Team**—Lockheed Missiles & Space Co. is assembling an industry team, including potential avionics guidance/control contractor, in anticipation of a possible industry competition for a new launch vehicle to put operational Transit navigation satellites into precise orbits. Present plans call for use of Scout launch vehicles, but Aerospace Corp. is reviewing a number of possible alternates, among them the Lockheed TRIPOD (Transit Injector Polaris Derived), a four stage vehicle based on the solid-propellant Polaris missile (AW Jan. 29, p. 23). Lockheed asked several avionics companies to submit proposals earlier this month for a small, lightweight inertial platform for TRIPOD. As yet, however, funds have not been allocated for an alternate Transit launch vehicle.

► **Redundant Adaptive Autopilot**—A redundant adaptive automatic flight control system, designed for advanced aerospace vehicles, such as Aerospace Plane, supersonic transport, TFX and VAX, has been developed by Sperry Phoenix Co. Working models of the system have displayed mean-time-before-failures in excess of 3,000 hr. The dual axis adaptive control system is lighter, occupies less volume than present-day single axis systems, an achievement made possible by the use of potted "cordwood" component modules.

► **CAL Studies Perceptron Uses**—Cornell Aeronautical Laboratory, which is emphasizing Perceptron applications in its ONR-sponsored studies, is using a digital computer to simulate Perceptron operation to determine changes in original Mark 1 concepts which will enhance machine's ability in character and target recognition. For example, CAL is investigating Perceptrons whose association-units have a trigger threshold value other than zero, used in the Mark 1, CAL's William Holmes reported at the ONR conference. Another objective is to determine optimum configurations for wiring sensor units to association units when the nature of the learning task is known in advance. The Mark 1 employed random wiring between sensor units and association units, which increases machine's flexibility, but may slow down its learning process for certain types of tasks.

► **Beryllium Bonded by New Technique**—Beryllium can be bonded to itself by a gas-pressure bonding process when exposed to a temperature of about 1,600F and a pressure of 10,000 psi. for two to four hours, according to studies conducted by Battelle Memorial Institute under Atomic Energy Commission sponsorship. Details on the process are available in report entitled "Preliminary Studies of Bonding of Beryllium-Clad Uranium-dioxide Fuel Elements," identified BMI-1545, priced at 50 cents, from Office of Technical Services, Commerce Dept., Washington 25, D.C.

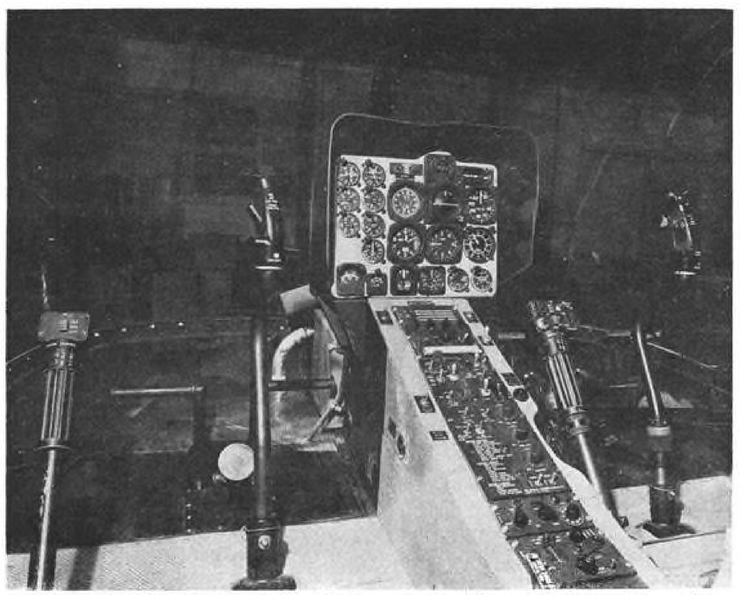
► **Vortac Channel Increase Studied**—Federal Aviation Agency has awarded contract to ITT Federal Laboratories to investigate techniques for increasing present number of Vortac channels. One technique would use different pulse code spacing to double number of distance-measuring-equipment channels.

► **Silicon Grown In Thin Sheets**—Westinghouse Electric scientists have developed techniques for growing silicon crystals in sheets as wide as ½ in., in thicknesses of 0.0005 to 0.035 in. and more than 3 ft. long. The thin sheets, with smooth parallel surfaces, are reported to be free of crystalline defects and directly useable for semiconductor devices. The new technique is an outgrowth of earlier Westinghouse technique for producing thin ribbons of silicon, known as dendritic growth. The new process uses a seed crystal that generates two parallel dendrites, which fill in to form the sheet.

KAMAN'S H-43B turbine-powered helicopter has become mainstay of 70 local base units of the USAF Air Rescue Service. Relatively high lifting power, ease of control and wide range of maneuverability are reasons H-43B is used extensively on rescue missions.

Aviation Week Pilot Report:

Kaman's H-43B Helicopter Demonstrates



AT THE END of the collective pitch stick, above the throttle control, is a panel containing the starter switch, engine speed governor switch, landing light On-Off, extension motor switches and the floodlight switch.

By Larry Booda

Bloomfield, Conn.—Kaman H-43B Huskie turbine-powered helicopter is a highly specialized vehicle whose virtues of relatively high lifting power, ease of control and a wide range of maneuverability overcome minor problems such as low-frequency vibration. It is the most versatile rescue aircraft in the U. S. Air Force inventory.

In appearance the H-43B resembles earlier Kaman piston-powered models by having the syncropter, or "egg-beater" type of rotor system which features two intermeshing two-bladed rotors.

To the ease of control that distinguishes the syncropter from tail rotor helicopters is added the further refinement of automatic revolutions-per-minute regulation that distinguishes the turboshaft installation. The result is a helicopter that is almost as easy to fly as a conventional lightplane.

In the tight situations often presented in crash-rescue work, Air Force pilots rate this ease of pilotage as the one feature that often spells the difference between success and failure.

Wide Versatility in USAF Rescue Missions

The AVIATION WEEK pilot evaluation of this aircraft which has become the mainstay of the 70 local base units of the USAF Air Rescue Service was conducted at the Kaman plant here, a short distance north of Hartford.

Adding to the distinctive rotor appearance of the H-43B is the oblong fuselage, flat on the bottom and sides, with clamshell doors in the rear and clear plastic bubble in front. Twin booms extending from the upper part of the fuselage support four vertical stabilizers. A movable horizontal stabilizer connects the vertical stabilizers and the booms. Each of the inboard stabilizers has a movable rudder attached to the aft edge.

The exhaust pipe of the single turbine engine extends from the upper part of the fuselage between the booms and over the horizontal stabilizer. Topping the aircraft are the twin pylons mounting the rotor blades and the engine mounted between. Four wheels are mounted on struts outboard of the fuselage near each corner. The front wheels are swiveling and the rear wheels are fixed and have brakes.

The H-43B is honest in its responses

EXHAUST PIPE of the single turbine engine extends from the upper part of the fuselage between the booms and over the horizontal stabilizer. Topping the aircraft are the twin pylons mounting the rotor blades and the engine located between.

AT RADIATION, CHALLENGE IS OPPORTUNITY

Example: PCM telemetry for "Nimbus"

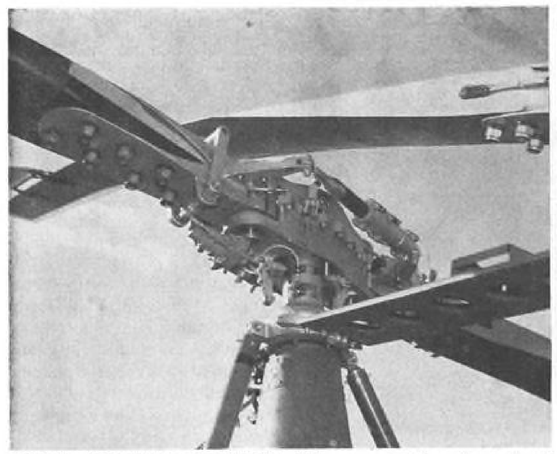
Accurate long-range weather forecasts will be man's best defense against the caprice of the elements. The *Nimbus* meteorological satellite system—being developed by the Goddard Space Flight Center of the National Aeronautics and Space Administration—will improve such forecasts.

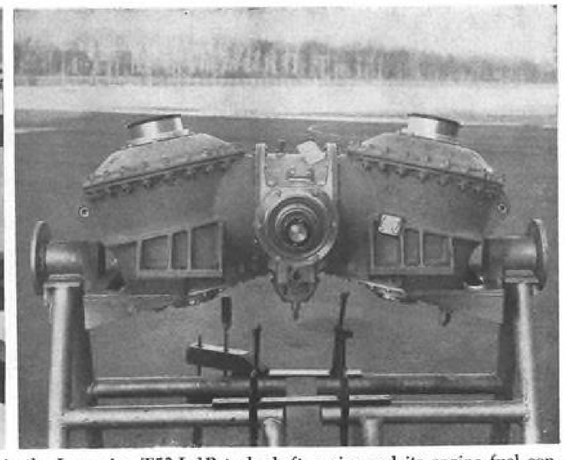
Radiation Incorporated was selected by NASA to design and build PCM telemetry for *Nimbus*. The requirements posed a challenge of system long life and high reliability that have led to major advances in the state-of-the-art. For *Nimbus* a new concept of power switching was developed that will result in a power saving of 30:1 over present methods. Other Radiation-built ground systems will process *Nimbus* data.

Nimbus, *Telstar* and OAO (Orbiting Astronomical Observatory) satellite PCM systems are but three of the many exciting projects in which we are presently engaged. If you're the kind of engineer who is stimulated, not stymied, by the myriad challenges of space electronics, you'll find kindred spirits at Radiation Incorporated. If such an environment appeals to you, send your resume or write for information to Personnel Director, **Dept. AW-32**, Radiation Incorporated, Melbourne, Florida —an equal opportunity employer.

RADIATION INCORPORATED

Communications systems—Data acquisition and processing—Automatic checkout—Antenna systems





KEY TO THE EASE OF CONTROL of the power to the rotor system is the Lycoming T53-L-1B turboshaft engine and its engine fuel control system. Engine is made up of a gas producer turbine which drives an axial flow compressor. Engine fuel is JP-4.

to control movements. In making landings without power it is not necessary to flare or pull up the nose as radically as with other designs. This AVIATION WEEK pilot flared excessively and crinkled the lower edges of the vertical stabilizers during an autorotation landing as the tail surfaces got too low to the ground.

It wasn't until after a cup of coffee in the hangar that it was realized that nobody was indoctrinated in the Huskie until such a mishap had occurred. In 30 min. the light plastic frangible bottom stabilizer edges had been replaced.

Rescue Requirements

In writing the specifications for a rescue helicopter, the Air Force demanded an aircraft capable of rapid starting and scramble to the site of a crash or other emergency, the ability to pick up survivors, fire control and suppression, crash entry and survivor removal and advanced first aid.

That it can fulfill this mission is attested to by the fact that there are now more than 100 instances of rapid rescue action in the case of crashes in addition to many other types of rescues.

The pilot's seat is located at the right side of the forward cabin compartment. All controls are arranged within easy reach of the pilot and the instruments are located on a center panel in the middle of the compartment forward. A console running aft from this panel contains electrical and radio switches, which will be described later.

A copilot's seat can be installed at the left of the pilot's seat. For the basic crash rescue mission the configuration consists of an attendant's seat and two litters in the rear compartment. With the litters removed, up to six seats can be installed in the rear compartment. A hoist is provided for rescue work and an external cargo hook can carry fire-fighting packages.

Gross weight of the H-43B for a typical rescue mission is 7,050 lb., which includes the pilot and crew members.

Key to the ease of control of the power to the rotor system is the design of the Lycoming T53-L-1B turboshaft engine and its engine fuel control system. The engine is made up of a gas-producer turbine which drives an axial flow compressor. Compressed air flows into combustion chambers. The hot gases produced first turn the gas producer turbine and then the power turbine whose shaft is coaxially mounted through the gas producer compressor to a reduction gear in the front of the engine. Power for the rotors is taken from there. Fuel for the engine is JP-4.

Some air is bled from the compressor to supply engine anti-icing for cabin heating.

RESCUE HOIST for the H-43B Huskie is electrically operated and equipped with 100 ft. of cable.

Engine power is controlled by the position of the collective control stick at the pilot's left side. Power turbine, and, consequently rotor speed, are constant. By lifting the collective stick, the rotor blades increase their angle of attack and produce lift. With this application of load, the slight decrease in speed of the power turbine causes the engine fuel control unit to meter fuel into the engine to produce more power. Fuel flow is also automatically metered to compensate for changes in air temperature and pressure. These automatic features are dependent on the actions of two flyweight servo governors, one for the gas producer turbine and the other for the power turbine.

If the automatic fuel control system fails, the motorcycle grip on the collective pitch stick acts as a throttle as in a piston helicopter. Thus in emergency conditions the training associated with the piston helicopter, where pitch and power have to be manually controlled to maintain rotor rpm, within safe limits, is necessary for safe flight and eventual landing.

Instrument Location

At the end of the collective pitch stick, above the throttle control, is a panel containing the starter switch, engine speed governor switch, landing light on-off and extension motor switches and the floodlight switch.

Before entering the H-43B a normal walkaround inspection covers 10 points and 40 items, including the rotor system, upper fuselage, powerplant, various sections of the fuselage, cabin interior.

In the cockpit, there are 45 steps to follow in inspection and setting of controls and switches before starting the engine. Obviously, a ready rescue aircraft must have had this checkoff list applied before going into an alert status.

Starting the engine is simple. During

the previous checkoff list the fuel pump must have been turned on and the throttle rotated to the left out of idle cutoff. Pressing the starter switch for one second actuates the starting sequence. If the oil pressure does not reach 20 psi. by the time the gas producer tachometer reaches 40% or if the exhaust temperature exceeds 600C, the throttle must be rotated right to idle cutoff. Gas producer idle rpm. is 42%.

The rotors are started by releasing the rotor brake lever. Upon increasing the throttle to flight idle and a gas producer rpm. of 62% and breaking all connections with ground equipment the aircraft is ready for taxiing.

Slight movements of the cyclic control stick will make the aircraft move in any desired direction. Turning is done with the turn pedals. Since there is no tail rotor to create turning moments, the turn pedals are in effect additional cyclic pitch controls.

These cyclic changes are applied to the rotors so that a circular force is applied in a plane perpendicular to the vertical axis, causing the aircraft to turn. Collective pitch creates lift equally about the vertical axis and parallel to it. Cyclic pitch applies the lift unequally about the vertical axis, causing pitching and banking movements and travel in the direction of the tilt of the plane.

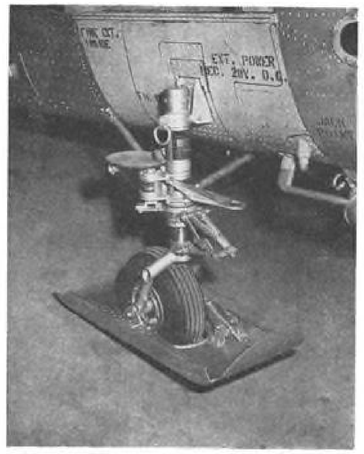
While taxiing, it is customary to check the tracking of the rotor blade tips on each side. If one blade does not track the same as the other they can be brought together by a simple adjustment. The result is smoother flight. Toe brakes are installed on top of the turn pedals.

For takeoff, the throttle is rotated to full open. The engine speed-governor switch is set at 88%. This can be changed according to the conditions of load and other variables. For liftoff, the collective pitch lever is raised easily until the wheel struts extend. The cyclic stick is used to keep the aircraft laterally and longitudinally level and the pedals to keep headed into the wind.

Hovering was tried first. A wind of about three knots was blowing, making remaining on one spot relatively easy. It was this maneuver that demonstrated the high degree of stability typical of the syncropter rotor system. Height control was easy with the collective pitch lever, while lateral and longitudinal movements were easily controlled with the cyclic stick.

The cyclic stick has some artificial "feel" in it through use of adjustable springs. There is less tendency to overcontrol with it than in single-rotor helicopters. The turn pedals require more throw for hovering turns than tail rotor types of helicopters.

Climb is easily initiated by easing



HELICOPTER is fitted with bear-paw landing gear. Front wheels swivel, rear landing gear are fixed.

the cyclic stick forward and increasing the collective stick slightly.

In level flight the collective stick can be locked in one position after a desired power setting has been made. Adjustments in flight then are made with the cyclic stick and the pedals.

The most noticeable feature, the moment flight begins, is the relatively violent low-frequency vibration at twice the rotor rpm. This "shaking" is much more pronounced than in other rotor systems. It is momentarily disconcerting but soon ignored. For military operations this is not considered an unfavorable feature, but is not likely to make passengers feel comfortable. By way of comparison, the twin tandem rotor systems are relatively less severe in shaking and the single main rotor systems are the smoothest.

Climb optimum speed is 45 kt. Normal cruise is between 65 and 85 kt. Maximum performance takeoffs can be

VERTICAL STABILIZERS of the H-43B have frangible plastic edges that may be replaced quickly if damaged.

made by using 104% engine rpm., full up collective and considerable forward cyclic stick throw.

Turns during climb, level flight and descent are almost like a fixed-wing aircraft. The same type of coordination between cyclic stick and pedals produces balanced bank and turn, with the ball in the turn and slip/skid indicator in the middle.

Landing Procedure

The landing check is gone over while downwind. Descent is made at a speed of 50 to 55 kt. At about 75 ft. altitude, the flare is begun. For a power-on landing a hover is entered at 5 ft. and the aircraft eased to the ground. A power-off landing involves a flare to about 5 ft. altitude and then nose-down and a landing in a level attitude with some forward speed. This procedure differs from other rotor systems where a nose-high attitude is maintained for power-off landings, with little or no forward speed.

Running landings can be made with power on at 15 to 20 kt.

Generally speaking, the greater stability of the H-43B makes it an easier helicopter to fly. But as mentioned before, a background of conventional piston power training is advisable. The syncropter is so easy to fly that the Navy and Marines stopped using the HTK-1 in their helicopter training program. Kaman pilot Ralph Lee demonstrated nose-high and tail-high maneuvers, lazy eights and other relatively radical aerobatics for helicopters.

Emergency procedures in the H-43B are essentially the same as in piston helicopters. Engine failure on takeoff or in hover will result in hard settling. Action with the collective pitch stick is to increase the setting, the reverse of what would be done at altitude in the event of a power loss.

During climb with forward speed, a normal autorotative landing can be made using the principle of maintaining forward speed until the time to flare. There are minimum flare and maximum flare procedures.

Restart can be attempted in the air as long as the exhaust gas temperature gage reads less than 600C. Restart could take as much as 2,000 ft. of altitude, so emergency landing procedures must be followed. In the event restart cannot be accomplished, the fuel boost pump must be shut off, the throttle turned to cutoff, fuel switch turned off and the battery switch turned off.

Other emergency procedures detail methods of ditching at sea and how to treat various electrical power failures.

Auxiliary equipment of the Huskie includes heating and anti-fogging systems, communications systems and direction finder and lighting.

Of primary importance to the mis-

THE GATEWAY TO THE WEST has become the Gateway to Space. The spirit of St. Louis first turned pioneers westward in a struggle that unlocked half a continent. It nourished the practical dreams of Charles Lindbergh and he opened an ocean and an era. The spirit of St. Louis has now spread through all America, charting the course for a great new American enterprise.

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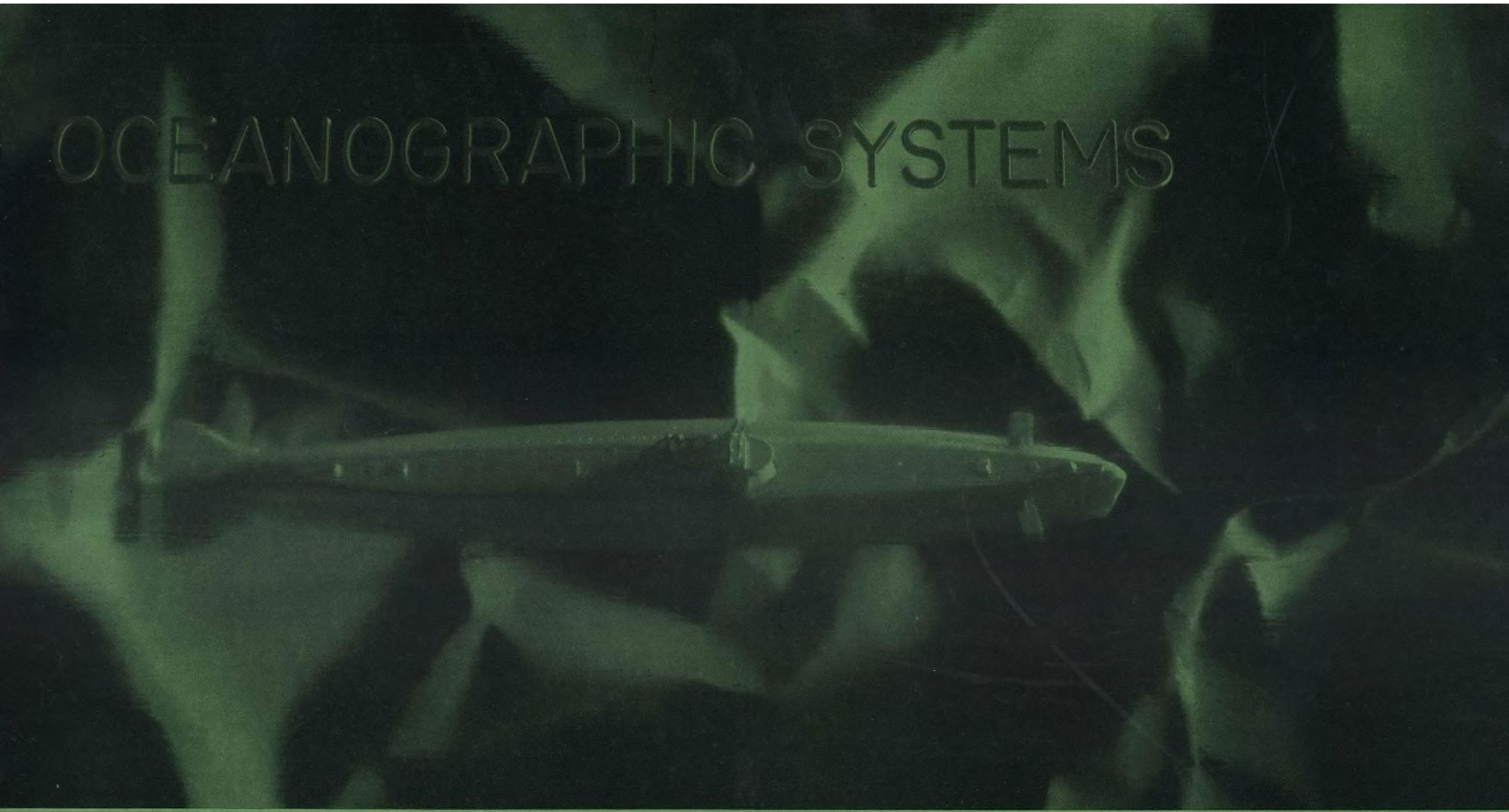

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Oceanographic work at Westinghouse is directed by the Ordnance Division at Baltimore and backed by the Central Research Laboratories at Pittsburgh. Present accomplishments, and the promise of others soon to come, are examples of how science serves Defense at Westinghouse. — Defense Products Group, 1000 Connecticut Avenue, N.W., Washington 6, D. C.

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THE RECALCITRANT SAUSAGE

LEACH HERITAGE OF THE AIR — 18

On his fourth try, coming out of the early morning sun at 3,900 feet, the Belgian again fired at the kite balloon at point-blank range. And still the gas bag would not burst into flame. Instead, the sausage suddenly shot up, as if relieved of a great weight, and collided with the little Hanriot H.D. 1 scout. For a second the plane poised, pivoted on its nose, then the pilot cut his engine as the balloon sagged and sank below him.

In the next instant, the Hanriot plunged over the side, nose first, gathering speed as it fell. As the propeller began to spin, the pilot opened the throttle and gunned his ship for home. The balloon, torn and leaking, fell to earth and exploded in fire.

It was May 15, 1918—the day Willy Coppens, Belgium's greatest World War I ace, scored his fourth and most famous victory. He emerged from the war as Lieutenant Willy Coppens, D.S.O., M.C., with 37 kills, including 26 balloons.

The Hanriot H.D. 1 Coppens flew almost exclusively had one major drawback: it was fitted with only one machine gun, centrally mounted on the fuselage. To compensate for his restricted firepower, Coppens began his career as a balloon buster with 20 precious rounds of incendiary bullets which he obtained from a French source and hoarded by making up an ammunition belt containing the incendiary rounds, each interspersed by three ordinary rounds at the beginning of the belt.

The Belgian ace calculated that 50 yards was the maximum range at which to open fire and that after his approach dive at 125 mph. he had little less than a second to pull up and avoid collision. His victory over the recalcitrant balloon on May 15 cost eight of his prized incendiary bullets, but they soon became plentiful through official channels.

Considered by many pilots a delight to fly and rated second to none for maneuverability, the nimble Hanriot H.D. 1 was powered by a 110-hp. Le Rhone rotary engine. Strong and quite light, the plane was designed with heavily staggered wings. It saw extensive and successful service on the Western and Italian Fronts and a small quantity was manufactured in the United States for the Navy.

Willy Coppens' final victory coincided with his last patrol at dawn on October 14, 1918. After exploding one enemy balloon at 2,400 feet he moved to his next target, which had been winched down to only 900 feet. Just 150 yards from the sausage he encountered a barrage of small-caliber machine gun fire and anti-aircraft and incendiary phosphorus shells. Seriously wounded in the left leg by an incendiary bullet, Coppens headed for his lines five miles away. But one of his Hanriot's induction pipes had been hit and he was forced to land in a small field. The undercarriage collapsed on landing, but Coppens was safe.

The brave Belgian spent months in a hospital, but even the loss of a leg could not keep him out of the sky. Willy Coppens flew again and became a widely known figure in postwar aviation.

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One of the most inspiring chapters in the history of technical evolution is the story of the men and flying machines of World War I. It is the highly personalized story of brave men—and the wood, wire, linen and rudimentary technologies that converted manpower to airpower. Today, Leach Corporation observes its 42nd year in electronics with the presentation of this Heritage of the Air series.

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Kaman Huskie Specifications

Dimensions:	
Span, side to side, with intermeshing rotors operating	51 ft. 5.4 in.
Length, fore to aft, with rotors operating	47 ft.
Diameter of each rotor	47 ft.
Height over rotor tips	15 ft. 6 in.
Height over rotor hubs	12 ft. 7 in.
Clearance of rotor tips from ground on each side	6 ft. 10 in.
Weight data:	
Aircraft basic weight, including 44 lb. of trapped fuel and oil	4,490 lb.
Maximum gross weight	9,150 lb.
Maximum external load (cargo hook)	3,000 lb.
Engine:	
Lycoming gas turbine	T53-L-1B
Shaft horsepower	860
Fuel consumption at sea level cruise, 6,500 lb. gross wt	552 lb./hr.
Performance:	
Maximum speed	103 kt.
Cruising speed	95 kt.
Range at takeoff gross wt. of 8,350 lb.	173 naut. mi.
Service ceiling at 6,500 lb. gross wt	21,150 ft.
Maximum rate-of-climb at sea level at 6,500 lb. gross wt	1,760 fpm.
Hover out of ground effect, sea level standard day	8,350 lb.
Hover in ground effect, sea level standard day	9,150 lb.

sion of the aircraft, however, is the equipment designed to be used in rescue work and carrying of cargo.

The aft cabin deck is equipped with tiedown rings for cargo which can be loaded through rear doors or the side door of the cabin. This aft cabin is 58 in. wide, 92 in. long and 46 in. high. The 10 tiedown rings can be used for litter and seat installations in addition to cargo.

A cargo hook is located at the center of the belly of the aircraft. An external manual hook release permits the ground crew to attach the sling to the hook. The load can be released automatically by a weight-sensing device which releases the load when the weight carried drops below 75 lb. as it would when the load is deposited on the ground. It can also be released manually by the attendant.

In the normal rescue configuration there are two litters and an attendant's seat installed in the aft cabin.

A rescue hoist is so installed that anything raised by it can be brought aboard through the aft cabin side door. The hoist is electrically operated and equipped with 100 ft. of cable. The cable feeds off the drum through a pulley mounted to a rigid tripod. A safety latch hook is attached to the cable by means of a damper which reduces shock loads, both to the helicopter and to personnel being rescued.

When the cable is fully up or down, limit switches automatically stop the motor. An automatic brake holds the cable in any position where it is stopped.

If the cable should become entangled with ground objects or in any other way snarled, a pilot-controlled guillotine cable cutter can be used to separate it from the aircraft. Up and down switches are provided on the pilot's cyclic stick and for the hoist operator on the attendant's grip. The pilot's control overrides the attendant's control in the event of an emergency.

There are two essential packages available for the local rescue mission, a rescue tool kit and a fire-fighting equipment outfit. The tool kit is carried in a cotton duck tool roll which is secured by straps to the aft wall of the forward cabin compartment. The kit contains a hatchet, V-blade knife, cable saw, keyhole saw, lineman's pliers, an assortment of eight screwdrivers and safety pins. A crash rescue first-aid kit is mounted on the back of the pilot's seat.

The fire-fighting equipment consists of a mechanical foam-type extinguisher, with insulating blanket and heater-trailer. It is equipped with a sling that can be engaged with the helicopter cargo hook described above. The heater is used to prevent freezing of the extinguisher during alert times at an airbase. The insulating blanket is used to reduce heat in hot weather.

The gross weight of the extinguisher is 1,000 lb. It is 5 ft. long, 4 ft. wide and 3½ ft. high. It consists of a tank filled with water and foam fluid combined, a nitrogen tank and a hose with a nozzle. The compressed nitrogen is used to pressurize the tank through a pressure reducer, forcing the fluid through the hose and nozzle.

On reaching the atmosphere, the fluid expands to eight times its normal volume, permitting the 83 gal. of mixture to yield 690 gal. of foam. The discharge can be varied from a narrow to a wide stream by rotating the nozzle control. The discharge lasts 50 sec. or more.

The heater-trailer unit is for ground use only. Tiedown straps are released when the extinguisher is carried aloft.

One of the more spectacular rescues performed by the H-43B took place at Larson AFB, Wash., when a Boeing B-52D crashed and burned on landing following an aerial refueling mishap. The helicopter beat back smoke and flames selectively so that ground firemen could effect a rescue.

In a different situation, a Huskie was sent to the site where a B-52 crewman had bailed out over a forest in Massachusetts. The helicopter hovered over 100-ft. trees and lowered a medic through the trees, using the helicopter's entire cable length, so that the injured man could be treated until ground rescue parties could reach him.

In another instance three boys were rescued from a cliff in Arizona.

The following records are held by the H-43B:

- **Altitude** for Federation Aeronautique Internationale E1D (medium-sized) helicopters; 32,840 ft., set Oct. 18, 1961. Certified by FAI.
- **Altitude with 1,000 kilogram load;** 26,369 ft., set May 25, 1961. Certified by FAI.
- **Time to climb** to 3,000 meters; 2 min. 44.5 sec. To 6,000 meters; 6 min. 42.3 sec. To 9,000 meters, 4 min. 11.5 sec. All awaiting certification.

Lockheed C-130E Meets Guarantees

Early flight tests of the Lockheed C-130E Hercules, designed to give transatlantic airlift capability with a 13½-ton payload, show that it meets performance guarantees, Lockheed-Georgia Co. reports.

First delivery is scheduled for April this year. The C-130E weighs 155,000 lb. compared with the 135,000 lb. gross weight of the current production model C-130B. Much of this weight increase comes from two external fuel tanks.

Powerplants for the C-130E are advanced Allison T56 turboprop engines driving Hamilton Standard Hydromatic propellers of 13.5 ft. dia.

At takeoff gross weight of 155,000 lb., Lockheed says, the Hercules will have a takeoff ground roll of 4,250 ft. It will climb out at 1,500 fpm. initial rate of climb on four engines, or at 750 fpm. on three. Four-engine service ceiling is 22,600 ft.; for three engines, it is reduced to 13,500 ft. Cruise speed at 20,000 ft. is 341 mph.

More than 100 of the C-130E model aircraft have been ordered by USAF.

TYPICAL OF THE ROOFTOP HELISTOPS in Los Angeles is this one on the roof of the Statler-Hilton Hotel. (See arrow.) Helicabs, a helicopter taxi service, has exclusive rights to landing pad which is large enough to accommodate only one helicopter at a time. Similar landing pads are being programed into the planning of many of the major buildings under construction in metropolitan Los Angeles.

Los Angeles Helicopter Utilization Grows

By William S. Reed

Los Angeles—Eighteen per cent of the nation's helicopters are based in the sprawling, traffic-congested Greater Los Angeles area and the probabilities are that this ratio will rise in the next few years.

The 6.5 million people living within a 25-mi. radius of the city center own 3.7 million automobiles, and the resultant highway traffic congestion makes an ideal situation for helicopter utilization.

Large corporations make use of helicopters primarily for transportation of key executives from corporate headquarters to other divisions located in outlying areas. The largest number of heliports for company use are owned and operated by North American Aviation, Inc., which has 10.

Transport of key personnel from the corporate offices at Los Angeles International Airport to the Rocketdyne Division and the General Atomics Division in Canoga Park takes only 17 min. for a 22-mi. trip. The same trip could take 1¼ hr. by automobile depending on the time of day. Travel time and distance to other North American divisions such as Autonetics in Anaheim is even greater, making use of a helicopter more advantageous.

Northrop Corp. has four heliports, Hughes Aircraft Co. three and Douglas Aircraft Co. two. Three hospitals in the area have helicopter landing facilities and an application was filed with the city council recently for operation of a helicopter ambulance service. Total number of heliports in the area, including the 13 owned and operated by Los Angeles Airways, the helicopter airline, is 52. In addition to the 52 heliports, there are 16 airports in the area at which helicopters can land.

A big boost to the utility of helicopters in the Los Angeles area would be the establishment of a large downtown heliport. The Helicopter Committee of the Los Angeles Chamber of Commerce's Aerospace Department recently surveyed 14 possible sites in the downtown area and nearly settled on one very likely prospect, a municipally owned parking lot near the city center.

After consideration of the parking lot site, however, the county administrator rejected the plan on the basis that it would create a noise problem and would cost valuable parking space which already is at a premium. Also a consideration is that the county realizes about $40,000 per month in revenue from the lot. Several other sites now will be investigated including reconsideration of some of the other sites studied in the original survey. Strong support for a public downtown airport is assured from high city and county officials who believe it is essential.

Construction of a minimum-cost heliport would require fencing off the parking lot area and eliminating 270 parking spaces.

Such a downtown heliport would definitely enhance the passenger market for Los Angeles Airways which connects 13 mail and passenger stops with Los Angeles International Airport. Los Angeles Airways has one downtown stop now, located atop the Post Office building, but this serves only for the pickup and delivery of mail and cannot handle passengers.

The helicopter airline so far has not been a big factor in the solution to the airport commuter problem, largely because of the amount and capacity of the equipment operated. Los Angeles

A new science-technology supports decision-making on a global scale. How do you control world-wide forces when decisions must be made in minutes or seconds, based on huge amounts of information, which in turn must be literally up-to-the-second? Decisions of this scale are made possible by a new science-technology: systems that provide information processing assistance for military and governmental leaders.

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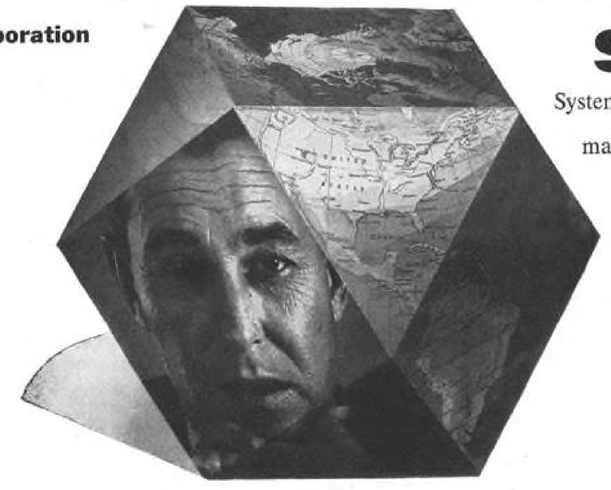


DECISION-MAKING ON A GLOBAL SCALE

DYMAXION PROJECTION BY R. BUCKMINSTER FULLER 11-234A

Airways has operated Sikorsky S-55s and an S-62 on its routes and, while it leads in pounds of mail carried and in mail revenue collected, it has fallen far short of New York Airways and Chicago Helicopter Airways in the number of passengers carried. Figures show that for 1960, Chicago Helicopter Airways carried 309,269 passengers and New York Airways carried 146,775 passengers, while Los Angeles Airways carried 39,184 passengers. However, the Los Angeles line carried four times as much mail as the Chicago operator and three times as much as New York Airways. Figures for 1961 through the third quarter show a similar trend but the picture for 1962 appears to be quite different.

In December, 1961, Los Angeles Airways took delivery of its first 28-passenger, twin-turbine Sikorsky S-61L. The second was delivered in January and a third aircraft will be delivered this month. A fourth S-61 will be delivered in April and a fifth will be delivered at some future date.

With the carrying capacity and extra speed of the S-61, the Los Angeles line calculates it can begin to accommodate some of the traffic which heretofore has been largely ignored because of a lack of capacity.

Arrival of the S-61s here seems to have generated some problems which were not foreseen earlier. Los Angeles Airways has been delayed in putting the big helicopters into service primarily because of the need to satisfy government regulatory agencies as to the suitability of operating methods and heliport facilities. Not only were the machines delayed in arriving here—the line expected to put them into service last summer (AW Apr. 10, p. 42)—but other obstacles such as the question of facilities has delayed introduction into service.

Further exploitation of the helicopter's usefulness undoubtedly will occur when a convenient, large downtown heliport is available for the use of both small, privately owned machines and the large commercial craft operated by the helicopter airline.

More than one such heliport is needed within the area, however, because Los Angeles does not have a central marketing area as exists in New York and Chicago. Even so, construction of a heliport in the downtown area would spur helicopter usage, and public heliports in outlying marketing areas will follow as a natural course, city planners believe.

Nonscheduled helicopter taxi service is available in the Los Angeles area between downtown rooftop helistops and International Airport as well as other area airports and approved landing areas. By telephoning a central switchboard, arrangements can be made for pickup and delivery at a specified time

BELL 47J HELICOPTER maneuvers for a landing on the rooftop helipad of the recently completed Signal Oil Building in downtown Los Angeles. Building is 16 stories high and typifies the Los Angeles skyline. Flying time to International Airport is 9 min. Travel by surface transportation takes 30 to 45 min. for the 20 mi. trip.

by Helicabs, Inc. Fares are close to those charged by taxicabs. Time, of course, is the advantage Helicabs offers, particularly for trips between downtown hotel locations and International Airport.

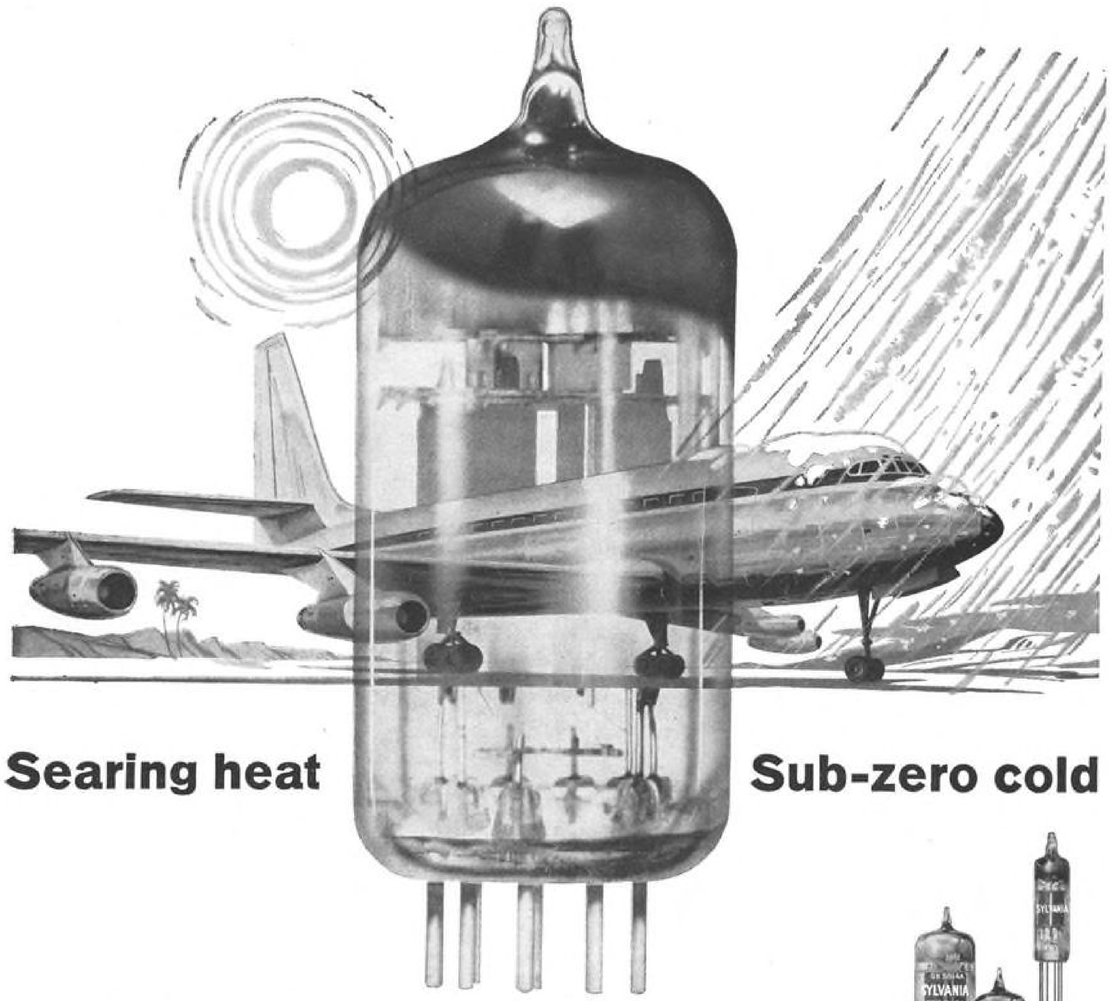
First commercial rooftop helistop was erected by Helicabs owner Bruce McNeil who has provided his own financial backing for the venture through McNeil Construction Co. McNeil's early efforts to obtain permission from the city for building a rooftop landing site met with skepticism, if not open disapproval, he said.

Examination of city ordinances disclosed that helicopter operations are permitted in industrial zones and McNeil determined that part of the centrally located Pacific Electric building was within such a zone. Construction of a heliport atop the Pacific Electric building was approved in accordance with fire department regulations and Helicabs started service in February, 1960.

Since then, McNeil has constructed four other helistops and has more in the planning stage. Downtown rooftop sites are located on the Biltmore and Statler-Hilton hotels. Another site is located on the front lawn of the Ambassador Hotel and the most recent site, opened in December, is on the roof of the Arroyo Seco Building in Pasadena.

Each of the rooftop sites, and the lawn landing pad, were built by McNeil without cost to the property owners. In return for his estimated $50,000 investment in a rooftop site, McNeil gets exclusive rights to use the pads for the operation of Helicabs. The company operates four Bell helicopters.

Economics of the operation are a long way from earning a profit. On a typical day at about 10 a.m., the flight schedule showed 17 flights booked for a total of 19 passengers, indicating a low load factor. Traffic now is about 500 passengers per month, a figure which McNeil says will rise to 1,000 per month within a year. He also expects that, as



Searing heat **Sub-zero cold**

...vital factors in avionics reliability!

Communications, navigation equipment must withstand widely varying aircraft and warehousing environments. Equipment reliability can be adversely affected by temperature-sensitive components.

Not so with the extraordinary electronic vacuum tube! It exhibits unusual tolerance to temperature extremes. Matter of fact, Sylvania GB Gold Brand Tubes for business-commercial aviation are life-tested for 500 and 1000 hours under high ambient temperatures as part of standard Sylvania testing procedures. They are designed to withstand bulb temperatures to 165°C. In addition, they tolerate shock of 500g, maintain high stability throughout life, offer exceptional uniformity and ease of interchangeability.

If avionics equipment reliability concerns you, be specific about the components you use. Make certain they are superior-quality electronic tubes—look for the Sylvania GB Gold Brand markings on the tubes. A complete list of GB Gold Brand types, and prototypes, is yours for the writing. Electronic Tubes Division, Sylvania Electric Products Inc., 1100 Main St., Buffalo 9, N. Y.

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the service catches on, the load factor will increase and fewer non-revenue flights will have to be made as the necessity for deadheading decreases.

McNeil foresees no great boom in the number of helicopters operating in metropolitan Los Angeles in the immediate future.

Costly Operation

Three factors dictate a slow growth in the use of helicopters as they now are being used, McNeil states:

• **High cost of equipment.** The Bell J-2s and Hs used by Helicabs enter service at about $84,000 apiece. Added to this is the cost of engine overhauls, component replacement and direct operating costs for 1,000 hr. per year flying time.

• **High cost of insurance.** Hull insurance rates amount annually to about 14-16% of the value of the aircraft. This amounts to about $1,000 per month for each of the operating helicopters and the rate is comparable to insurance on a crop duster which operates on a much more hazardous mission. In addition, liability insurance is high as is passenger insurance.

• **High cost of personnel.** Helicopter pilots operating over urban areas must have a high degree of competency and proficiency. Subsequently, the highly skilled pilots and maintenance personnel required for safe operations can command high wages.

McNeil, nevertheless, plans to continue Helicabs and expand his service ultimately to a fleet of 10 helicopters. The success of the rooftop pads constructed so far has persuaded designers of new structures to include rooftop pads in their plans. Two new buildings now being constructed in the Los Angeles Wilshire district will have rooftop helicopter landing pads. The efficiency of helicopters in avoiding downtown traffic is beginning to be utilized now by businesses such as banks and department stores to bring the day's receipts to a central location to facilitate billing and other clerical functions.

Charter Operations

Mercury Helicopter Service, operating out of Torrance Airport, 18 mi. south of the city center, is one of the better known charter operators in the Los Angeles area. Mercury numbers 56 clients including aerospace companies, construction companies, oil companies, banks, department stores, federal, state and local government agencies, movie studios and food markets.

The clients have contracts with Mercury which specify a minimum amount of flying time annually and they are billed at a lesser hourly rate than the one-time customer who is charged from $100 to $130 per hour, depending on the type helicopter.

JetStar Joins Canadian Transport Fleet

Lockheed JetStar utility aircraft is undergoing a shakedown period in Canada as a prelude to its being phased into the Canadian Department of Transport fleet. Aircraft will be used in evaluating navigational radio aids at high altitudes and setting traffic-control procedures.

Mercury so far has only one downtown stop located atop the newly completed Signal Oil Co. building. An agreement exists with Signal giving Mercury exclusive rights to the landing area, an arrangement which was effected because Signal was Mercury's client before the building was erected. Two more sites soon will be available to Mercury in the Wilshire district following the completion of two multi-storied office buildings. Mercury will not use these sites exclusively but will share them jointly with other operators.

Mercury was founded in October, 1958, by James W. Gavin. The company went through a period of barnstorming much like that which occurred in the early days of aviation. Stunts such as the delivery by helicopter of Santa Claus or a local television clown were standard fare. Gavin says he has done his share of these stunts but considers them undesirable in a long-range business outlook. Gavin says he became increasingly worried about operating helicopters in places like supermarket parking lots where groups of children would be likely to crowd close to the aircraft. One accident resulting from this type of operation might have ruined the company financially in addition to creating adverse publicity for the helicopter industry. Mercury gave up and continues to refuse any charter work in the nature of barnstorming.

One of Mercury's helicopters, a supercharged Bell 47-G, is operating in New Mexico under contract to Northrop's Radioplane Division. Under a contract guaranteeing 60 hr. per month, the Mercury Bell was employed to retrieve Radioplane drones used for target practice on the Army's White Sands range. The drone retrieval program turned out well and the helicopter has been employed on other missions such as supplying personnel located in high mountainous terrain where surface transportation is very difficult.

Motion picture companies are providing more work for Mercury as the success of one film operation seems to generate more ideas for the use of helicopters. A typical charter will be for Mercury to take the part of a Russian helicopter in a forthcoming movie. This will necessitate painting the helicopter a dull green and emblazoning a red star on the fuselage.

Not only will the helicopter be used as a prop in the movie but it also will be used as a platform for photographing aerial sequences.

Motion picture photography from helicopters formerly was not too successful but the development of new blades which reduce low-frequency, high-amplitude vibrations makes aerial photography much more practical.

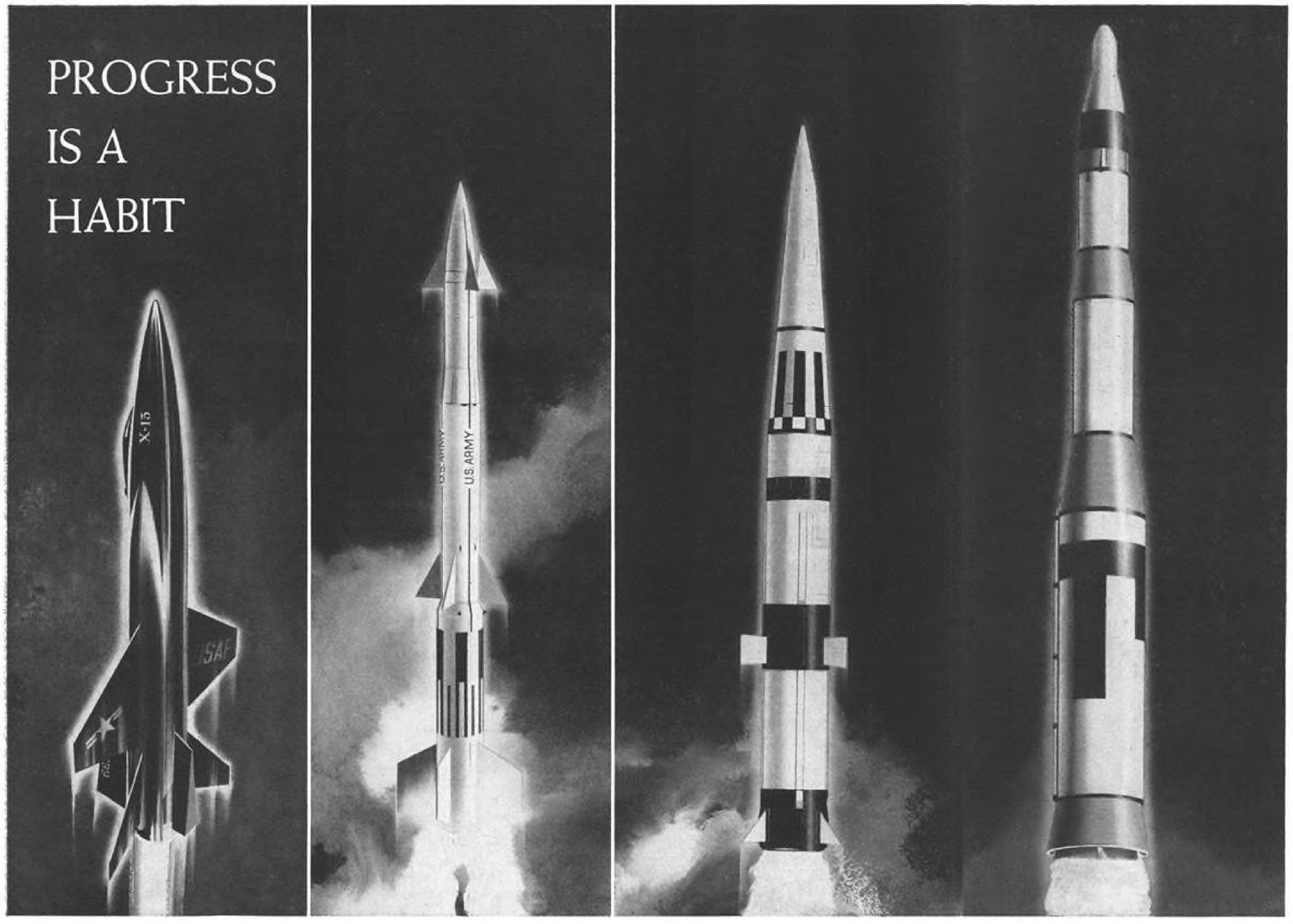
Approach Techniques

Mercury's chief pilot, Peter K. Pascal, with whom this AVIATION WEEK reporter rode from atop the Signal Oil Building to Mercury's Torrance headquarters, discussed the methods of rooftop operation and some of the hazards extant in it. Two types of approaches are used in rooftop landing, although there seems to be no variation in takeoff technique.

• **Slow, easy approach** using considerable power.

• **Fast approach** made with considerably less power.

Each of the above methods has its



X-15 NIKE-ZEUS PERSHING MINUTEMAN

Repeatedly successful in flight...giant strides in the race for space

With frequency and regularity bordering on the monotonous, propulsion systems from Thiokol powering these major U.S. missiles have been meeting objectives in flight tests... current and past. ■ Since March of 1959, the XLR-99—most powerful man-rated rocket engine in the world—has been carrying man to heights and speeds never before attained by piloted aircraft. Each excursion into the near reaches of space has added another notch to the progress of manned flight, and knowledge for future application. Its latest triumph: exceeding the 4000 mph design. ■ Hurled into space by the most powerful solid rocket engine of known flight record—450,000 lbs thrust—Nike-Zeus shows rapidly increasing promise as America's anti-missile missile. The first stage propulsion system was developed and is built by Thiokol who is now also producing the new high energy Zeus second and third stage.

Thiokol

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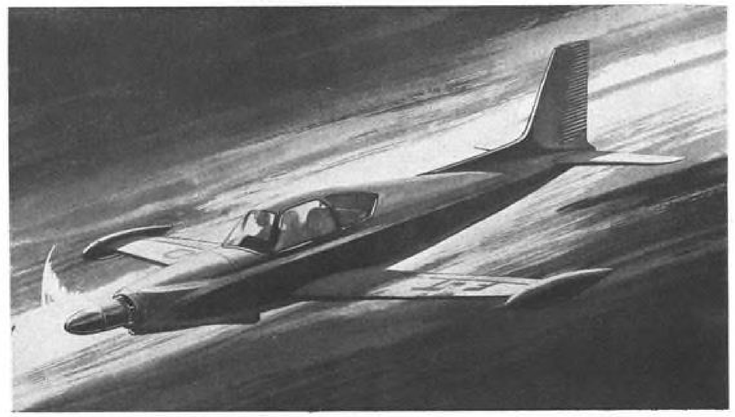
Thiokol's production maturity has given the military highly reliable Pershing and Minuteman—at budget-paring low cost. Minuteman boasts the largest single solid rocket motor ever flown. Recent performance ranks Pershing as the Army's most significant solid-fueled artillery weapon.

FIRST IN
ROCKET PROPULSION



French Design Turboprop-Powered Lightplane

Currently in production, the four-seater Antelope (note artist's conception), is being built by SIPA, a private French airframe manufacturer. SIPA 251 Antelope is powered by a single Turbomeca Astazou 11 560-hp. turboprop. Aircraft will have a cruising speed of 264 kt. and a range of 1,025 mi. First flight of the aircraft is scheduled for this spring.

advantages but both of them require considerable technique. The first, favored by Pascal, provides the advantage of probing the wind currents which may behave oddly in the vicinity of tall buildings. With this method, there is only a brief moment when it is problematical whether or not the machine will land on the roof or in the street if the engine fails at an awkward time. Should it fail before reaching the roof, sufficient altitude usually will be available to effect some lift from the rotors before ground contact.

The fast approach is adopted by some pilots because it can be made nearly power-off in the event of engine failure. It has the disadvantage of not allowing the pilot to feel out the prevailing wind currents in the landing area. Conflicts between proponents of the two methods remain unresolved since it is largely a matter of individual preference. Main hinge of the debate is the possibility that an engine failure might occur at precisely the wrong moment allowing the helicopter to strike the side of the building or only a portion of the landing pad, although such an accident has not occurred in Los Angeles.

A public service, possible only through use of the helicopter, is provided by a local radio station here which provides traffic reports to motorists during peak traffic hours.

Operating under the name of Airwatch, the helicopters take to the air each morning from 6:50 to 9 a.m. and again from 4:50 to 6 p.m. On days when traffic is heaviest, Monday morning and Friday evening, Airwatch uses two helicopters to report Freeway conditions and other surface traffic. Helicopters carry the normal VHF radio gear with which they communicate with controls towers and Airway Traffic Control plus a receiver tuned to the police broadcast band and to the local radio station. On cue from the station controller, the helicopter pilots broadcast reports directly. Reports generally consist of Freeway traffic information along with advisories on where alternate routes should be taken.

Effectiveness of the helicopter traffic reports can be observed readily. On a recent Friday evening, heaviest traffic time for the Freeway system, this AVIATION WEEK reporter rode with Airwatch's Herb Green to observe and report traffic conditions and possible effects of the aerial surveillance. Effect of the traffic advisories is observable, Green says, reporting that on numerous occasions when jams have resulted from accidents, he has observed motorists turning off the Freeways seeking the alternate routes suggested by him.

Airwatch also has rendered other public services. A prime example was the spotting of the Bel Air fire disaster last November. The first wisp of smoke was observed shortly before 8 a.m. while one of the two Airwatch Bell 47Hs was on routine traffic patrol. The alarm was turned in to the radio station immediately. Airwatch's helicopters then flew members of the police and fire departments on surveys of the fire area.

Airwatch flies its two Bells 120 to 150 hr. per month and recorded one high of 157 hr./month. Included in this total is a small amount of promotional flying which is devoted to transporting radio, television and motion picture personalities. Charges for the flying time average out to what apparently is an average in the area—$85 per hour. This cost does not, however, reflect a profit factor because the radio station and Airwatch are jointly owned.

BEECH MODEL 80 QUEEN AIR features more powerful engines, higher cruise speed and increased gross weight over predecessor.

Beech Increases Queen Air Power, Speed

By Erwin J. Bulban

Wichita, Kan.—More powerful, heavier and faster version of the six-to-nine-place Beech Queen Air twin-engine executive transport has been certificated by Federal Aviation Agency and is now being unveiled to the company's distributors, dealers and customer prospects. Aircraft is being taken on a cross-country tour beginning in mid-March with a trip to the Dallas, Tex. area.

Basic Model 80 Queen Air will cost $135,000 compared with previous cost of the aircraft of $126,000. The Model 80 is now the highest price airplane in the Beech line—the model G18S is selling for $132,000.

The new Model 80 Queen Air—so designated because of its 8,000-lb. gross weight—features the use of improved Lycoming geared and supercharged fuel-injection IGSO-540-A1A engines rated at 380 hp. for takeoff compared with the earlier Model 65's 340-hp. Lycoming IGSO-480-A1B6 powerplants. Even on the basis of a 300-lb. gross weight increase, the new engines provide this latest airplane with a cruise speed of 226 mph. at 65% power and 2,750 rpm. at 16,800 ft. and speed of 212 mph. at 65% power using 2,600 rpm.

Significant points about the new airplane include:

• **Cruise speed 12 mph. faster** than the Model 65 can be achieved at 65% power while burning only one additional gallon of fuel per hour. Accurate fuel management is possible through installation of a Bendix fuel injection system with both automatic and manual mixture control and fuel flow meters. The system consists of a regulator to measure air flow by means of a Venturi tube. The regulator is actuated by the differential pressures in the Venturi to regulate fuel flow in correct proportion to the air flow through the tube. The automatic mixture control maintains constant fuel flow with constant air mass flow regardless of outside temperature and altitude. The manual mixture provision permits maximum economy and range operation.

• **Stall speed is 80 mph.,** same as the lighter Model 65. This was achieved largely by reducing the air gap between the flaps and wing trailing edges, improving air flow over the surfaces.

• **New swept vertical tail,** 6 in. taller and 4 sq. ft. larger in area, makes possible the same minimum control speed of 95 mph., even though the power is increased. Longer tail arm and larger area provides more effective rudder. Vertical surface actually is a scaled-up Baron tail, providing the Beech "family line" identification.

• **Powerplant improvements** over the Lycoming IGSO-480-A1B6, in addition to the 40-hp. increase, which was accomplished largely by increasing the stroke approximately a half-inch, include use of a heavy-duty No. 30 propeller spline, improved main and rod bearings, shell-molded cylinder heads, additional bearing support for the supercharger idler gear and Inconel exhaust valves for improved service life. Basic weight of the IGSO-540-A1A is 60 lb. heavier than the Model 65's powerplant. Engine also includes Bendix Scintilla low-tension magnetos and all-weather spark plugs providing better high-altitude performance and longer spark plug life.

Airframe is basically the same as the earlier Model 65, which the company states will be retained in the product line along with the new Model 80, but some clean-up is evident as a result of building the additional tooling required for Model 80 production.

Both vertical and horizontal tail surfaces utilize smooth skins compared with the Model 65's grooved skins and some larger skin panels are used on the model fuselage to reduce the number of rivets.

Grooved, or beaded, skins were eliminated in the horizontal stabilizers by use of honeycomb bonded stiffeners to handle loads formerly taken up by the ribless stabilizer's beaded skins.

Honeycomb bonding technique for airframe components was used extensively by the company in making up wing of its new four-place Musketeer and its appearance in the stabilizer of the new Model 80 Queen Air is a further indication that its use can be expected in additional applications on the company's aircraft in the future.

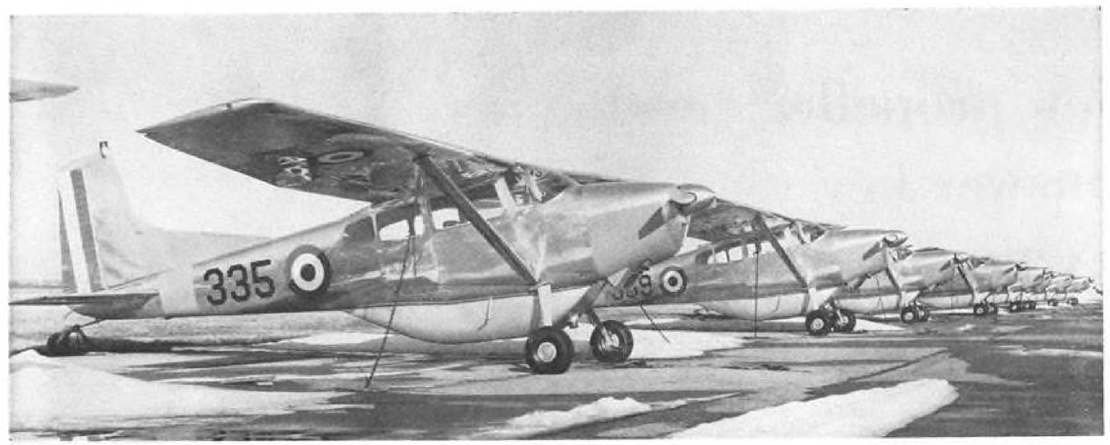
Beech Model 80 Queen Air

Weights:	
Gross weight	8,000 lb.
Maximum landing weight	7,600 lb.
Empty weight	4,800 lb.
Passengers, luggage, oil and 180 gal. fuel	2,024 lb.
Loadings:	
Wing loading	28.9 lb./sq.ft.
Power loading	11.1 lb./hp.
Dimensions:	
Wingspan	45 ft. 10.5 in.
Over-all length	35 ft. 3 in.
Height to top of fin	14 ft. 8 in.
Performance [1]:	
Maximum speed at 11,500 ft	252 mph.
Cruise speed (70% power—2,750 rpm.) At 15,000 ft	230 mph.
Cruise speed (65% power—2,600 rpm.) At 15,000 ft	212 mph.
Cruise speed (45% power—2,400 rpm.) At 15,000 ft.	189 mph.

Cruise Range:	180 gal.	230 gal.
At 70% power at 10,000 ft	710 mi.	965 mi.
At 70% power at 5,000 ft	715 mi.	965 mi.
At 65% power at 10,000 ft.	785 mi.	1,070 mi.
At 65% power at 5,000 ft	800 mi.	1,070 mi.
At 45% power at 15,000 ft	925 mi.	1,295 mi.
At 45% power at 10,000 ft	960 mi.	1,320 mi.
At 45% power at 5,000 ft	990 mi.	1,330 mi.

Rate of Climb at Sea Level:	
Two engine climb at 8,000 lb.	1,500 fpm.
One-engine climb at 8,000 lb. (Max. continuous power)	275 fpm.
One-engine climb at 8,000 lb. (takeoff power)	335 fpm.
Service ceiling—two-engines at 8,000 lb.	29,100 ft.
Service ceiling—one engine at 8,000 lb	12,500 ft.
Stall speed (zero thrust), gear and flaps down 30 deg.	77 mph.
Stall speed (zero thrust), gear and flaps up	95 mph.
Takeoff distance (20-deg. flaps), ground run.	1,060 ft.
Takeoff distance (20-deg. flaps), over 50-ft. obstacle.	1,450 ft.
Landing distance (30-deg. flaps), ground run.	1,160 ft.
Landing distance (30-deg. flaps), over 50-ft. obstacle.	2,070 ft.

[1] Unless otherwise noted, performance is based on "average gross weight," with half fuel tanks. Data formerly was based on full gross weight. Exception is "landing distance," which considers maximum landing weight of 7,600 lb.



Cessna Skywagon Fleet Delivered to Peru

Peruvian Air Force has taken delivery of nine Cessna Skywagons to be used in the nation's back-country development program. Peru also has purchased two Model 320 Skyknights. Skywagons are equipped with cargo packs for increased carrying capacity.

PRIVATE LINES

Federal Aviation Agency has scheduled a second series of regional conferences to discuss proposed changes in general aviation operating rules with pilots and aircraft operators. Initial series of 88 meetings across the nation was conducted last October. Second round of meetings will begin in April. The first will be held Apr. 13 at Fairfax Airport, Kansas City, Kan. Others will be Apr. 18 at Anchorage, Alaska; Apr. 19 at Atlanta, Ga.; Apr. 24 at Washington D. C.; Apr. 26 at Honolulu, Hawaii; Apr. 28 at Ft. Worth, Tex.; Apr. 28 at Van Nuys, Calif.; and Apr. 30 at Harrisburg, Pa. FAA will present proposed rules changes at the meetings and ask for comment.

Contract for the development of a lightweight altitude radar beacon for general aviation aircraft has been awarded Transco Products, Inc. Los Angeles, Calif. The beacon will be capable of automatically reporting altitude in 500-ft. increments from 1,000 ft. below sea level to 15,000 ft. MSL and at a maximum range of 100 mi. The equipment will weigh about 5.5 lb. A similar contract has been awarded Hazeltine Corp., Great Neck, N. Y. (AW Feb. 19, p. 93).

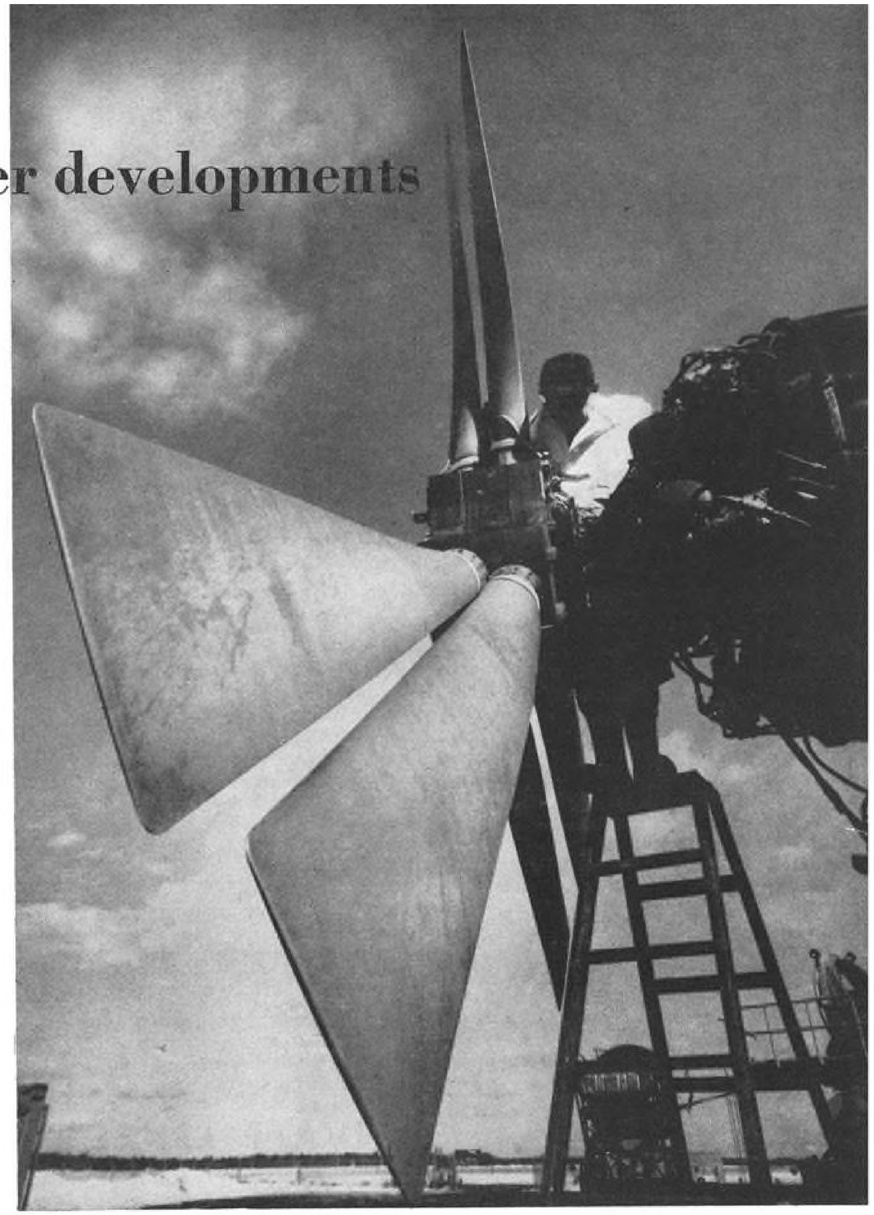
Piper Aircraft Corp. reported $6,900,838 sales for the first quarter of Fiscal 1962, ending Dec. 31. Net income after taxes was $95,144 or 9 cents per share. Sales for a similar period of FY 1961 amounted to $7,000,628 and net income after taxes was $257,153 or 24 cents per share. Unit sales for the quarter were 572 as opposed to 402 for 1961.

Twelve production line positions have been assigned for 1121 Jet Commander executive aircraft being developed by Aero Commander, Inc. Four distributors have placed orders for demonstrator models of the 6-8 place turbojet. First deliveries are planned for late 1963.

Full year warranty is being guaranteed on all new Aero Commander aircraft by Aero Commander, Inc. The warranty has been established, the company said, because quality control procedures have increased the service-free operating time of the aircraft.

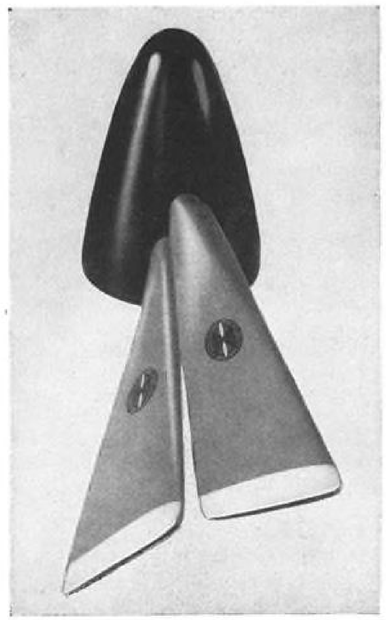
Hydro-Electric Power Commission of Ontario, Canada, has taken delivery of a Sikorsky S-58 helicopter to aid in the construction of a 50-mi. power line through bush country of northern Ontario. Only a small portion of the right of way is accessible by road.

5 New propeller developments to answer key VTOL problems

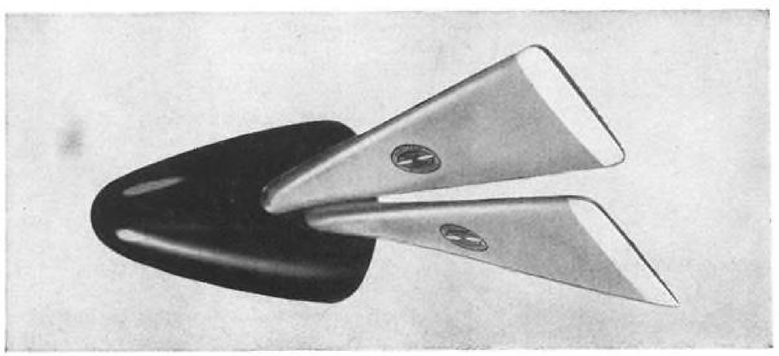


1. The variable-camber propeller, now under development for the Navy, combines capabilities of both a high- and low-lift airfoil to meet high takeoff thrust requirements without sacrificing cruise efficiency. By differentially changing the angle of paired blades mounted on a common hub, the variable-camber propeller provides an ideal solution to a classic problem of VTOL flight: the need for high takeoff lift *and* efficient cruise capability of the propulsion system.

Present studies show the variable camber propeller could make possible a number of major performance increases for varied types of future aircraft.

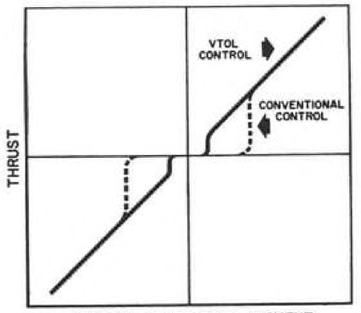


FOR TAKE OFF AND LANDING, blade angles are adjusted differentially so that each pair of blades simulates a high-camber surface for maximum thrust.



FOR CRUISE, the paired blades automatically position to act as individual, low-camber surfaces for maximum efficiency.

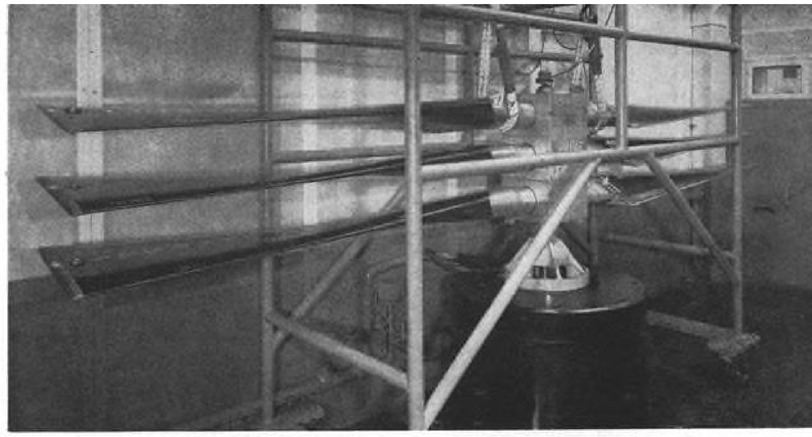
2. An advanced redundant control system, with self-contained, separate hydraulic systems, components, and stand-by master controls, is also under development. This system will provide a whole new level of reliability and sensitivity through critical VTOL operations—lift-off, landing, and transition to forward flight.



SENSITIVITY COMPARISON of VTOL and conventional propeller controls.

3. Shrouded propeller versions of the variable camber and conventional blade propellers are presently in advanced stages of study at Hamilton Standard. For VTOL and other aircraft applications, shrouded propellers with 30% smaller blade diameters will deliver performance equivalent to free propellers with conventional size blades. Resulting size and weight savings meet VTOL requirements for compact system configurations.

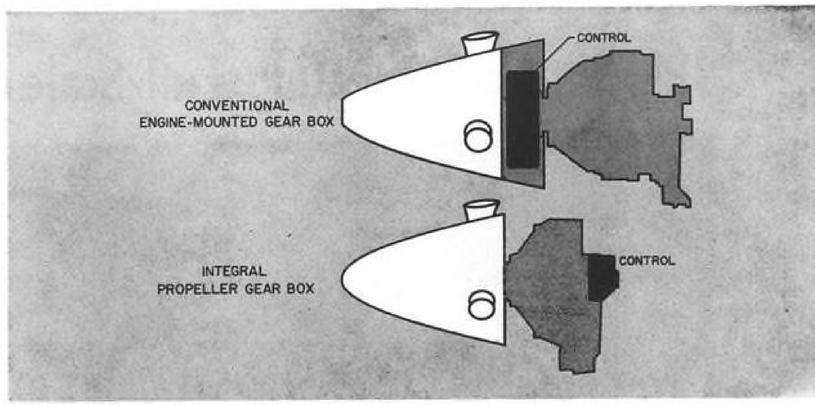
SHROUDED PROPELLER, as part of intensive Hamilton Standard test program, undergoes high-speed wind tunnel tests.



FULL-SCALE lightweight blades receive extensive fatigue tests at Hamilton Standard.

4. New Lightweight blades, under development for the variable camber and conventional propellers, consist of a primary load-carrying steel spar and a fiberglass shell. The proven tubular steel spar design approach permits a high strength-to-weight ratio; while the fiberglass cover provides a minimum weight airfoil, easily tailored to any specified blade planform.

In VTOL applications, for example, this blade design will reduce propeller weight by as much as 25%, and will permit a significant decrease in over-all aircraft weight with correspondingly improved performance.



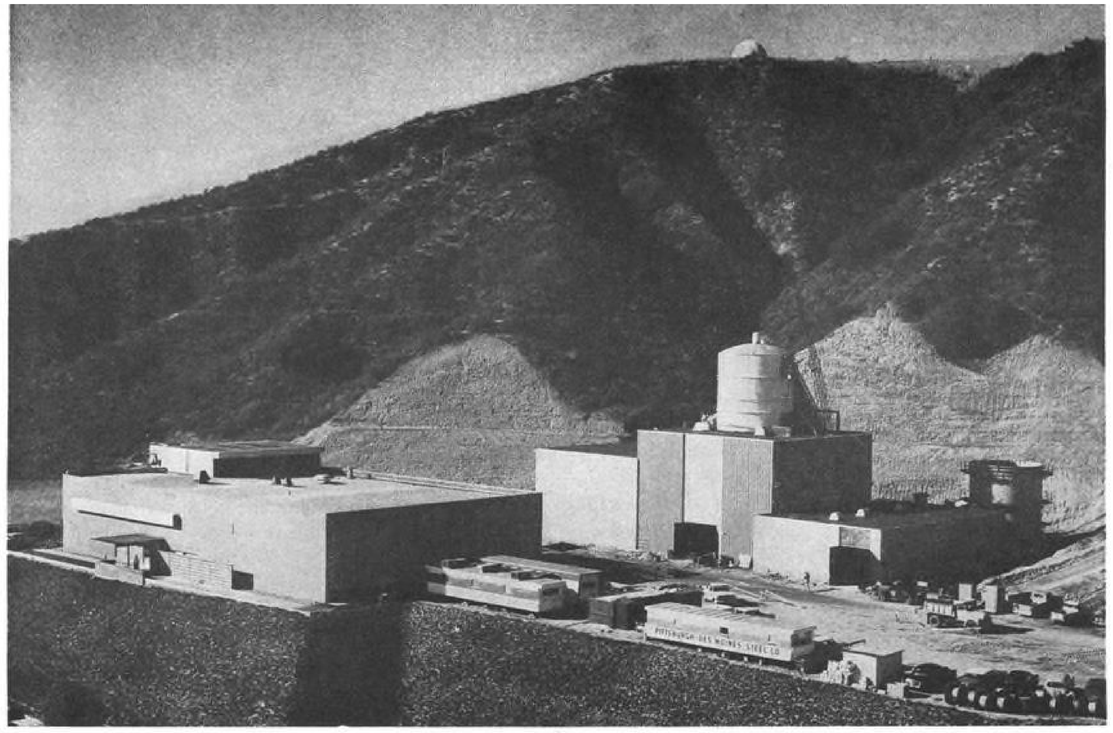
INTEGRAL GEAR BOX propeller installation eliminates duplicate housings and other components, achieves a 15-20% reduction in the combined propeller and gear box weight. Permits considerably more compact configurations for VTOL aircraft.

5. A weight-saving integral gear box, which combines engine reduction gearing and main propeller controls within the propeller assembly, is also being developed under Navy contract. The integral gear box will simplify gearing in any propeller application and provide important weight savings in VTOL and other advanced aircraft designs.

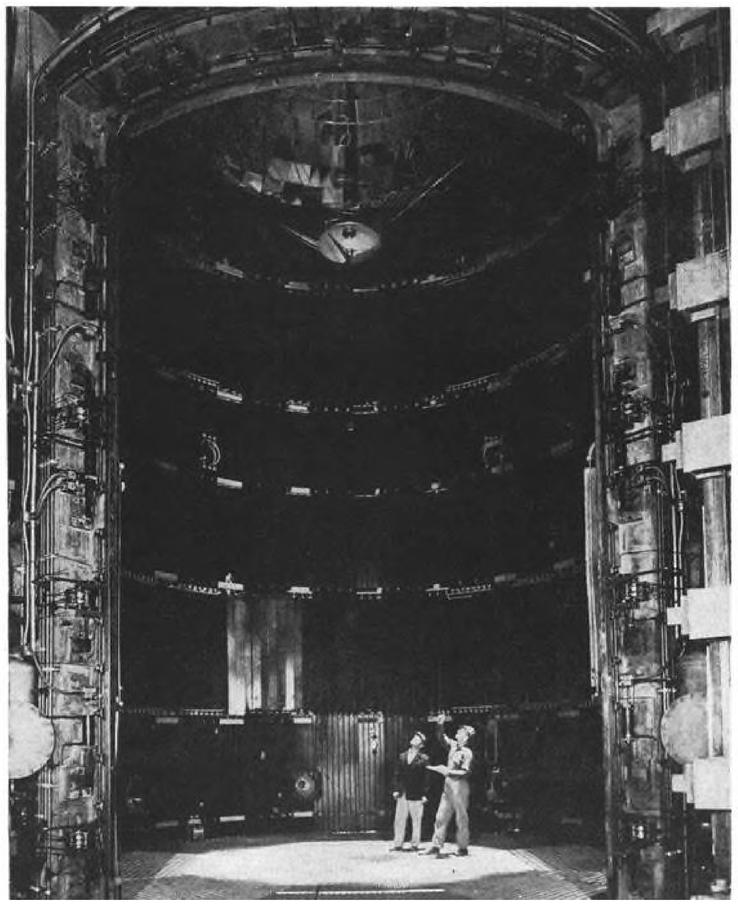
Answering key problems of VTOL and other advanced aircraft is the object of a comprehensive development program at Hamilton Standard today. This work is a natural outgrowth of more than forty years of designing and producing propellers for the aircraft industry.

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION

AEROSPACE & INDUSTRIAL ENGINE CONTROLS • ENVIRONMENT CONDITIONING SYSTEMS • GROUND SUPPORT EQUIPMENT • TURBINE STARTERS
SOLAR POWER GENERATORS • STATIC POWER SYSTEMS • AUTOMATIC STABILIZATION SYSTEMS • ELECTRON BEAM MACHINES • PROPELLERS



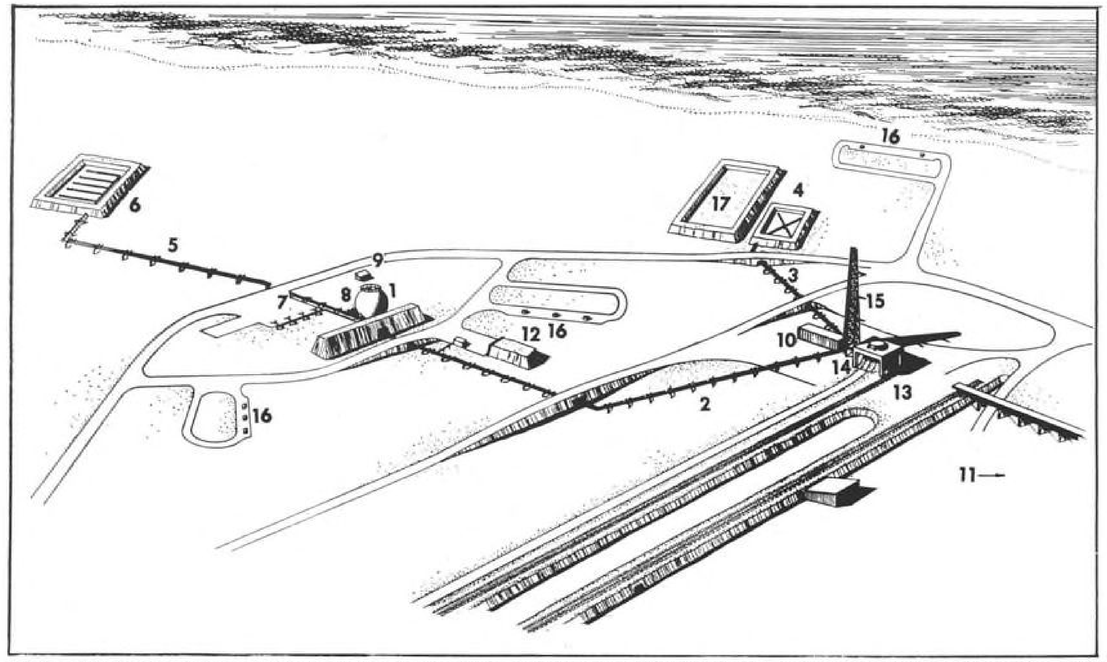
JPL Simulator Testing Full-Scale Mariner Model



Pasadena, Calif.—Tests on a thermal model of the Mariner Venus probe in a newly completed space environmental simulator at California Institute of Technology's Jet Propulsion Laboratory were begun recently by Consolidated Vacuum Corp.

For three weeks, the full-scale Mariner model measuring 10 ft. high x 14.5 ft. across its solar panels will be subjected to the rigors of an environment near that of outer space. Pressure within the cylindrical 47 ft. x 26 ft.-diameter chamber will be held to 10^{-6} millimeters of mercury or about one-billionth of an atmosphere. At the same time, the Mariner will be subjected to heat equivalent to that of the sun generated by 131-arc mercury xenon lamps of 2.5 kilowatts each. To preclude absorption of heat by the walls of the chamber which would normally be radiated back to the test subject, the walls of the chamber will be cooled to a temperature of —315F so that heating conditions consistent with those found in outer space will be reproduced.

Solar radiation will be simulated by directing the radiation from the mercury xenon lamps, each backed by a 16-in. reflector, first into a parabolic mirror then into a hyperbolic mirror. From there the light is reflected into the chamber through a lens. The beam, which is 3 ft. in diameter, is widened to 12 ft. by reflecting it onto a 2.5 ft.-diameter mirror then to a parabolic mirror at the top of the chamber. This produces a collimated beam which realistically reproduces the radiation of the sun.



LIQUID HYDROGEN storage and transfer system developed by Air Products and Chemicals, Inc., is shown in drawing of Cape Canaveral's Saturn Complex 37B. Spherical tank (1) is used to store liquid hydrogen shipped from West Palm Beach. Other features of the complex are: liquid hydrogen transfer line (2), launch area vent line (3), launch area burn pit (4), storage area vent line (5), storage area burn pit (6), liquid hydrogen fill manifold (7), pressurization coil (8), electric equipment house (9), advance ground control station (10), block house (11), RP-1 storage area (12), service tower area (13), launch pad (14), umbilical tower (15), camera positions (16), and drain pit (17).

Saturn Liquid Hydrogen Facility Readied

Liquid hydrogen storage and transfer system for initial and follow-on Saturn upper stages is being fabricated and tested by Air Products and Chemicals, Inc., and will be installed this summer at Cape Canaveral's Saturn Complex 37B.

The system, developed under a $1.7-million National Aeronautics and Space Administration contract, will be used first with the S-4 stage on the Saturn C-1 and is expected to be applicable to the S-2 and S-4B stages on advanced Saturn vehicles.

Air Products currently is testing system components at its main plant in Allentown, Pa., and the Air Force's liquid hydrogen production facility operated by the company at West Palm Beach, Fla. Following turn-over of the system to NASA this summer, the space agency will conduct further tests using liquid hydrogen.

When the system becomes operational, probably late this year or in early 1963, liquid hydrogen will be shipped by trailer trucks from West Palm Beach to the launch complex and stored there under pressure in a spherical, 125,000-gal. tank. Special insulation will be provided throughout storage and transfer to maintain hydrogen at its liquid temperature of —423F.

Transfer of liquid hydrogen to the launch vehicle will be accomplished at two flow rates—a fast rate to fill about 90% of the fuel tanks and a rate approximately one tenth as fast to "top off" the upper 10% to exact capacity.

A vacuum-jacketed transfer line with an inner tube constructed of a nickel-steel alloy will be used in the fueling operation. The alloy has a low expansion coefficient to reduce the number of bellows required in the line, the company says.

High Vacuum

Air Products will completely evacuate the line sections to establish a high vacuum prior to system installation at Cape Canaveral. Field installation is to be simplified, requiring only the welding together of line sections. A static vacuum with a two-year minimum life span is specified.

Liquid hydrogen sub-cooler will be incorporated in the transfer line to assure constant hydrogen temperature during the fueling. A specially-designed vacuum pump will be used in conjunction with the sub-cooler to generate a temperature difference between the hydrogen fuel and the coolant fluid, also liquid hydrogen.

Venting systems are to be integrated with the Saturn vehicle's flow and automatic sequencing requirements. If draining and disposal of hydrogen are necessary, the vents are designed to bleed off large quantities of gaseous or liquid hydrogen. Controlled combustion of hydrogen drained through the vent system will be accomplished at a safe distance from the launch area.

Instrumentation in the over-all system is designed for simplicity and ease of maintenance. Operating sequence of automatic and semi-automatic capability has been built into the system to permit operation from a site removed from the launch blockhouse.

The liquid hydrogen fueling operation is divided into four major phases, according to an Air Products official:

• **Cooldown** of the transfer line. Nitrogen or helium atmosphere will exist in the line before cooldown is initiated. Since all gases except helium freeze out at the temperature of liquid hydrogen,

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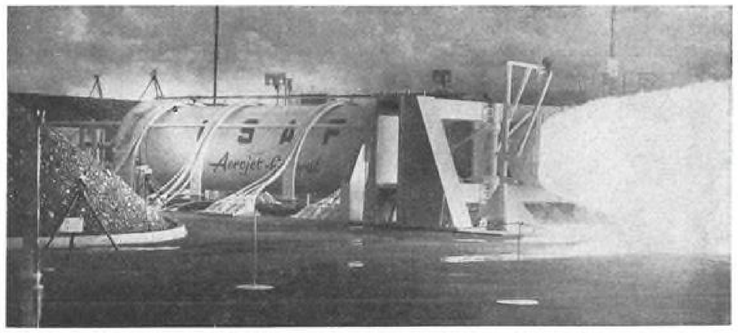


Second 100-in.-dia. Solid Rocket Fired

Second firing at Sacramento of an Aerojet-General 100-in.-dia. solid-propellant motor in a 53-ft.-long configuration of three center segments plus two end caps produced a maximum thrust of approximately 600,000 lb. and average thrust of about 500,000 lb. Duration of firing was 97 sec. See cover and p. 11.

helium will be used to replace the nitrogen in the system before the admission of liquid hydrogen.

• **Main fill** of the engine tanks will proceed at the fast flow rate, with the top off rate beginning near the end of the cycle. Tanks will be filled to capacity, and an automatic valve closure sequence will seal off the hydrogen line.

• **Line purging.** An inert gas will be introduced into the line after a successful launch to remove surplus hydrogen and maintain the transfer system in an inert atmosphere until the next fueling operation.

• **Return of liquid hydrogen** from the transfer line to the storage tank. The line slope will drain the liquid toward the tank, and helium gas may be admitted to the line to speed up flow.

Eye Retina Monitor For Simulator Planned

Development contract for a recording and monitoring ophthalmoscope to observe eye retina changes in personnel undergoing tests in space flight motion simulators has been awarded to Pacific Optical Corp., Inglewood, Calif., by National Aeronautics and Space Administration.

Contract issued through NASA's Ames Research Center calls for development by mid-1962 of an ophthalmoscope capable of recording cellular disturb ances in the retina caused by extreme dynamic forces.

Officials of Pacific Optical, a division of Chicago Aerial Industries, Inc., believe the device will provide informa tion on the problems of weightlessness.

The recording system will be located within a specially designed centrifuge capsule. The capsule will contain a closed circuit television camera, operating through the reflex portion of the simulator's photographic system and transmitting a record of eye movements.

Meteor Impacts On Moon Being Studied

Meteor strikes on the moon's surface —and the possible consequent danger represented to astronauts landing on the lunar surface—are being studied by Martin-Marietta Corp. during a 10-day period each month.

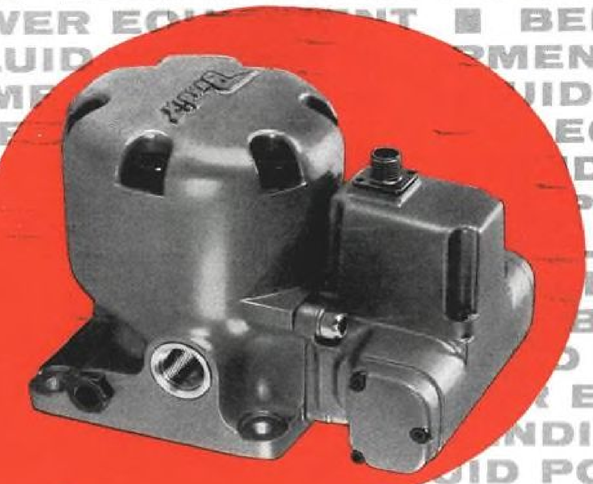
The company-funded study, conducted by Martin's Space Systems Division, employs an optical transportable telescope with a 12.5-in. lens located northwest of Baltimore, Md. Magnification power is 600 and study periods range from the moon's third quarter through the new moon to the first quarter, when the earth effectively acts as a shade between sun and moon. An area approximately one-eighth of the lunar surface has been selected for intensive watching.

Images of meteor strikes are picked off the telescope by a photomultiplier, which amplifies the signal and passes it to a paper-tape recorder. The flares caused by the strikes are time-correlated with the signal broadcast by the National Bureau of Standards over station WWV. Intensity of flare is also recorded.

Observations began last December and, based on limited experience so far, Martin scientists believe that an average of 10 to 12 meteors strike the lunar surface at velocities of about 54,000 mph.

Threshold size of the meteors recorded by the system is that of a child's marble or larger.

Martin scientists hope to know by mid-year whether this technique is valid for determination of the frequency, size and force of meteors hitting the lunar surface. If this pilot study does prove to be successful, the experiment may be expanded with a second telescope and more accurate magnetic tape recorders.



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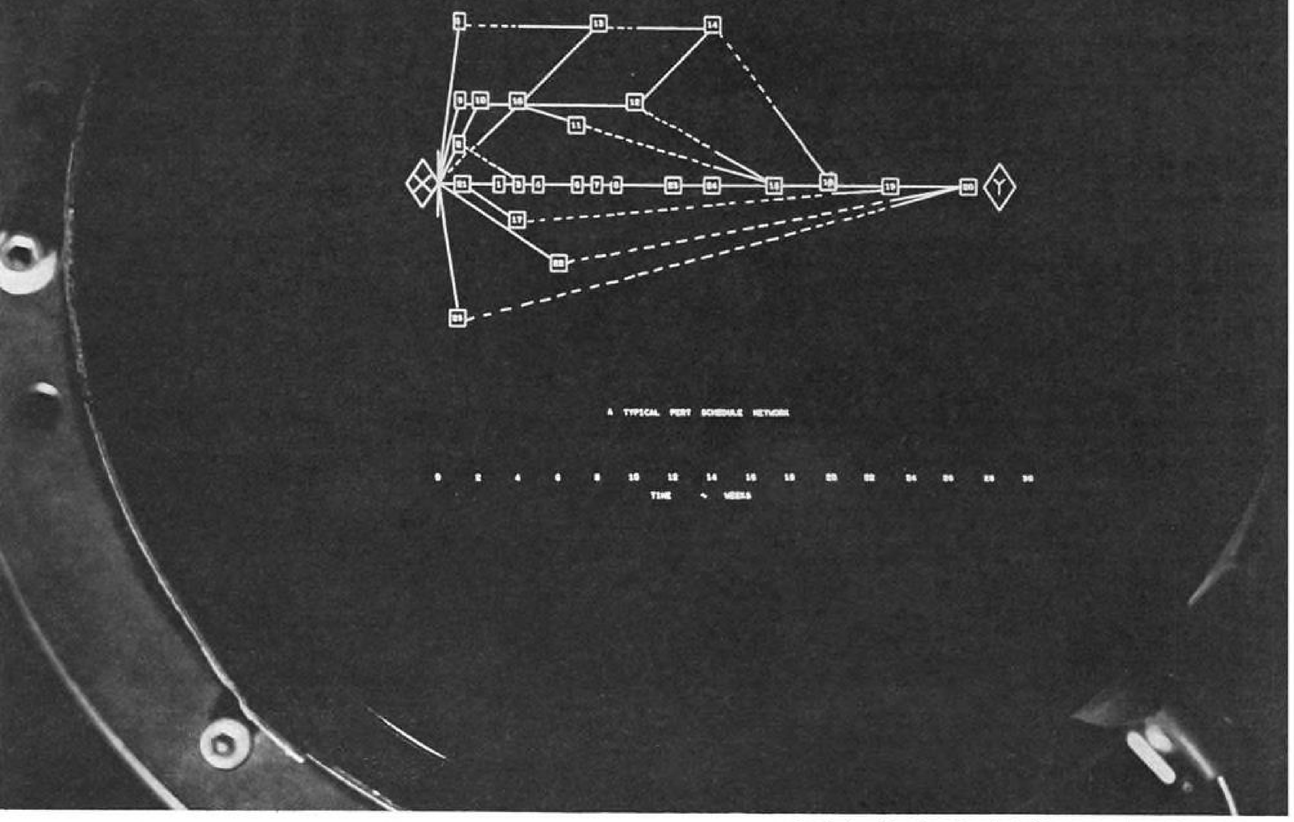

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PRODUCTION BRIEFING

Hamilton Standard Division of United Aircraft Corp. will provide propellers for Military Air Transport Service Lockheed C-130E turboprop transports under a $10-million contract from Navy Bureau of Ships.

Barnes Engineering Co., Stamford, Conn., has received a $1,422,000 contract from Lockheed Missiles and Space Co. to produce horizon sensors for Agena space vehicles. Sensors are infrared devices which activate small jets to keep the vehicle in a programed attitude relative to the earth.

Telecomputing Corp.'s Advanced Structures Division, Los Angeles, Calif., has received a $360,000 contract from Boeing Co. to provide vertical fin-tip fairings for the 727 jet transport.

Westinghouse Electric Corp. will continue design and development of a reactor for use in the Nerva nuclear rocket engine under a follow-on contract from Aerojet-General Corp., Nerva prime contractor. Contract portion covering the next nine months' work on the project totals $8.5 million.

Electro-Optical Systems, Inc., Pasadena, Calif., has received contracts totaling $354,215 from National Aeronautics and Space Administration for additional research and development of electric propulsion engines.

North American Aviation, Inc., has received a $3.3-million Navy Bureau of Weapons contract for modification, testing, demonstration and evaluation of the T2J-1 jet trainer with dual engine installation.

Bechtel Corp., Vernon, Calif., will perform architectural and design engineering for three construction projects at National Aeronautics and Space Administration's Marshall Space Flight Center, Huntsville, Ala. The projects, estimated to cost about $2 million, include expansion of the test division blockhouse, two 28,000-gal. liquid oxygen storage tanks and partial construction of a liquid hydrogen test facility.

General Dynamics/Electronics will supply modification kits to add air-to-air ranging capability to TACAN navigation aid systems aboard all Navy tactical aircraft. Contract exceeding $2 million from BuWeps calls for modification kits which will enable pilots to determine distance separating each other as well as distance and direction between the aircraft and TACAN ground stations.

The Lincoln Laboratory program for ballistic missile range measurements and penetration research includes:

EXPERIMENTAL RESEARCH

Measurements and analysis of ICBM flight phenomena for discrimination and for decoy design purposes, including optical, aerodynamic and RF effects.

SYSTEM ANALYSIS

Studies to apply research findings to advance the technology of ICBM and AICBM systems.

INSTRUMENTATION ENGINEERING

Designing radar, optical and telemetry equipment with which to measure ICBM flight effects under actual range conditions.

RADAR SYSTEMS RESEARCH

Extending the theory and application of radar techniques to problems of discrimination, countermeasures and performance in a dense-target environment.

HYPERSONIC AERODYNAMICS

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USAF Studies U.S., Soviet Space Potential

(Air Force Lt. Gen. James Ferguson, deputy chief of staff for research and technology, told the House Armed Services Committee recently that it will take a concerted national effort to create a military posture adequate to counter the potential threat of the Soviet Union's military activities in space. In a public statement released after the closed hearing, Gen. Ferguson evaluated the Soviet threat and outlined the Air Force Space Plan (AW Feb. 26, p. 25), a study of the status of space technology in the Air Force today and of its long-range objectives. AVIATION WEEK is publishing significant excerpts from this statement because of their importance to the aerospace industry.)

The basic military strategy of the free world has been founded, in recent years, on technological superiority in all combat media. Retention of our technological superiority is challenged by the major space efforts and recognized accomplishments of the Soviets. It may be extremely difficult, if not impossible, for atmospheric defense systems to counter some of the possible military applications of the Soviet advances in space technology.

There are, in effect, three major military problems confronting us today. . . . First, there is a marked imbalance between the Soviet bloc and the free world relating to intelligence activities. . . . Second, our defense against Soviet ballistic missiles is inadequate—in the event deterrence fails. Third, the Soviets have demonstrated increasing competence in space technology which may have application to a broad spectrum of military systems. Since we cannot know the Soviet's intentions, we must be prepared to respond to a variety of threats—and to react without delay when the need is clearly defined.

Potential solutions to each of the above problems are offered by space systems, techniques, and applications. I stress the word, "potential." Much basic and applied research remains to be done merely to ascertain that solutions are technically feasible. Thereafter, advanced development will be required to demonstrate subsystem or system capability and economic feasibility. If, then, the decision is made to prepare for inventory production, operational development of the full system will be undertaken.

. . . We have completed our intensive study of the potential Soviet threat, the status of our technology relative to space applications, and the long-range objectives and needs of the Air Force. These long-range objectives and needs have been derived from a national viewpoint. We have considered them in relation to programs of other agencies, particularly the National Aeronautics and Space Administration. This has permitted us to prepare a coordinated, well balanced plan for the future which makes the best use of our limited resources. We have prepared and published a document, called the Air Force Space Plan, which summarizes our current views on these subjects and identifies specific technological objectives for the next 10 years. Under a cover letter from the Chief of Staff, the Space Plan provides basic guidance to the whole of the Air Force research and development community. Most of what I will have to say . . . is based on the Space Plan.

I shall discuss in succession these topics: the philosophy underlying our interest in space capabilities, the military tasks to be performed in space, the technological problems we foresee and the research and development programs we think will solve them, the current status of our accomplishments in the past year, and finally, our conclusions.

LT. GEN. JAMES FERGUSON

Lt. Gen. James Ferguson, deputy chief of staff, research and technology, U. S. Air Force, was born in Smyrna, Turkey, Aug. 15, 1913. His British parents later settled in Whittier, Calif., and he was naturalized as an American citizen Mar. 28, 1930.

In 1934, he enlisted in the Air Corps, completed flying training and became a second lieutenant in 1938. Gen. Ferguson served in Europe during World War 2, in Turkey after the war and then in Korea.

He was named deputy Commander of Tactical Air Command's Ninth Air Force in 1952. He became Vice Commander, Air Research and Development Command in 1959 and last April became Vice Commander, Air Force Systems Command.

Gen. Ferguson was assigned as deputy chief of staff, research and technology, Headquarters USAF, and promoted to lieutenant general last December.

The U. S. national space policy recognizes four reasons for conducting projects in space: to increase scientific knowledge, to exploit commercial applications, to strengthen military capabilities, and to enhance national prestige.

The prime objective of Air Force space policy is to exploit space so as to retain U. S. military superiority in order to insure the peaceful use of space. To accomplish this, it is necessary to regain the lead in military space technology.

It is clearly recognized, however, that space systems must be considered to concert with all other weapon systems. Space systems will be selected for development and use when they offer either the only means or the best means of performing a specific mission. Space systems and related advances in technology will be further exploited for their prestige and scientific value.

Development Pattern

In thus extending and exploiting space flight technology, the Air Force will be continuing the pattern of development which has led in a single lifespan from Kitty Hawk to Cape Canaveral: from the Wright Brothers' first primitive airplane not only to Mach 3 aircraft but also through the first air-breathing cruise missiles to the Minuteman intercontinental ballistic missile. This logical progression has already led to unmanned satellites which are now essential for certain military missions. It has led from the X-1 experimental rocket aircraft through the X-15 and is leading now to the Dyna-Soar. It will lead beyond, to manned space stations and possibly to advanced aerospace craft capable of self-contained flight to and from space. All of these advanced craft have potential applications to critical military missions. The Air Force will play the major military role in developing these capabilities.

. . . The Secretary of Defense by directive of 6 March 1961 has assigned to the Department of the Air Force the responsibility for research, development, test, and evaluation of Department of Defense space development programs and projects which are approved after the date of the directive. This same directive authorizes each military department and Department of Defense agency to conduct preliminary research to develop new ways of using space technology in order to perform its as-

Bad weather costs big money. When ceilings and visibilities fall below minimums, jet operators in particular face huge losses, because of schedule disruptions, idle equipment, passenger and cargo diversions. Lower takeoffs and landing minimums are the answer, provided these can be achieved both safely and economically. *They can,* because Sperry has been at work for years on every aspect of the problem.

Sperry has made hundreds of *fully automatic* landings to date, solidly proving both concepts and equipment. First prototypes of the ultra-reliable automatic pilot of the future – the Sperry SP-50 with built-in glide slope extension capability for upcoming Boeing 727 jetliners–already have been delivered. The famed SP-30 system, in service aboard the Douglas DC-8, Convair 880 and 990, was designed with the automatic landing needs of the future in view. Douglas and Sperry already have demonstrated automatic takeoffs and landing approaches *to the point of flare* in the DC-8, employing SP-30 with glide slope extension and other advances.

Among new Sperry flight instrument concepts is a system which will electronically display runway approach lights on the pilot's windscreen, in any weather. Other "look-ahead" windscreen displays are in flight test. Electronic monitoring and pilot warning systems, autopilot and sensor comparators are in being today, and under continuing development.

The immediate Sperry goal is safe, economical reduction of landing minimums to 50 feet. A little farther in the future are *practical* systems for zero-zero takeoffs and landings, adaptable to each operator's needs.

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signed functions. Upon completion of such preliminary research and upon DOD approval of follow-on development efforts, the Air Force would normally be assigned developmental responsibility. I can assure you that the Air force intends to be fully responsive to the needs of other services and DOD agencies.

The timely and economical development of the nation's space capabilities will require the closest cooperation among all participants. A true reciprocal arrangement must exist between the Air Force and NASA if full advantage is to be taken of the technical accomplishments of each agency. The Air Force and NASA have already established the broad basis for cooperation and a concerted effort is now being made to establish the principles and to formalize arrangements in connection with the lunar program which will permit the fullest cooperation at all levels of Air Force and NASA management.

At the technical level, we are in agreement with NASA officials that our programs must be mutually supporting –rather than competitive.

Accordingly, the 10 major NASA-Air Force management agreements which have been consummated since 1959 will be followed by such additional arrangements as may be required by the expanded NASA program. Ninety-three Air Force Research and Development officers are now assigned to duty with NASA. These data illustrate the extent to which NASA and Air Force efforts are already integrated within the National Space Program.

Pressing Needs

It is important to note, however, that some operational and related technological needs are not common to both the civilian and military effort. Later in my discussion of the Air Force's pressing technological needs I will point up a number of these differences. By closely integrating our program with NASA in furtherance of its goals, while at the same time conducting independent research on purely military needs, the Air Force will make its best contribution both to the national effort and to the nation's future military space capabilities.

The Air Force has devoted considerable study to discerning the military potential of proposed space systems.

A number of early military applications are feasible during the next five to seven years. These will include space systems offering potentials better than those otherwise attainable for geodetic mapping, warning of ballistic-missile attack, aiding surface navigation, and meteorological surveillance. Communication satellites promise a better means of global military communications. Beyond these early applications, space is expected to offer many possibilities. Some of these future applications will undoubtedly not be conceived until additional progress is achieved in space technology and operations. Most of the future application which can be anticipated now must await further technological progress before being defined in detail. Therefore, these applications are best described now in terms of the military tasks they may perform.

Warning Systems

These future applications will certainly include improved space systems for attack warning and for nuclear test detection. These systems will also contribute to improved warning of intent of a potential aggressor. Further, it should be possible to obtain space systems which will considerably extend early ground-based capabilities for surveillance of uncooperative satellites.

Space systems may provide a breakthrough in the area of defense against ballistic missile attack. They may provide techniques for early interception of hostile missiles. Moreover, this earlier intercept would provide additional security through defense in depth and tactical flexibility against other types of space weapon systems.

Should the survivability of earth-based systems become marginal, deploying systems in deep space may be the only means of providing dispersal and remote location to insure survivability. For example, space-based command and control systems may offer a significant increase in survivability. Further, disruption of communications between earth and space may require space-based command and control stations for control of space operations as an extension of our present airborne command and control units.

Meteorological surveillance, navigational aids, and research and development testing will continue to be important support tasks having space applications. Other principal support tasks that are expected to evolve are logistics (including in-space maintenance and repair), solar-flare warning, training, and rescue.

Military space technology has as its broad foundation many fundamental technological areas. In general, capabilities in these areas will be required for either civilian or military space programs. However, the inclusion of military needs will frequently demand special or unique characteristics in one or several of these capabilities. Such factors as cost, dependability, reusability, quick reaction, positive control, security, and the combat environment have different implications for military missions than they have for scientific, commercial, or prestige applications. For example, rendezvous in a hostile

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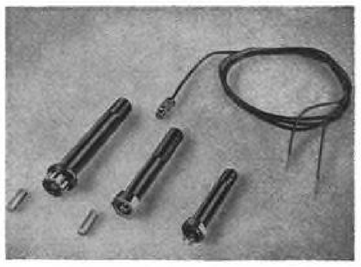

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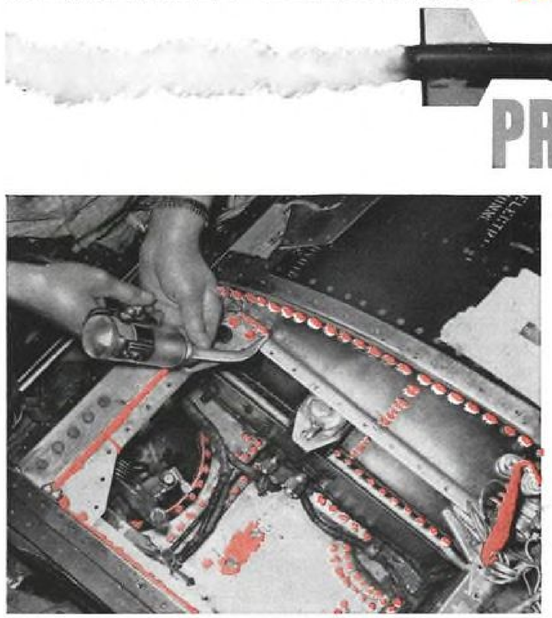
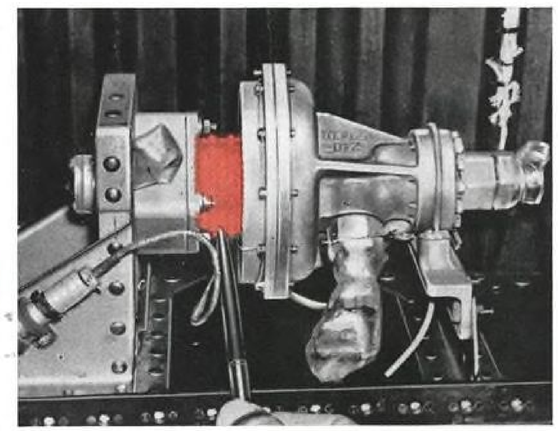
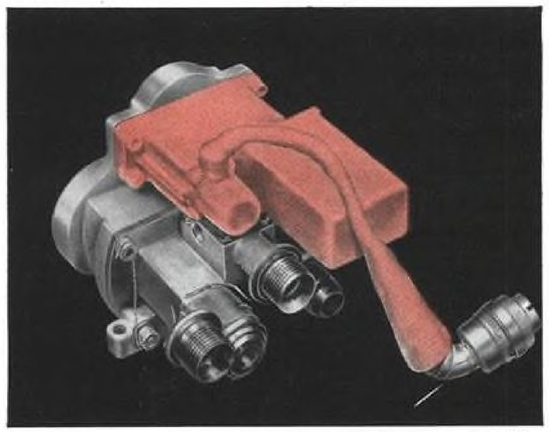


Critical pressurized areas of the X-15, designed and built by North American Aviation through a joint NASA-Air Force-Navy research project, are sealed with General Electric RTV (room temperature vulcanizing) silicone rubber. After a thorough analysis of all high temperature sealants, RTV was selected to seal the aft bulkhead behind the cockpit, instrumentation compartment and shelving near the ship's mid-section.



RTV adhesive seals heating blanket for helium pressure regulator. RTV rubber forms tenacious bonds to most materials provided surfaces are properly primed. It is easily removed from unprimed surfaces. It can be applied by dipping, pouring, spraying or buttering—cures in place at room temperature to form a tough, flexible seal. Cure times can be varied from minutes to hours depending on catalyst used and heat, if applied.



Protection against hydrogen peroxide spillage is provided by RTV silicone rubber coating on this three position actuator. RTV is commonly used to protect against moisture and many chemicals. It's used in almost all U.S. missiles and space vehicles, not only for sealing, but for electronic potting and encapsulating, and as thermal insulation. It combines excellent electrical properties with physical protection.

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	RTV-11	RTV-20	RTV-40	RTV-60	RTV-77	RTV-88	RTV-90
Viscosity, Poises	120	300	450	550	8,000	10,000	12,000
Color	White	Pink	White	Red	White	Red	Red
Consistency	Easily Pourable	Pourable			Spreadable Thixotropic Paste		Stiff Paste
Temperature Resistance	FROM −90°F TO +600°F FOR EXTENDED PERIODS TO 9,000°F FOR LIMITED TIME AS THERMAL INSULATION						
Specific Gravity	1.18	1.35	1.37	1.47	1.33	1.47	1.47
Radiation Resistance	10^7 ergs/gram						
Tensile Strength, psi	350	450	550	650	500	750	750
Shrinkage, %	0.4	0.2	0.2	0.2	0.3	0.3	0.2
Durometer, Shore A	45	50	55	60	50	65	60
Volume Resistivity, ohm-cm	$6x10^{14}$	$5x10^{15}$	$1x10^{14}$	$2x10^{14}$	$1x10^{15}$	$1x10^{14}$	$2x10^{14}$
Solids Content, %	100	100	100	100	100	100	100
Elongation, %	180	140	120	110	220	110	190

A wide range of RTV compounds meet a variety of application requirements. Low viscosity RTV-11 (or transparent LTV-602) is used for potting electronic assemblies and coil impregnation. RTV-77, 88 and 90 are mainly used for high-temperature sealing and for thermal insulating and ablative applications. Intermediate viscosities meet other insulating and sealing requirements, are also used as flexible mold materials.

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environment with noncooperative, evasive targets will be a military requirement. In contrast, the lunar landing program will involve rendezvous with cooperative targets in specified and controlled orbits. An early awareness of such implications as these and a growing understanding of the potential military usefulness of space have been instrumental in shaping the Air Force space program. As a result, we have undertaken a series of closely related efforts. These efforts have been initiated both to exploit the earlier military space applications and, at the same time, to expand our capabilities in several well-defined areas of technology. I will now discuss these 11 areas with you and will outline briefly the major programs which are under way and some which we can foresee as desirable during the next few years.

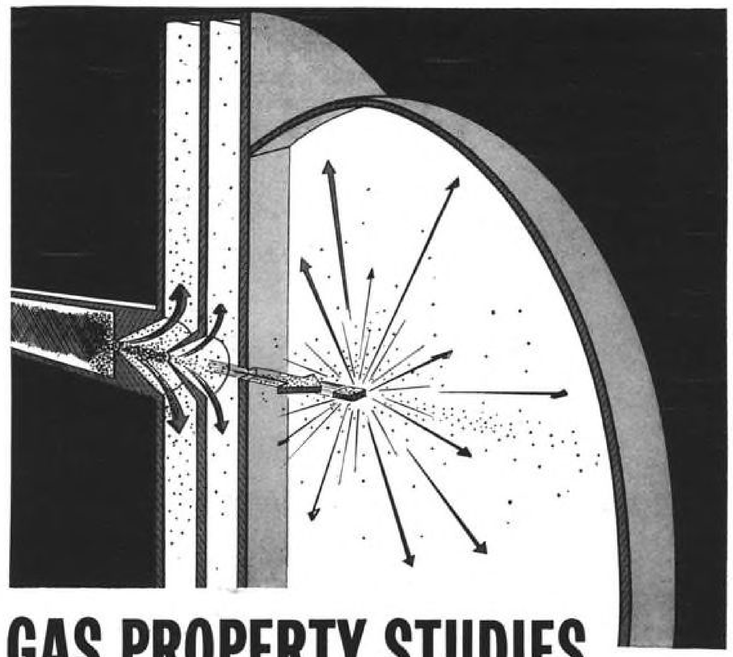
Improved Boosters

To begin with, all space payloads require launch vehicles to get them into space. While launch readiness, reliability, and cost reduction are desirable for all space activities, they are mandatory if routine military operations are to become practical. Consequently, we are pursuing two concurrent courses. First, we are working toward increasing the thrust of chemical boosters for the earlier military missions in space. Secondly, we are bringing forward the technology of nuclear rockets in anticipation of benefiting from their great potential for longer endurance, more favorable thrust-to-weight ratios, and reduced cost per payload-pound in orbit. In the chemical area, increased payload capacity will result from modifications to the Titan 2 booster. Such modifications as the addition of solid storable rockets, for example, could result in the capability for placing several tons in orbit. The large solid booster program will provide the basic technology for development of future rocket motors capable of placing even larger payloads in orbit. The Atomic Energy Commission and NASA are currently carrying the primary efforts in nuclear rocket technology.

Within our present funding restrictions we are conducting corollary studies aimed at gaining maximum advantage from their efforts.

In-Space Propulsion

If the payload is to maneuver in space, in-space propulsion ranging from low-thrust devices to high-thrust engines is required. Although low-thrust propulsion is essential to virtually all missions in space, such requirements as interception or avoidance of noncooperative objects dictate a need for a high degree of maneuverability not essential to scientific operations. Continued effort in applied research upon low-



GAS PROPERTY STUDIES
BY MOLECULAR BEAM

• Depicted above is a tailored interface hypersonic shock tunnel used as a source of high speed neutral atoms and molecules for a "molecular" beam. With this beam, the constituents of air are made to collide at the relative kinetic energies appropriate to the high temperatures encountered in hypersonic flight. Too hot to be produced by an oven, yet too slow to be obtained conveniently from an ion beam by charge exchange, these particle energies can readily be obtained from a shock tunnel. In the hypersonic nozzle random energy is converted into well-directed uniform translational motion. When scattered from a gaseous target, this beam will allow differential cross sections to be measured and provide much needed data on which to base better calculations of gas properties. When scattered from a solid surface, the beam can provide information about the exchange of energy between the beam and the surface as well as information about the structure and chemical characteristics of the surface.

At CAL we are engaged in a wide variety of fundamental studies in which spectroscopic, microwave, and other techniques are combined with shock tube and shock tunnel methods in efforts to unfold the behavior of the atoms and molecules of air.

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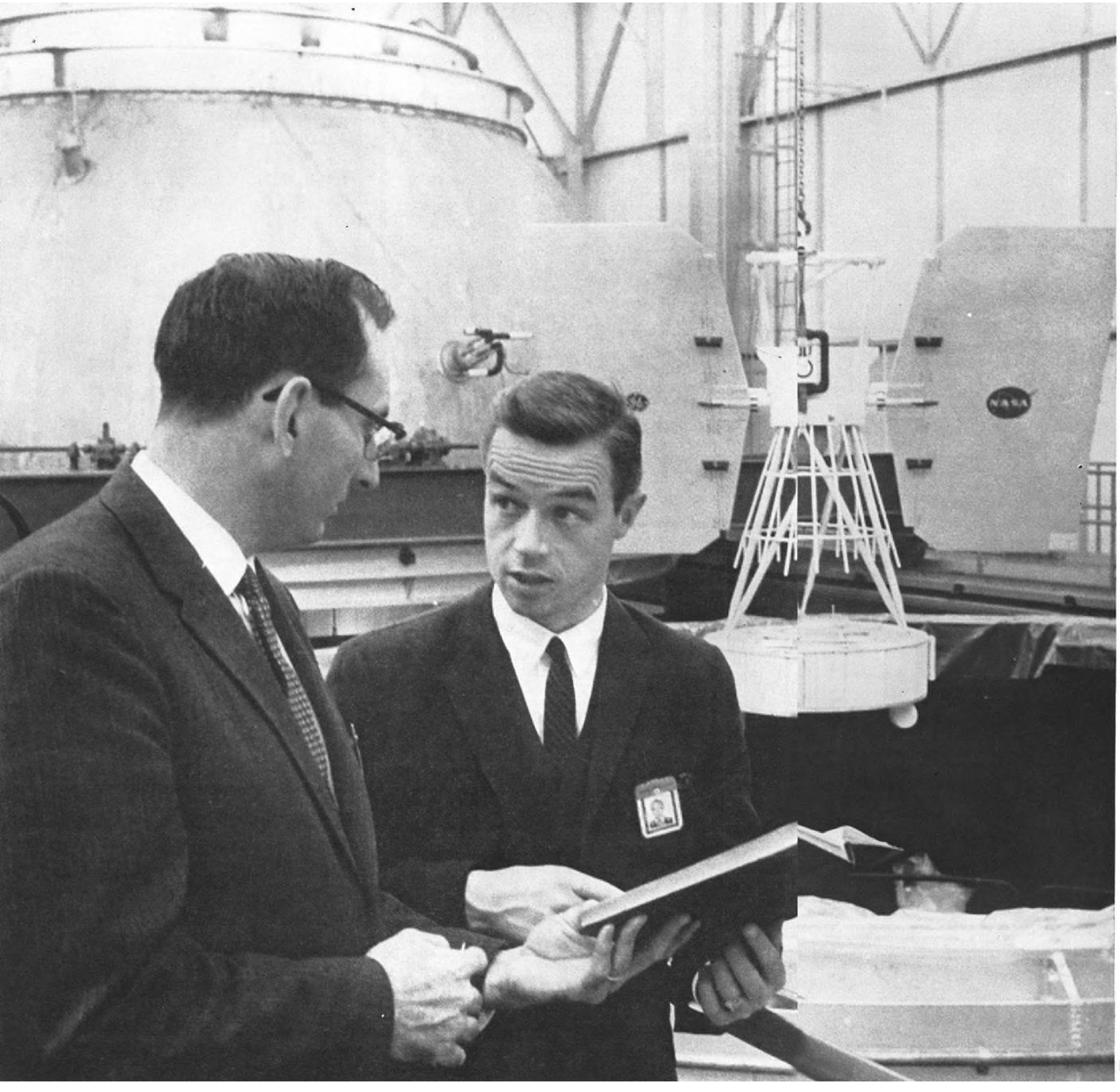

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U.S. Air Force Sets Four World Climb Records With Its T-38 Trainer

On February 19 the U.S. Air Force announced that its own supersonic T-38 trainer broke four time-to-climb records previously held by one of the highest performance fighter aircraft. Taking off from a standing start, the T-38 reached:

9,843 feet (3,000 meters) in 35.624 seconds
19,686 feet (6,000 meters) in 51.429 seconds
29,529 feet (9,000 meters) in 64.76 seconds
39,372 feet (12,000 meters) in 95.74 seconds

These world records were set by Major Walter Daniel in a Northrop T-38 at Edwards Air Force Base, California. His time to 29,529 feet was 16 seconds (or 20 per cent) faster than the previous record.

The young men who enter the U.S. Air Force today can look forward to beginning their supersonic flying program in a trainer matched to the performance of the most advanced tactical aircraft. Next month the Air Training Command will graduate the first class of pilots to receive their training in the record-breaking T-38.

NORTHROP

thrust electrical propulsion is expected to culminate this year in the first test of an ion engine in space.

Further testing of electrical propulsion units will be conducted in a series of coordinated Air Force, NASA, and AEC tests under a program utilizing nuclear power supplies. The higher thrust requirements for rapid and sustained maneuvering in space may be met earliest by chemical rockets using storage propellants. We have presently under consideration several efforts which have been under way in the applied research program. These considerations may show the necessity for undertaking an advanced technology program on a chemical upper stage for in-space maneuvering.

The most promising approach for later maneuvering capability, however, undoubtedly is represented by the nuclear rocket.

I have been speaking thus far of payloads in space, whether manned or unmanned. Obviously, if the payload includes man, bioastronautics equipment is necessary to sustain life and to permit man to function effectively. How effectively, we have yet to learn. Consequently, the pressing question of special military interest is: "Can man effectively perform specific military combat and non-combat functions in space?" The Mercury program will provide some early data at the lower orbital altitudes. However, to answer the question for longer duration missions and for operations through the Van Allen belts, we believe that a logical progression of experiments is necessary in order to proceed with dispatch and confidence. The Air Force has interest, extensive experience, and unequalled national capability in bioastronautics and has, in fact, been carrying on a vigorous applied research effort in this field, in addition to our extensive participation in the Mercury program. However, our investigations to date have been largely limited to ground-based testing. We are currently studying and making plans for those advanced technology programs which would involve testing in space to determine man's military capabilities in space. These programs would, of course, provide substantial contributions to the over-all National Space Program.

The effective use of man in space and the adequate design of the vehicle and payload demand detailed environmental data on space. The needs for these data are common to all agencies concerned with the design of systems capable of prolonged, dependable orbital operations. Because of this, we in the Air Force are relying heavily upon the efforts of NASA to provide us with these basic scientific data. We are, however, carrying on applied research

DEFENSE CONTRACT AWARDS

First Fiscal Quarter Summary—1962

Now available free from AVIATION WEEK AND SPACE TECHNOLOGY are summary reports of defense contract dollar awards covering the first fiscal quarter of 1962. These reports show defense dollars awarded in 168 product/system categories as compiled by Frost & Sullivan, Inc. Information is also available on the fourth fiscal quarter of 1961.

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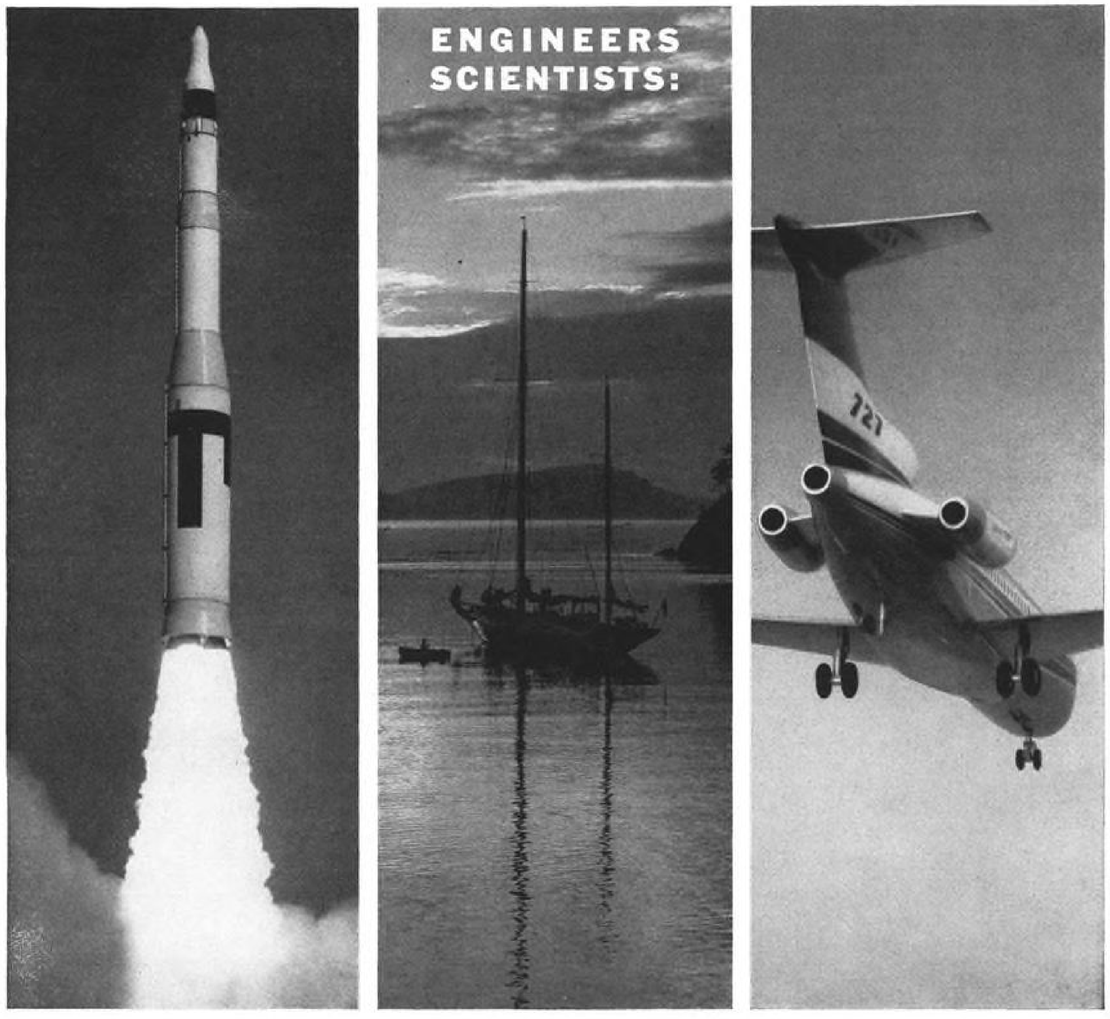

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in those aspects of the environment which influence the design and operation of systems unique to military operations. As an example, the military requirement for continuous operation makes especially critical the need for solar flare forecasting. We have developed crude techniques for this. By further research, we expect to significantly improve these capabilities within this decade.

If operation from a space vehicle or base other than the one used for transport is required, a capability for rendezvous, docking, and transfer is necessary. We believe, however, that the earliest military capability needed in this area of technology is for rendezvous with noncooperative satellites in order to inspect them. As we reported to you last year, we have undertaken the Satellite Inspector Program (621-A) to provide for an early feasibility demonstration of unmanned rendezvous. Within the limitations of our available funds we have given this program the highest priority, and the first rendezvous demonstration will be an early accomplishment. The capability for manned rendezvous is another military need. We expect, however, to depend upon the National Aeronautics and Space Administration Gemini program for the initial step toward this capability.

Power Supplies Required

As capabilities to operate equipment in space are achieved, power supplies will be required. We in the military have a special interest in power supplies for long-duration, high-power systems of several hundreds of kilowatts. As an example of their application, they will be required for future electrical propulsion units. Accordingly, we have under way the Spur program which will result in the demonstration of a long-duration, high-power system by the latter part of this decade, based upon current funding. For the nearer-in applications, at more modest power levels, we may undertake in the near future an advanced technology program for a smaller solar power supply. As a step toward higher powered nuclear supplies, a 3-kilowatt nuclear power source will be tested in space within a few years.

One of our primary missions in space is surveillance. Observation from space for this or any purpose requires sensors. This area of technology has occupied a particularly significant position in our Midas program, as you are aware. Within this program and in conjunction with the highly successful Discoverer program we have been advancing sensor technology at a rapid pace. Much remains to be done, however, and the pursuit of improved infrared sensors, higher-resolution photographic cameras, and improved radars represents a large portion of our applied research projects. Many of these projects are approaching fruition. We are examining many of them now with respect to their evaluation in space through a series of related advanced technology programs.

The Space Detection and Tracking Systems, Spadats, which is partially operational now, will detect and track space objects and will provide the acquired data directly to North American Air Defense Command and Defense Center.

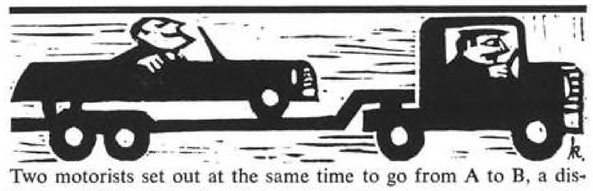
Communications Technology

Communications from space to earth, to other points in space, or between points on earth via space require communications equipment which will function satisfactorily in space. The special military interest in communications technology arises from the need for an integrated secure system of military communications which will reliably operate under any anticipated condition including the presence of interference—manmade or natural. At the present time, Air Force communications efforts are confined to the applied research program. In project West Ford we recently attempted unsuccessfully to disperse small dipole reflectors in orbit to serve as a passive, jam-resistant area communications system. We expect to repeat this experiment soon. Beyond this, our efforts in applied research and studies of anticipated requirements have resulted in defining certain active satellite communications requirements of interest to the Air Force.

Re-entry and Recovery

The return of payloads from space requires re-entry and recovery. To be of continuing military value, military space operations must be capable of routine performance. Considerations of effectiveness, economy, flexibility, and recoverability preclude long-term operational employment of any manned system designed for one time or infrequent scientific experiments. We believe that this means that there is a specific need for techniques permitting selective, conventional aircraft-type landings within the largest possible geographical area and with subsequent re-use of the vehicle after minimum refurbishment. In addition, the possible future requirements for military systems pose a potential need, not shared by nonmilitary agencies, for precision re-entry. We are, in our applied research and advanced technology programs, pursuing projects relating to these objectives—advanced aerospace propulsion concepts, advanced guidance and control systems, and others. The Discoverer program has been instrumental in providing improved orbital injection and re-entry and

PROBLEMATICAL RECREATIONS 108



Two motorists set out at the same time to go from A to B, a distance of 100 miles. They both followed the same route and traveled at different, though uniform, speeds of an integral number of miles per hour. The difference in their speeds was a prime number of miles per hour, and after they had been driving for two hours the slower car was five times further from A than the faster car was from B. How fast did the two motorists drive? —*Contributed*

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recovery techniques which may have later application to future military systems.

In addition to these areas of technologies, there are unique military needs in the areas of weapons and command-control equipment technology. In each of these two areas, we are primarily limiting our efforts to applied research. In the weapons area, we are investigating the feasibility of new weapon concepts. We are already aware that the most effective weapons in space may prove to be of a non-nuclear variety. In this area, as in all areas, it is essential that we do not become fixed on any one approach or achievement as the ultimate solution. In this same vein, we must not be restricted from exploratory developments merely because a clear application is not yet evident. The command-control function, as the need for positive control extends beyond the limited horizons of past years to the vast regions of space surrounding the earth's surface, imposes challenging problems.

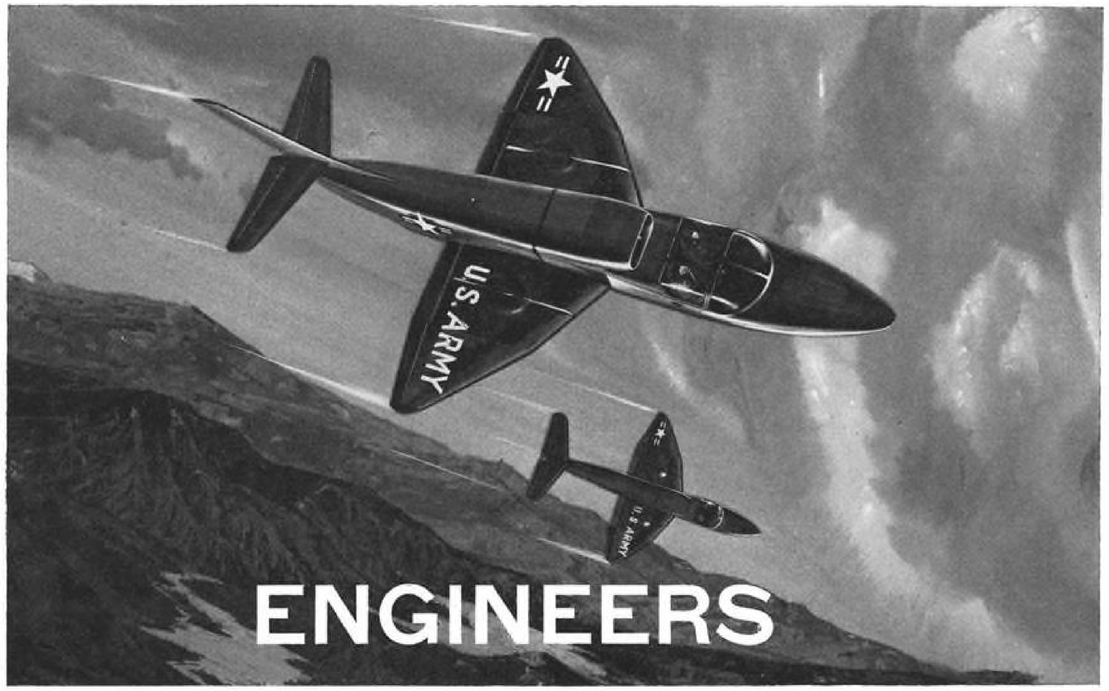
We are limited at the present time to investigation of these problems in our applied research program.

Man's Space Role

I have briefly touched on the major technological areas which underlie future military exploitations of space. They concern: launch vehicles; in-space propulsion; bioastronautics; environmental data; rendezvous, docking, and transfer; power supplies; sensors; communications; re-entry and recovery; weapons; and command-control. There is one further subject I would like to discuss at this point, however—man's role in space. Man has certain qualitative capabilities which machines cannot duplicate. He is unique in his ability to make on-the-spot judgments. He can discriminate and select from alternatives which have not been anticipated. He is adaptable to rapidly changing situations.

Thus, man's inclusion in military space systems will significantly increase the flexibility of the systems, as well as increase the probability of mission success.

As an example, the early flights of the X-15 aircraft were analyzed to determine the flight success rate on an unmanned basis. Malfunctions occurring in several flights would have resulted in loss of the aircraft if it had been unmanned. Instead, all flights were completed successfully with the exception of one where repairable landing damage was sustained. It is for these reasons that we believe that man is essential not only in operational space systems, but also in those programs designed primarily to further technological capabilities in space. It appears that the Soviets have come to the same con-



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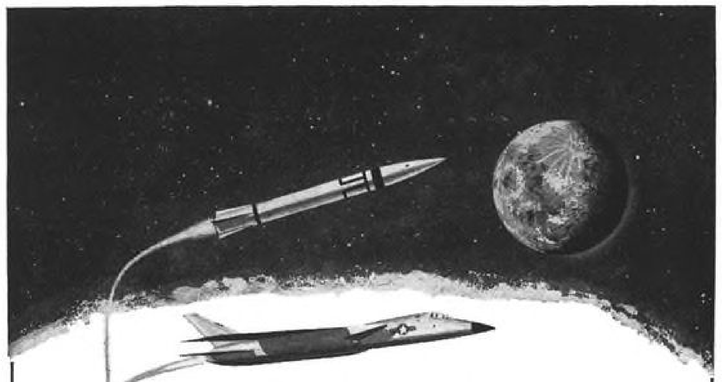

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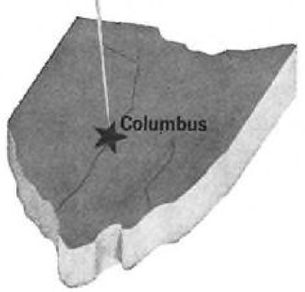

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clusion. Much of the Soviet space effort with which we are familiar is devoted to manned space developments.

Many of the programs that we have under way now will soon require testing of systems and subsystems in the true space environment. We have studied these testing requirements, and we have concluded that a manned military test station in space provides the only reasonable solution to the problems of testing equipment designed for use in space. We are convinced that a manned, military test space station program should be undertaken as early as possible. We are tending toward a proposal that this be a coordinated program with NASA, possibly employing the Gemini vehicle as an initial transport vehicle for use with the orbital test station. Through this coordinated program, it seems reasonable to assume that the best interests of both the military and civilian test programs in space could be served.

Significant Milestones

The discussion thus far may have seemed to imply that all our space accomplishments are yet to come. However, we have not been standing still: a number of significant milestones have already been achieved. Considerable progress has been made since the launch of Discoverer 1 in February, 1959. Among the accomplishments to which we look with pride are the 36 Discoverers launched as of December, 1961, of which 25 have been lofted into orbit and 11 have been successfully recovered from orbit. Just last December the capsule from Discoverer 36 was recovered after four days in orbit—which is a new record for time in orbit and recovery. The success in this program has increased our scientific knowledge and has strengthened our military capabilities. The probability of successful re-entry and recovery of payloads from orbit is steadily increasing.

We have successfully orbited two Midas satellites this past year and we have acquired useful data.

Dyna-Soar Program

The Dyna-Soar program, a cooperative effort with NASA, was recently reoriented from suborbital to early attainment of orbital flight to provide early technology for controlled re-entry and recovery needed for potential future military applications. The configuration for the Dyna-Soar orbital glider has been selected in preparation for its first orbital flight. An intensive analysis has been conducted on the Dyna-Soar program and we believe we have determined the best way to accelerate the schedule to achieve manned orbital flights in the Dyna-Soar at the earliest possible date. All key glider and associate contractors have been selected and

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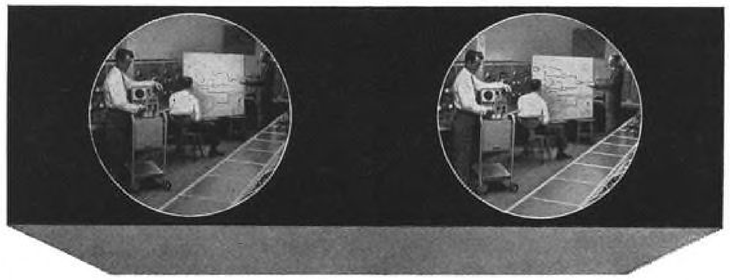

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program redirection has been defined. The Dyna-Soar system project office is implementing its program redirection plan and is currently on schedule.

Programing is under way to meet the booster requirements for orbital flight.

It must be re-emphasized that the characteristics of manned military space vehicles must necessarily be considerably different from manned space vehicles employed for scientific experimentation and explorations. These differences are related to such factors as launch response time, maneuverability in orbit, maneuverability during re-entry phase, precision recovery with conventional landing, vehicle re-use after minimum refurbishment, and weapon incorporation. Except for maneuver in orbit, the Dyna-Soar system has been specifically designed to meet the above characteristics. The Dyna-Soar program represents an entirely new approach to advancing military technology. We are proceeding with a system of developments to determine feasibility and to define the military missions which might be performed with the system.

The Satellite Inspector development and test program has been examined to determine a way in which it can be accelerated to give us an early capability.

Future Concepts Studied

A series of intensive studies on future concepts has been completed. These studies have permitted us, in many instances, to define the characteristics of future, desirable military space systems.

The status of our operational commands, insofar as space systems are concerned, has also been affected. The Air Defense Command and Strategic Air Command are the operational commands most concerned with space systems. Air Defense Command is already operating an element of the Space Detection and Tracking System (Spadats) under the operational control of the Commander-in-Chief NORAD. This is in accordance with the policy that we have proposed: that space systems will be operated by the services under the operational control of the existing unified or specified command responsible for the functional area concerned. In addition, our operational commands are actively participating in all of our current planning for future space systems. I can assure you that when we have developed space systems to the extent that they are ready to be turned over to the operators—our operating commands will be ready.

Although the list of our accomplishments is long and one in which we take pride, there are at present many shortcomings. For instance, we cannot

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All of the glamour that surrounds hardware in orbit often obscures one very meaningful fact. As much as 80% of a complete space system is, and remains, on the ground.

Here's another fact. Within General Electric, technical competence for the ground-based portion of space programs concentrates here in Syracuse, New York.

For instance, the highly reliable radio-inertial guidance system our engineers developed for ATLAS (now operational with the USAF) is the same system that has been used for booster guidance on 75% of America's space shots.

Another system, utilizing an entirely different set of engineering concepts, is MISTRAM*. Its current function is to introduce a revolutionary magnitude of precision into ICBM trajectory measurement. Important future ramifications lie in extending the system to global ranges, satellite tracking, space guidance and hypersonic traffic control.

Still other programs such as GEESE (General Electric Electronic System Evaluator), the vast-scale Air Weapons Control System 412-L. Theoretical and Applied Space Physics, Radiation Effects Research, and many more, provide rugged exercises in technical ingenuity.

MISTRAM's basic system concept involves a geometric arrangement of 5 ground radio receiving stations. Missile position, trajectory and velocities are continuously calculated with great accuracy from phase differences in a beacon signal received from the missile. Radar is used only to orient the radio receiving antennas in the general direction of the missile.

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adequately defend against the ballistic missile. We are unable to provide full scale and timely surveillance of space. We can now put only small payloads into orbit. . . . We cannot, despite our relative success with Discoverer, launch, track, operate, and recover satellites with the routine proficiency that is so important to military operations. We have not yet developed sufficient confidence in satellite operations that we are willing to entrust to them the nation's security. Satellites cannot be placed in orbit under fast-reacting conditions. The cost of putting a satellite into orbit is still too high for extensive military operations. Power supplies for satellite system operation are presently limited in their output. There are many urgent military tests that cannot be conducted simply because we cannot duplicate on earth the in-space environment. For these, . . . an orbiting military laboratory is required. In the meantime it is essential that adequate ground facilities also be provided. We in the research and development family are well aware that facilities are as important as the systems they support and are frequently the pacing item. In support of the Air Force Space Plan, we have already prepared an over-all facilities plan which is now being reviewed by our Scientific Advisory Board.

The Air Force space programs which I have presented to you as a part of the current budget submission will provide a significant step toward removal of these deficiencies and realization of our 10-year space plan.

Soviet Threat

Historically, we have been able to come from behind and catch up in technological areas in which, for one reason or another, we have lagged. This has happened, for example, in jet engines, radar, and ballistic missiles. However, if we fall too far behind in space technology, we may not be permitted to catch up. If the Soviets were to attain a really significant lead in space technology—as by developing, producing and deploying a space-based system which could intercept during boost—we might be denied access to space for military, commercial, or even for research purposes.

This is a very critical time period in our nation's history. Rapid advances have been made in the last few years across a broad spectrum of technology. Not once, but several times, the nation has been surprised by our principal adversary in a variety of technical fields even though specific warnings were sounded by groups having official responsibility in these areas. The nation cannot afford to risk the consequences of further surprises.

In summary, the Air Force believes

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EDUCATIONAL ADVANCEMENT—Engineers at Pratt & Whitney Aircraft have an unusually fine opportunity to continue their formal education under the United Aircraft Corporation Graduate Education Program with full tuition costs being paid by the company directly to the institutions involved for those who successfully complete the requirements for advance degrees. Excellent courses are offered at the Rensselaer Polytechnic Institute Hartford Graduate Center located a few miles from our East Hartford Plant as well as at other fully accredited schools in Connecticut.

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All replies will be handled promptly and in complete confidence.

Pratt & Whitney Aircraft DIVISION OF UNITED AIRCRAFT CORP.

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Test Engineers

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that there are major unsolved national problems to which space systems offer potential solutions, that certain of these solutions are available now, that realization of additional future solutions is dependent upon advancing the state of military space technologies, that the proposed 1963 Air Force Space Program is a significant next step to future space capabilities, and that the program in future years will need to be even more vigorous and comprehensive.

Large Space Chamber Contract Awarded

Space environmental chamber with 200-ft. diameter will be studied for USAF under a research contract awarded by Arnold Engineering Development Center, Air Force Systems Command, to the Bechtel Corp.

Purpose of the contract is to study alternate structural and system configurations during a nine-month period. At the end of that time, USAF will evaluate the report to aid in establishing final design criteria.

Planning and construction of a smaller unit, the Mk. 1 Aerospace Environmental Chamber (AW Sept. 25, 1961, p. 221), currently is under way at AEDC, with completion scheduled for the end of this year. The Mk. 1 chamber is 35 ft. in diameter and about 70 ft. high. It could easily fit inside the proposed new chamber, and be moved in nearly upright through the airlock, which is about 70 ft. in diameter.

The new chamber will be used to check out complete spacecraft and space systems in vacuum and thermal conditions close to those of space. Provisions for operational tests of nuclear-powered vehicles will be built into the chamber.

Bechtel, as prime contractor for the study, will head a team including Chicago Bridge & Iron Co., Arthur D. Little, Inc., National Research Corp. and FMC Corp. McDonnell Aircraft Co. and David Clark Co. will serve as consultants.

Vacuum Chamber to Test Saturn S-2 Components

Vacuum chamber which will permit thermal studies in simulated altitudes up to 330 mi. will be built at North American Aviation's Aerospace Laboratory and will be used immediately upon completion in late summer or early fall for system and component testing for Saturn S-2 booster and Apollo spacecraft programs. The chamber, to cost approximately $300,000, will be company financed and will be used for space research on a corporate-wide basis.

It will be a horizontal stainless steel cylinder 15 ft. in dia. and 26 ft. long.

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Manufacturers Representative Wanted. Fluid control component and systems manufacturer, supplier to the missile and aerospace industry, has prime territories available, especially throughout Central and Rocky Mountain States. Send complete details. Pneu-Hydro Valve Corp., 52 Horse Hill Road, Cedar Knolls, New Jersey.

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Ex Marine aviator, Comm SMEL., inst., BSME. Age 30, 4 yrs. engr. experience desires position in engr. marketing and/or flying. 1800 hrs. from cubs to jets. Prefer S.W. or West Coast. PW-8464, Aviation Week.

Project Engineer—Heavy experience design, operation, maintenance lighter-than-air vehicles and design, erection large radar structures. Extensive practical background. Capable all project phases from initial proposal through design to termination. A&P PW-8453, Aviation Week.

Public Relations with sales background in commercial airlines. Served twelve years State Legislature. Eight years Dist. Mgr. commercial airlines. Desire connection with company or association. William Lennox, 1418 N. Tejon, Colo. Spgs. Colo.

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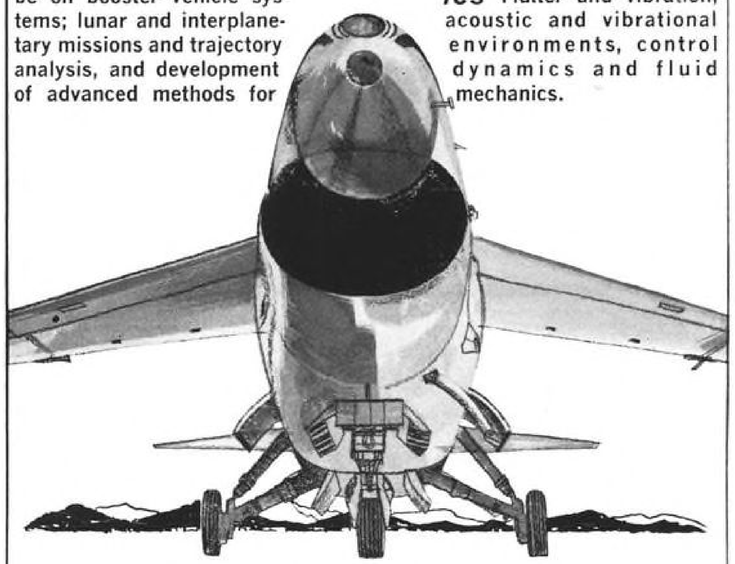

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Physiological Hazards Of Space to Be Studied

National Aeronautics and Space Administration has given the University of California a grant of $590,000 to develop techniques and instruments to measure changes in the body of an astronaut that may develop from long exposure to the space environment.

Responses of macaque monkeys will be studied in relation to effects of radiation, weightlessness and prolonged confinement. Recording instruments will be devised in such a way that the monkeys are unrestrained inside space simulator quarters to assure that the physiological changes recorded are due to actual space conditions and not the results of physical restraints on the animals.

The grant will cover a four year project and will be conducted by the University of California's Space Sciences Laboratory.

Fissio-Chemistry May Cut Chemical Costs

Possibility of inexpensively producing now expensive chemicals by a process called atomic formation of fissio-chemistry will be explored by Aerojet-General Nucleonics, San Ramon, Calif., under a $4-million, three-year Air Force contract.

The company already has converted quantities of ammonia into hydrazine by the process, which involves using a special atomic reactor as a chemical production plant.

Under the new contract, Aerojet is building a large-scale fissio-chemistry loop, designed to operate continuously in an atomic reactor, which is expected to be ready in 18 months.

The program is under direction of the Manufacturing Technology Laboratory of Air Force's Aeronautical Systems Division.

Rocketdyne to Build Space Engine Facility

North American Aviation proposes to start construction in April on an $815,000 facility to be used by its Rocketdyne Division to develop liquid propellants and engines for outer space use.

The construction, subject to approval by the Washoe County Board of Adjustments, would be on land North American owns near the cities of Reno and Sparks, Nev., about one mile north of North American's nearly completed advanced solid propellant research facility.

Facility will be built with company funds and target date for completion has been set for October.

USAF Contracts

Air Force Office of Scientific Research recently awarded 31 grants and contracts valued at more than $1.1 million to universities and industrial and non-profit research laboratories. Basic research grants included:

Georgia Institute of Technology, Atlanta, Ga.—$26,426 for research in nucleic acid chemistry.

University of Southern California, Los Angeles, Calif.—$45,230 for research in spectra of crystals.

University of Michigan, Ann Arbor, Mich.—$32,000 for research on decision processes.

Syracuse University, Syracuse, N. Y.—$18,560 for approximation by polynomials; spaces of function and other problems.

University of North Carolina, Chapel Hill, N. C.—$10,660 for research in bounds for characteristic roots of matrices.

New York University, New York, N. Y.—$27,742 for pattern analysis of planar geometric configurations.

Rensselaer Polytechnic Institute, Troy, N. Y.—$25,380 for research in physical phenomena for logical functions.

University of California, Berkeley, Calif.—$30,000 for a generalized Algol 60 compiling system; $78,180 for computational research in astrophysics; $22,000 for research in electronic structure of metals.

University of Connecticut, Storrs, Conn.—$5,292 for research in trigonometric polynominals and Fourier Series.

Texas A&M Research Foundation, College Station, Tex.—$13,121 for study of liquids and binary mixtures through NMR techniques.

University of Western Ontario, London, Ont., Can.—$20,000 for research in millimeter E-M radiation produced by high energy electron beams.

University of Rochester, Rochester, N. Y.—$79,000 for studies of primary cosmic ray interactions and high energy physics.

University of Maryland, College Park, Md.—$25,424 for research in detection and generation of gravity waves.

Pennsylvania State University, University Park, Pa.—$53,874 for research in crystal imperfections and surface properties of high melting metals studied by field ion microscopy and field evaporation.

University of Pennsylvania, Philadelphia, Pa.—$72,962 for research in the properties of single crystal germanium surfaces.

University of Delaware, Newark, Del.—$61,200 for research on diffusion in crystals.

Air Force Office of Scientific Research contracts included:

General Applied Science Laboratories, Inc., Westbury, N. Y.—$40,000 for continued study of aerodynamic noise.

General Atomic Division, General Dynamics Corp., San Diego, Calif.—$78,540 for study of interaction between hydrogen and oxygen atoms and surfaces.

General Dynamics, Electronics Research Division, Rochester, N. Y.—$16,454 for continued study of high-intensity sound propagation.

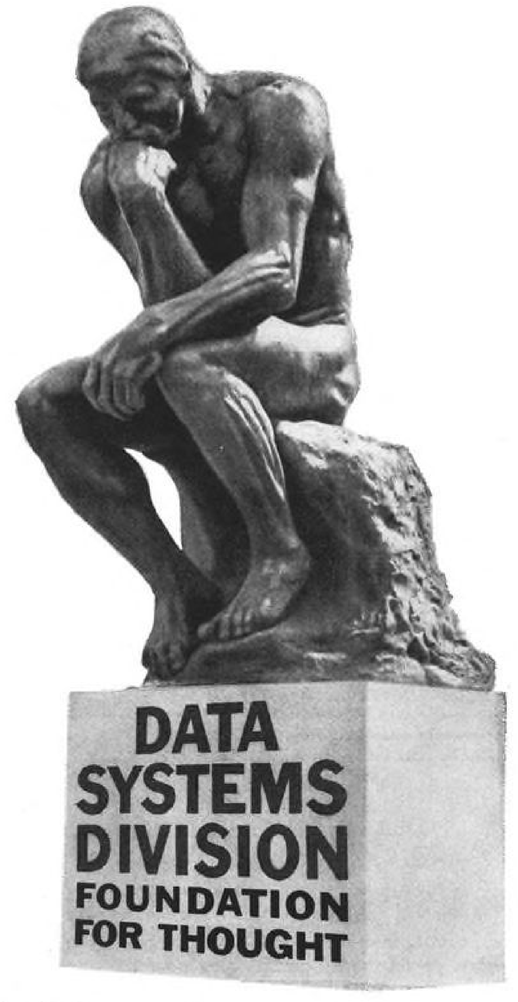
Aeronautical Research Associates of Princeton, Inc., Princeton, N. J.—$20,117 for study of the properties of driven vortices.

Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.—$44,045 for continued study of vibrational relaxation of some diatomic gases; $38,144 for study of phase migration in a monothermal field.

United Aircraft Corp. Research Laboratories, East Hartford, Conn.—$46,564 for theoretical research on thermodynamic and transport properties of gases at high temperatures.

Rocketdyne Division of North American Aviation, Inc., Canoga Park, Calif.—$37,620 for calculation of vibrational force constants.

Massachusetts Institute of Technology, Cambridge, Mass.—$33,800 for study of sensory mechanisms.



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For more about the Defense Systems Department and current openings, see our ad on Page 93.

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LETTERS

Cape Airline Service

I wish to take issue with an item published in the Feb. 5 issue of AVIATION WEEK under the heading of Airline Observer (p. 47).

This article dealt with the airline services rendered to Cape Canaveral, Fla., and read in part, "However, insufficient sales, reservations and information facilities are creating an increasing volume of complaints . . ."

Eastern Air Lines, recognizing the importance of rendering good service to the Cape Canaveral area, in November, 1961, remoted the reservations and information services formerly located at the Melbourne Airport to the Area Reservations Office located in Tampa. This change improved service to the public in many ways. First of all it permitted us to utilize Eau Gallie, Fla., telephone facilities which, being more centrally located than Melbourne, permitted the public from a much wider area of the Cape installation to call Eastern Air Lines without making a toll call. Secondly, the new facility offered more telephone trunks and more people to answer them than did the former Melbourne Airport operation. Thirdly, the change made reservations and information services available to the public 24 hours a day. It also made available, for the first time, system availability on all of Eastern's flights, and the immediate confirmation of space requests on any of 11 other airlines with whom the Tampa Area Office had direct communications. On Mar. 5, 1962, the Tampa Area Reservations Office will become an electronic office utilizing the Univac "Real Time" System, thereby further improving the service to customers.

In January, 1962, the Tampa office handled 100% more telephone calls on the direct lines from Eau Gallie than the Melbourne Reservations Office handled in January, 1961. To further point out that Eastern Air Lines is fully serving all corners of the Cape Canaveral area, I mention that we also handle the reservations and information services for Orlando and Daytona Beach in our Tampa Area Reservations Office.

Your reporter's remarks, of course, were not specific, but I am confident that they do not apply to Eastern Air Lines. To prove my point I suggest that if your reporter finds himself in the Cape Canaveral area he call 262-1553 for reservations and information to Fly Anywhere in the World.

G. J. DEBOR
Area Reservations Manager
Eastern Air Lines
Tampa, Fla.

Training Slashed

Your "Perceptive Reader" from Amityville, N. Y., touched upon one of the greatest tragedies within the industry when he wrote of the deterioration of flight engineer training programs in your Jan. 15 issue (p. 126). The ALPA, through its equal train-

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ing demands upon the carrier and the carriers acceding to these economic pressures, has slashed flight engineer training programs from approximately eight weeks down to, in many cases, as little as three weeks, and this has been done at a time when the most complex aircraft ever developed were being placed into service.

In September of 1960 (a month before the present program was adopted), the FAA proposed a higher level of training for the flight engineer. They were met with considerable resistance by ALPA, which insisted that technical knowledge was not required by the crew because to do otherwise would militate against its program of taking over the flight engineer's job for its own members. The Air Transport Assn. protested vigorously on the grounds that it did not want to be "over regulated" with excessive training requirements. FAA officials "solved" the problem by transferring the flight engineer program from the division that proposed the increased training after studying the subject for over a year to another division that, within 24 hr., approved the present inadequate flight engineer training minimums.

Following a recent rash of incidents involving the hydraulic systems on one of these transports, the FAA was shocked and concerned to learn of the inadequate knowledge that flight crew members possessed in regard to this system—yet it was FAA that, in October, 1960, established the figure of 120 hr. as the minimum ground school for flight engineers on jet equipment. The training on piston aircraft is even less, as the CAB records on the Imperial Airways accident at Richmond, Va., will indicate.

How did this happen? Here are a few of the reasons:

The Air Line Pilots Assn., fearing technological unemployment as a result of jet productivity, decided in 1956 that the easiest way to cope with this matter would be to replace the present flight engineer with a third (ALPA) pilot.

In order to promote this scheme they had to have a "grabber," as Bob Newhart would say—ergo, the "fail-safe" (all pilot) crew.

In 1956 the manufacturers began to preach a theme of "simplicity" in order to sell this highly productive but very expensive machine.

ALPA vigorously supported this idea in order to convince the industry that this "simple" airplane could be flown safely and efficiently without the services of a specialist flight engineer.

In an effort to belittle the flight engineer's job, ALPA insisted on equal training, knowing that the carriers could not afford to train three men to the same high level that they had been training the flight engineer.

The carriers, under extreme economic pressure from the Air Line Pilots Assn., acceded to the concept of equal training and immediately reduced the amount of training given the flight engineer with the result that nobody on the airplane was thoroughly trained or knowledgeable of the aircraft's highly complicated and intricate systems.

When FAA introduced its inadequate training standards, the airlines, much to the delight of ALPA, immediately grasped upon this as means of further reducing its training programs.

Now that the technical training for flight engineers has been cut in half there is new impetus to have the flight engineer take unneeded pilot training to conform with ALPA's desire to capture jurisdiction over the flight engineer's job.

TWA stated before presidential Emergency Board Number 140 that:

"There has been no obsolescence of the job or professional skill of the flight engineer. The flight engineer's job still remains to be done but will be assigned to another member of the crew unless the engineer acquires 'new and additional qualifications not required by the FAA but imposed by the carrier' (and recommended by the presidential commission) as a means of resolving an interunion dispute."

This story has its counterpart on every major airline. The industry and related government officials had better search their souls thoroughly before they continue further down this path of expediency. Attempting to solve such a highly technical matter as the crew complement of a 600 mph., 150 ton transport by yielding to social and economic pressures could have some pretty nasty results.

R. A. BROWN
President
Flight Engineers' International Assn.
Washington, D. C.

TFX Fighter Award

Having followed the TFX tactical fighter problem with some interest, I was appalled by implications that the contract might be determined by factors other than the best design proposal.

Any design team which can succeed in satisfying all the services concerned and produce an aircraft capable of performing efficiently all the missions assigned to it deserves recognition for an outstanding achievement.

If the aircraft is ever used in the defense of our country, I'm sure the American people will be more concerned about its capabilities than about the present political reviews, economic impacts and "spread the work" philosophy.

The two finalists in the design competition are old pros in the aircraft business.

Also, the Air Force and Navy have competent engineers to evaluate their proposals.

Let Boeing and Convair fight it out on the drawing board, and may the better design win the contract.

EVERETT PARRISH

Information About Teflon Hose From The People Who Invented It

No. 1 in a series

SIGNIFICANCE OF COLOR

Resistoflex originated and in 1953 introduced Teflon* hose assemblies via gas turbine applications. Since then millions of assemblies have gone into service in all areas of the aero-space industry, and an outstanding record for performance and reliability has been compiled.

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The black color is a result of a carbon black component being added to the Teflon extrusion compound by a process covered by Resistoflex Patent No. 2,752,637. The purpose of the carbon black is to act as a moderator for the large liquid extrusion-lubricant fraction of the Teflon resin mix. Its excellent absorption characteristic and fine particle size provide millions of microscopic lubricant reservoirs uniformly dispersed throughout the mix. Despite the most exacting controls, Teflon resin displays a wide range of lubricant retention capability. Hence, the carbon black particles, in their function as a moderating agent, serve as suppliers of additional lubricant or receivers of excess lubricant during the passage of the resin mix through the vital constricting throat of the tubing extrusion dies. For this reason black tubing has consistently shown uniformity of structure.

Some have assumed carbon black was merely a color coding for identification. Some have even thought coloring was to hide defects. Some colorings used, because of their poor dispersal characteristics, have resulted in serious agglomeration problems and unreliable structure. Uncolored hose, while not aggravated by the improper use of pigment, continues to be plagued by structural defects resulting from the variation in resin lubricant absorption capability.

Some day the basic resin, which has improved in uniformity over the years, will not require a moderator. Until then, Resistoflex will continue to manufacture black hose by the same methods that have been so well proven in field service.

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