# Aviation Week & Space Technology

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November 4, 1963


SPECIAL REPORT:

## Boeing 727 Three-Engine Jet Transport

Bell Sioux Scout Attack Helicopter



# FOR ALL SELF-LOCKING FASTENER REQUIREMENTS

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lightweight all-metal fasteners



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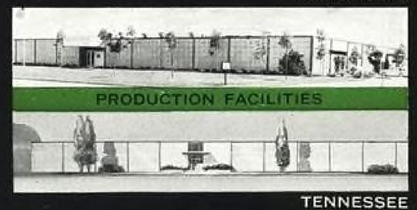
nylon insert locknuts



FOR INDUSTRIAL AND MILITARY APPLICATIONS

Here are the same high standards of Engineering and Manufacturing which have made KAYLOCK Fasteners famous, now being applied to the production of GREER Nylon Insert Locknuts.

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**GREER STOP NUT COMPANY, INC. • A Subsidiary**
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# The red line tells you: This is the world's most reliable jet tire

**New Goodyear Red Streak jet transport tire is so ruggedly built—it delivers as much as 15% more landings per tire—and airline records prove it.**

Here's what's back of the amazing record—15% more landings per tire—compiled by major airlines in the first year the Goodyear Red Streak jet tire has been available:

**Shredded Wire Shield**



First, a shredded wire shield protects the carcass by resisting cuts and cut-growth problems, which frequently necessitate early tire changes and prevent tire retreading.

**Reinforcing Tread Ply**

Next, reinforced tread ply design permits use of extra rubber in the tread, protects tires from hazardous tread chunking and peeling under severe high-speed, heavily loaded jet transport operating conditions.



**Automatic Wear Indication**

When 80% of the tread is worn, this red reinforcing ply begins to show . . . makes tire inspection easier, tells when tire-change time is near. And, unlike other wear indicators, it makes the tire stronger.

**Low-Profile Rib Tread Design . . .**



. . . puts more rubber where the tire meets the runway, increases tread life. Special tread design furnishes the best balance for maximum tread wear and coefficient of friction under all conditions, snow or ice, wet or dry.

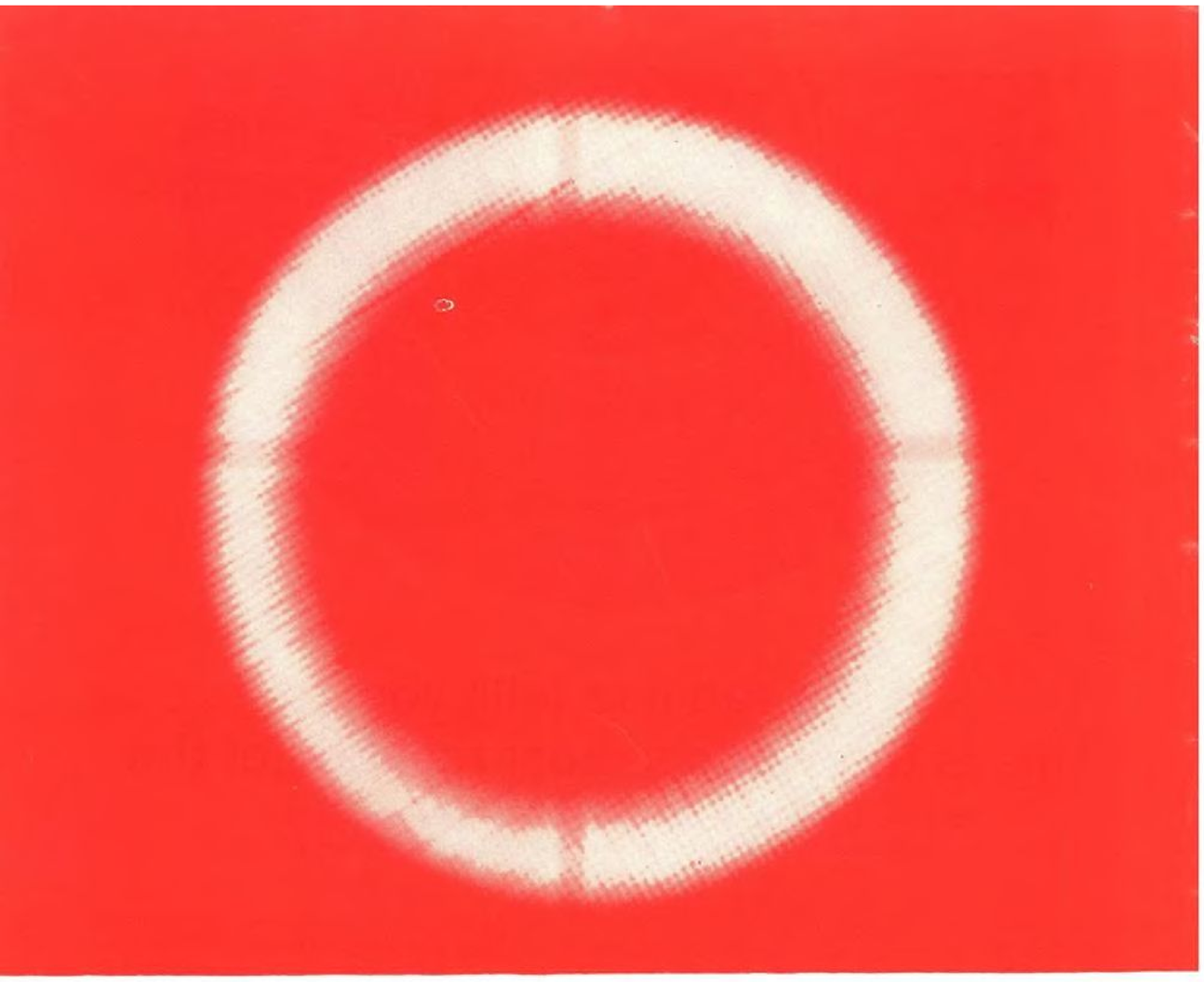
**Plus Many Other Features . . .**

. . . specially compounded tread rubber, computer-calculated balanced ply construction, super-strength beads, high-pressure cures and quality control that checks the tire 140 times during its production. It all adds up to . . .

**. . . The Best Jet Tire Buy in the Business**

Get full details on the Red Streak—world's most reliable jet tire. Write Goodyear, Aviation Products, Dept. K-1715, Akron, Ohio 44316.

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AVIATION PRODUCTS



# For higher TWT efficiency...a hollow beam



**STS-188, a 2 kW, S band TWT proves Sperry's capability in depressed collectors. Six other models ranging through S, C, and X bands, are also operational at 10 W, 20 W and 2 kW power levels.**

This photograph of a hollow, high-perveance electron beam helps us measure our progress toward a goal of higher efficiency for traveling wave tubes. That's because its halo shows us how we're doing on beam control, and lets us know how our higher perveance electron gun designs are working out.

We do a lot of other things to increase TWT efficiency. Seven different types of depressed-collector TWT's are already in the field . . . operating at power levels as high as 2 kW. And we're making constant progress on the design and manufacture of shorter, more effective attenuators.

In short, Sperry is doing quite a job on the technical considerations that improve efficiency of traveling wave tubes. 25% efficiency is already a reality on many of our models, and better things are coming.

**A FREE TECHNICAL PAPER** gives the details, both theoretical and practical. If you are searching for higher efficiency in broadband microwave systems, get your copy today. Write Sperry, Gainesville, Florida, or contact your Cain & Co. representative. In Europe, contact Sperry Europe Continental, Paris.

SPERRY ELECTRONIC TUBE DIVISION
SPERRY RAND CORPORATION
GAINESVILLE FLORIDA


## AEROSPACE CALENDAR

Nov. 11-15—Institute on Reliability Engineering and Management, Tucson, Ariz. Sponsors: University of Arizona; Northrop Space Laboratories.

Nov. 12-14—Symposium on Supersonic Airliners, London, England. Sponsors: British, French and U.S. Air Line Pilot Associations.

Nov. 12-14—Fall Joint Computer Conference, American Federation of Information Processing Societies, Las Vegas Convention Center, Las Vegas, Nev.

Nov. 13-14—Seminar on Automatic Checkout Equipment and Techniques, Columbus, Ohio. Co-sponsors: NASA's George C. Marshall Space Flight Center; Battelle Memorial Institute.

Nov. 13-14—Fifth General Assembly, International Technical Institute for Flight Engineers, La Maison des Ailes, Brussels.

Nov. 13-15—18th Annual Meeting, Armed Forces Chemical Assn., Statler-Hilton Hotel, Washington, D. C. Host: Air Force.

Nov. 17-22—Winter Annual Meeting, American Society of Mechanical Engineers, Bellevue-Stratford Hotel, Philadelphia.

Nov. 18-19—Symposium on Unconventional Inertial Sensors, Farmingdale, N.Y. Sponsors: Republic Aviation Corp.; N.Y. Scientific and Technical Liaison Office, Air Force Systems Command's Research and Technology Div.; Bureau of Naval Weapons. (Classified.)

(Continued on page 7)


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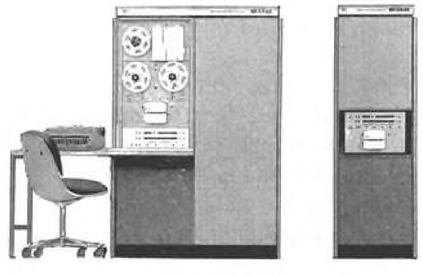


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In scientific/engineering applications, SDS 900-Series computers give more answers per dollar, more reliably, than comparable machines. The SDS 920 costs $98,000. The smaller SDS 910 costs only $48,000. Although both are new from the ground up (the first unit shipped in August, 1962), alert users such as JPL, Bell Labs., NASA, Motorola, G.E., Honeywell and RCA are already on the customer list. Care to join them?



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OTHERS ONLY .3 SQ. IN.**

**Every Air-Maze filter is the answer to a specific problem. This large filter* screens 10 micron-size particles out of jet fuel. Made of stainless steel, it goes into a jet engine developing a 17,000-pound thrust. The filter element is permanent and cleanable. The smaller filter* is designed to screw into a hydraulic system. It screens 2 micron particles, this time out of hydraulic fluid. So what about your filter problems? If necessary, we'll design and build a special filter just for you. Send us the hard jobs, the precise jobs. We like a challenge. Write or call Rockwell-Standard Corporation, Air-Maze Division, Cleveland 28, Ohio.**

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**AIR-MAZE** FILTERS ARE PRODUCED BY ROCKWELL-STANDARD CORPORATION

ROCKWELL R STANDARD ®




## AEROSPACE CALENDAR

(*Continued from page 5*)

**Nov. 18-20**—Sixth National Symposium, Society of Aerospace Material and Process Engineers, Olympic Hotel, Seattle, Wash.

**Nov. 18-22**—10th National Plastics Exposition, Society of the Plastics Industry, McCormick Place, Chicago, Ill.

**Nov. 19-21**—1963 AtomFair, Hotel Americana, New York, N. Y. Co-sponsors: Atomic Industrial Forum; American Nuclear Society

**Nov. 19-21**—Conference on Stratosphere-Mesosphere Structure, El Paso, Tex. Sponsors: Texas Western College; American Meteorological Society; AIAA.

**Nov. 19-21**—42nd Annual Meeting, Aviation Distributors and Manufacturers Assn., Shamrock Hilton, Houston, Tex.

**Dec. 3-5**—Joint Annual Meeting and Convention, National Pilots Assn. and National Aviation Trades Assn. including the National Air Taxi Conference, Fontainebleau Hotel, Miami Beach, Fla.

**Dec. 3-5**—33rd Symposium on Shock, Vibration and Associated Environments, U. S. Naval Research Laboratory, Washington, D. C.

**Dec. 3-5**—Annual Meeting, Assembly of the Radio Technical Commission for Aeronautics, Washington, D. C.

**Dec. 4-6**—Testing of Manned Flight Systems Conference, American Institute of Aeronautics and Astronautics/NASA Flight Research Center, Edwards AFB.

**Dec. 4-6**—Ultrasonics Engineering Symposium, Institute of Electrical and Electronics Engineers, Marriott Motor Hotel, Washington, D. C.

**Dec. 5-6**—14th National Conference on Vehicular Communications, Institute of Electrical and Electronics Engineers, Adolphus Hotel, Dallas, Tex.

**Dec. 6**—Fourth Annual Seminar on the Reliability of Space Vehicles, Institute of Electrical and Electronics Engineers, Airport, Marina Hotel, Los Angeles.

**Dec. 11-13**—Conference on Heterogeneous Combustion, American Institute of Aeronautics and Astronautics, Palm Beach, Fla.

**Dec. 13-14**—National Vendors Meeting, Space and Flight Equipment Assn., San Diego Aerospace Museum, San Diego.

**Dec. 16-17**—Conference on Non-Linear Processes in the Ionosphere, National Bureau of Standards Boulder Laboratories, Boulder, Colo.

**Dec. 16**—Sixth Annual Army Aviation Contract Services Symposium, Mayflower Hotel, Washington, D. C. Sponsor: National AeroSpace Services Assn.

**Dec. 30**—Annual Meeting, American Assn. for the Advancement of Science, Cleveland, Ohio.

**Jan. 7-9**—Tenth National Symposium on Reliability and Quality Control, Statler Hilton Hotel, Washington, D. C.

**Jan. 13-17**—Society of Automotive Engineers Automotive Engineering Congress & Exposition, Cobo Hall, Detroit, Mich.

**Jan. 19-23**—16th Annual Convention, Helicopter Assn. of America, San Marcos Inn, Chandler, Ariz.

**Jan. 20-23**—Annual Winter Meeting, American Institute of Aeronautics and Astronautics, Hotel Astor, New York, N. Y.

(*Continued on page 9*)




# How the world became flat

Across Canada, over the pole, ringing Europe, to the Middle East, leaping the Pacific and linking much of Southeast Asia is a microwave military communications network, binding together the community of free nations. ■ Billions of bits of data and countless phone conversations and teletype messages are exchanged daily. Contact time from one command point to any other is typically only a matter of seconds. This took some doing.[1] ■ Figuratively speaking, the earth had to be flattened to permit contact between transmitter and receiver. Over-the-horizon communications at microwave frequencies was made possible by forward-scatter tropospheric propagation—"tropo" for short. Kilowatts of microwave energy are needed. They are generated by amplifier klystron tubes. ■ The modern power klystron had its beginnings in the discovery of the principle of velocity modulation at Göttingen in 1934.[2] Other brilliant expressions of the same basic principle developed independently in the U. S. in 1937 and 1939. ■ The power klystron is inherently large. Because it is also essentially simple, it may, with skill, be designed simultaneously for high power, high gain, long life and military ruggedness. All these are essential to the task of "tropo" communications. So successful was this approach to the problem that the klystron is the sole microwave power source for every element in the network. ■ And so successful has one company been that its amplifier communications klystrons are used almost exclusively. That company is Eitel-McCullough. Eimac has designed, developed and delivered over 95% of these communications klystrons. The life of an Eimac power klystron in this service ordinarily exceeds 25,000 hours. *More than a few are now past the 50,000 hour mark.* ■ Upon such formidable foundations, Eimac continues to forge into other areas. It is now at work in a government-sponsored effort intent on achieving a million watts of continuous microwave energy at a frequency whose limit today is about 50,000 watts. (This is an almost unbelievable accomplishment, if anyone can do it. There is good reason to think Eimac can.) ■ Eimac ground-station klystron amplifiers are now in worldwide service in satellite relay transmission. And Eimac has developed new ultra-lightweight driver klystrons for the world's largest linear accelerator. All largely on self-sponsored research programs. ■ These are typical of Eimac's technical achievements in electron power tube development. Anyone can prove the earth is round. It takes special skill and capability to flatten it.

1. *This story is told more fully in "The World is a Puddle" booklet. Write for your free copy.*
2. *By coincidence, this was also the year Eitel-McCullough, Inc. was founded. The discoverer of the velocity modulation principle is now an Associate Director of Research at Eimac. A reprint of his historic 1935 report on the discovery is yours for the asking.*

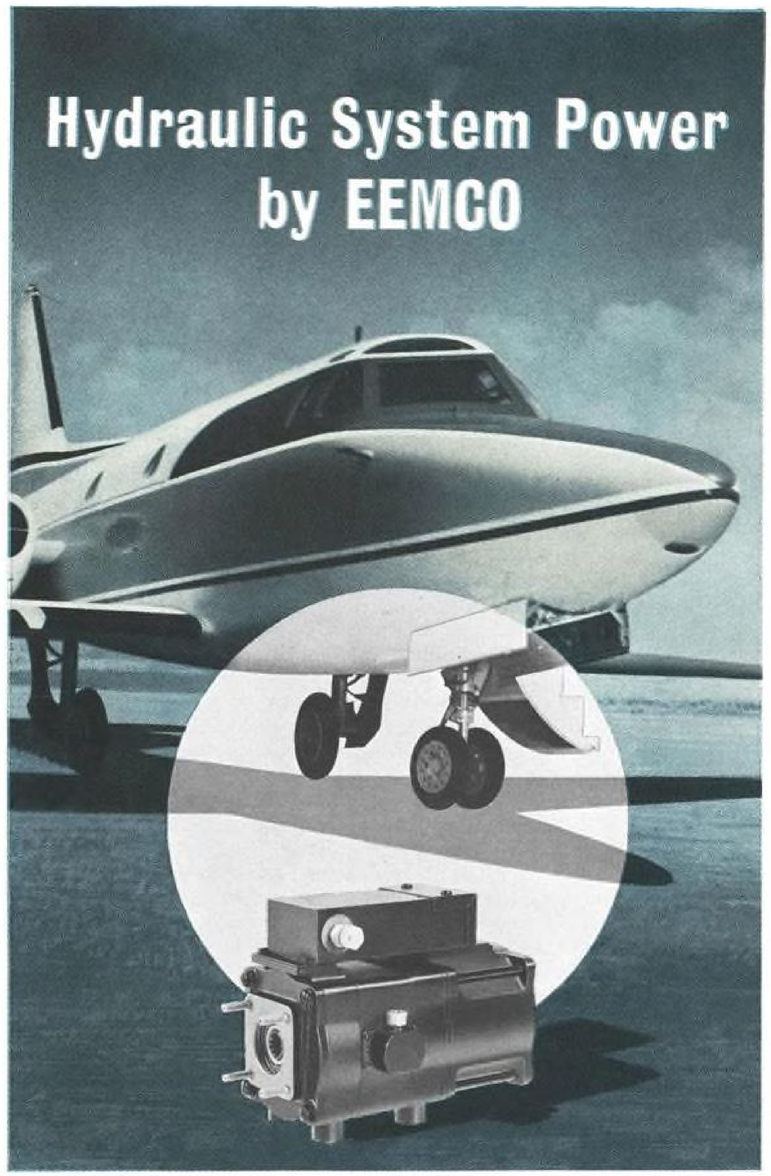
Eimac®

**EITEL-McCULLOUGH, INC.**

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Subsidiaries: National Electronics, Inc., Geneva, Illinois
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# Hydraulic System Power by EEMCO



Many of America's leading aerospace manufacturers depend upon EEMCO motors and actuators for new aircraft and missiles. The twin-jet Sabreliner, by North American Aviation, needed a reliable, high performance motor to drive the pump on the main hydraulic system. EEMCO came up with the right design, and now EEMCO motor D-1291 is standard equipment on the 500 mph Sabreliner–both commercial and military versions. □ Motor D-1291: 25 volts, dc; 12,000 rpm; 4.5 hp ; current 175 amps; Duty cycle–to 10,000 feet, 15 seconds on at 4.5 hp , 300 seconds off–to 52,000 feet, 8 seconds on, 300 seconds off; explosion proof; weight with radio interference filter 13.8 pounds; thermal cut-out; temperature–altitude per MS 33543, curve II; conforms to MIL-M-8609 □ For information on EEMCO state-of-the-art motors, actuators, and starter-generators for aerospace and industrial applications, write or call the EEMCO Division of Electronic Specialty at the address shown below.

ES is a diversified, dynamic, multi-divisional organization serving defense and industry over a broad range of vital areas with advanced systems, sub-systems, and state-of-the-art components. Major contributions are currently being made in the following:

**ELECTRONIC AND ELECTROMECHANICAL CONTROLS:**
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**COMMUNICATIONS:**
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**POWER:**
precise power systems, dynamotors, computer power sources, motor - generators, actuators, starter generators, power conversion systems, transmission towers for public utilities.

**SPACE CONDITIONING:**
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Systems Laboratories conduct research, development and study programs in reconnaissance, electronic countermeasures, interferometer phased array systems, and total energy packages; integrating divisional components, sub-systems, and specialized technical skills.

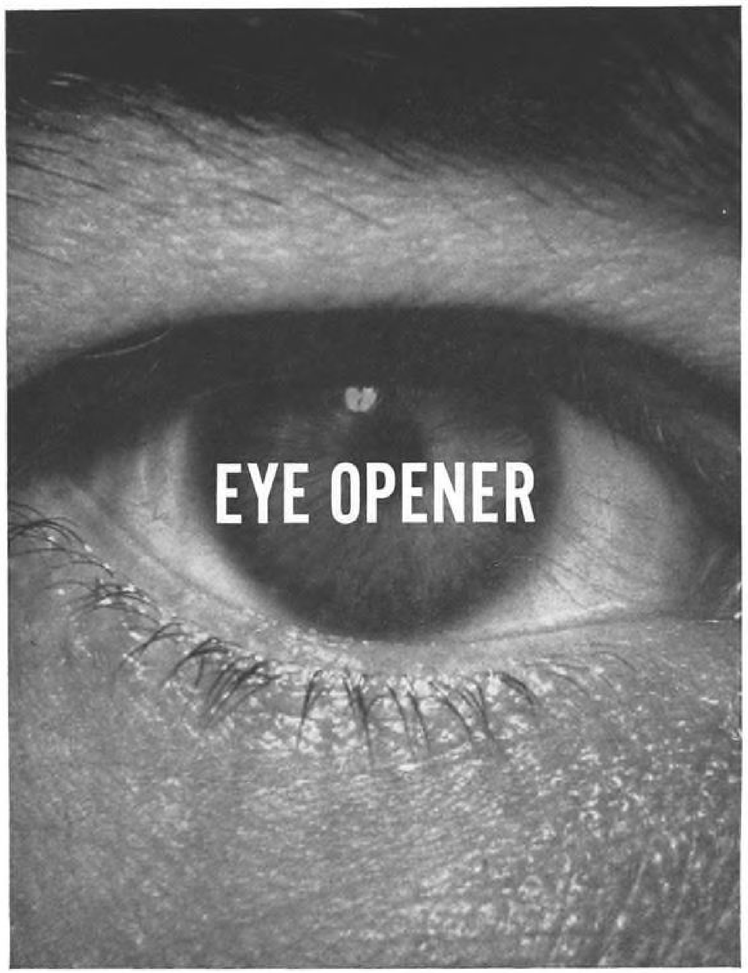
*For information concerning the corporate systems capability, product line, or research and development programs, write to the Director of Marketing, address below.*

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## AEROSPACE CALENDAR

(Continued on page 7)

**Jan. 29-31**—Solid Propellant Rocket Conference, American Institute of Aeronautics and Astronautics, Palo Alto, Calif.
**Feb. 5-7**—Fifth Winter Convention on Military Electronics, Institute of Electrical and Electronics Engineers, Ambassador Hotel, Los Angeles, Calif.
**Feb. 19-21**—International Solid-State Circuits Conference, Institute of Electrical and Electronics Engineers, Sheraton Hotel and University of Pennsylvania, Philadelphia, Pa.
**Mar. 9-10**—Aerodynamic Testing Conference, Marriott Twin Bridges Motor Hotel, Washington, D. C. Sponsors: American Institute of Aeronautics and Astronautics; U. S. Navy.
**Mar. 23-26**—International Convention, Institute of Electrical and Electronics Engineers, Coliseum and New York Hilton, New York, N. Y.
**Apr. 1-2**—Fifth Symposium on Engineering Aspects of Magnetohydrodynamics, Institute of Electrical and Electronics Engineers, Massachusetts Institute of Technology, Cambridge, Mass.
**Apr. 1-3**—Fifth Annual Structures and Materials Conference, American Institute of Aeronautics and Astronautics, Riviera Hotel, Palm Springs, Calif.
**Apr. 6-8**—International Conference on Nonlinear Magnetics (Intermag), Institute of Electrical and Electronics Engineers, Shoreham Hotel, Washington, D. C.
**Apr. 13-16**—Third International Flight Test Instrumentation Symposium, College of Aeronautics, Cranfield, England.
**Apr. 19-25**—International Conference & Exhibit on Aerospace Electro-Technology, Institute of Electrical and Electronics Engineers, Westward-Ho Hotel, Phoenix.
**Apr. 24-May 3**—1964 German Air Show, Hanover Airport, Hanover, West Germany.
**May 4-6**—Aerospace Propulsion Meeting, American Institute of Aeronautics and Astronautics, Cleveland, Ohio.
**May 5-6**—Fifth National Symposium on Human Factors in Electronics, Institute of Electrical and Electronics Engineers, San Diego, Calif.
**May 11-13**—16th Annual National Aerospace Electronics Conference (NAECON), Institute of Electrical and Electronics Engineers, Biltmore Hotel, Dayton, Ohio.
**May 19-21**—International Symposium on Microwave Theory and Techniques, Institute of Electrical and Electronics Engineers, Idlewild Airport, N. Y.
**May 25-27**—General Aviation Design & Operations Meeting, American Institute of Aeronautics and Astronautics, Wichita, Kan.
**June 2-4**—National Telemetering Conference, American Institute of Aeronautics and Astronautics/Institute of Electrical and Electronics Engineers/Instrument Society of America, Biltmore Hotel, Los Angeles, Calif.
**June 29-July 2**—First Annual Meeting & Technical Display, American Institute of Aeronautics and Astronautics, Sheraton Park Hotel, Washington, D. C.
**Sept. 7-13**—1964 Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.


## 3...300...OR 3,000 MILES OUT...

Opening the "eyes" of a vehicle—the navigational ports—is no mean feat in space. An actuation system must be devised to sequentially unlatch, open, close and latch doors in the vehicle's skin. The TELEFLEX answer to this challenge is a unique electro-mechanical system that will operate in either intense cold or the sun's direct heat. This, without benefit of a heat shield or protection of atmospheric pressure (think of the phenomenon of "outgassing" which can cause cold weldment of adjacent metals). It's another example of TELEFLEX problem-solving capabilities which extend over a broad spectrum of control and feedback systems, including unusual accomplishments under hostile environmental conditions. Put these capabilities to work for you. TELEFLEX INCORPORATED, North Wales, Pa.

*Creative engineering of control and actuation systems*

TELEFLEX INCORPORATED



## *Now flying!*

This is the MU-2! Turbo-jet efficiency and economy—325 miles per hour cruising at 20,000 feet—1760-mile range—7 passengers. Excellent for take-off at small airport (a special lifting device takes the MU-2 into the air within a short-run of approximately 1,000 feet). First of its kind to be produced in Japan for this era of private aircraft. SHIN MITSUBISHI Heavy-Industries, Limited presents the practical answer to corporate business flying. The MU-2 prototype is now undergoing extensive flight tests.

Experts who have seen the MU-2 in flight agree that it is one of the smartest, safest and most comfortable small planes to fly the sky-lanes. Designed for busy people who are both economy- and safety-minded, they will also appreciate the ease with which the MU-2 is handled.

**SHIN MITSUBISHI**
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**NEW YORK OFFICE:** c/o Mitsubishi International Corp., 120 Broadway, New York 5, N.Y., U.S.A.

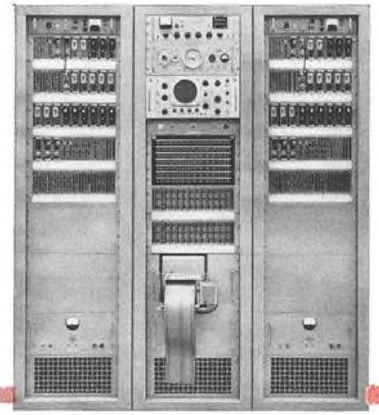
**Mooney Aircraft Inc., Texas, undertakes the sales of the MU-2 in the area of U.S.A., Canada and Mexico for Shin Mitsubishi Heavy-Industries, Limited.**

# ASTRODATA

## CUSTOM TIMING SYSTEMS FROM STANDARD ASSEMBLIES

You get solid state timing systems tailored to your specific requirements—from sophisticated range timing systems to portable instrumentation—with Astrodata's unique, building-block production technique.

For example, you can select fundamental units from the table below, then designate standard options to obtain exactly the timing functions most suited to your particular requirements. Numerous standard options have been designed and built to provide you with the most versatile—and highly reliable—timing equipment available today.



### TIME CODE GENERATING SYSTEMS

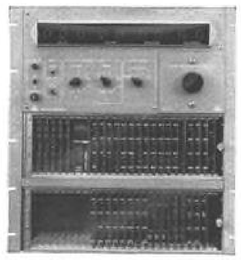
IRIG, NASA, AMR, PMR, White Sands, Eglin and special codes available

**Model 6190** Up to 8 serial time codes simultaneously... standard pulse rates... decimal display ... stability to 1 part in $10^8$.

**Model 6140** Up to 4 serial time-of-day codes simultaneously... standard pulse rates... decimal display ... stability to 1 part in $10^8$.

**Model 6100** Up to 4 serial time-of-day codes... standard pulse rates... binary display... stability to 1 part in $10^8$.

### TIME CODE TRANSLATOR SYSTEMS



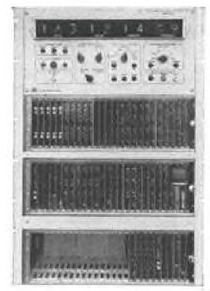
**Model 6220** UNIVERSAL... translates all serial time codes to decimal display... parallel BCD output. Tape Search and Control Units (Models 6224, 6225, 6226) available for universal automatic tape search.

**Model 6204** translates serial time code... provides parallel output and display consistent with input code format.

**Model 6201** translates time-of-day serial code to parallel output and binary display.

**Model 6200** converts input serial time codes to time-of-day display.

### TERMINATING SYSTEMS



**Model 6420** TIME CODE TRANSLATOR/GENERATOR... operates as Translator and/or generator... synchronizes time code generator to input serial time code... no interruption of output on loss of input signal.

**Model 6620** Timing terminal unit... provides basic module for standard terminal function assemblies... can be assembled to provide any necessary terminal, signal conditioning or conversion functions... assemblies available: AGC amplifiers, demodulators, neon drivers, high level amplifiers, balanced line drivers, galvo amplifiers, relay drivers.

A new 48-page handbook of the most commonly used time code formats has been compiled as a handy reference for instrumentation engineers. For your free copy write to

For applications assistance when considering your timing system, contact your nearest Astrodata representative or the Timing Instrumentation Group direct.

**ASTRODATA INC.**
240 E. Palais Road • Anaheim, California



**. . . army's new mobile missile . . .**

The Army is developing the highly mobile *Lance* missile to provide close support for tactical combat divisions requiring either conventional or nuclear fire power for their wide variety of missions.

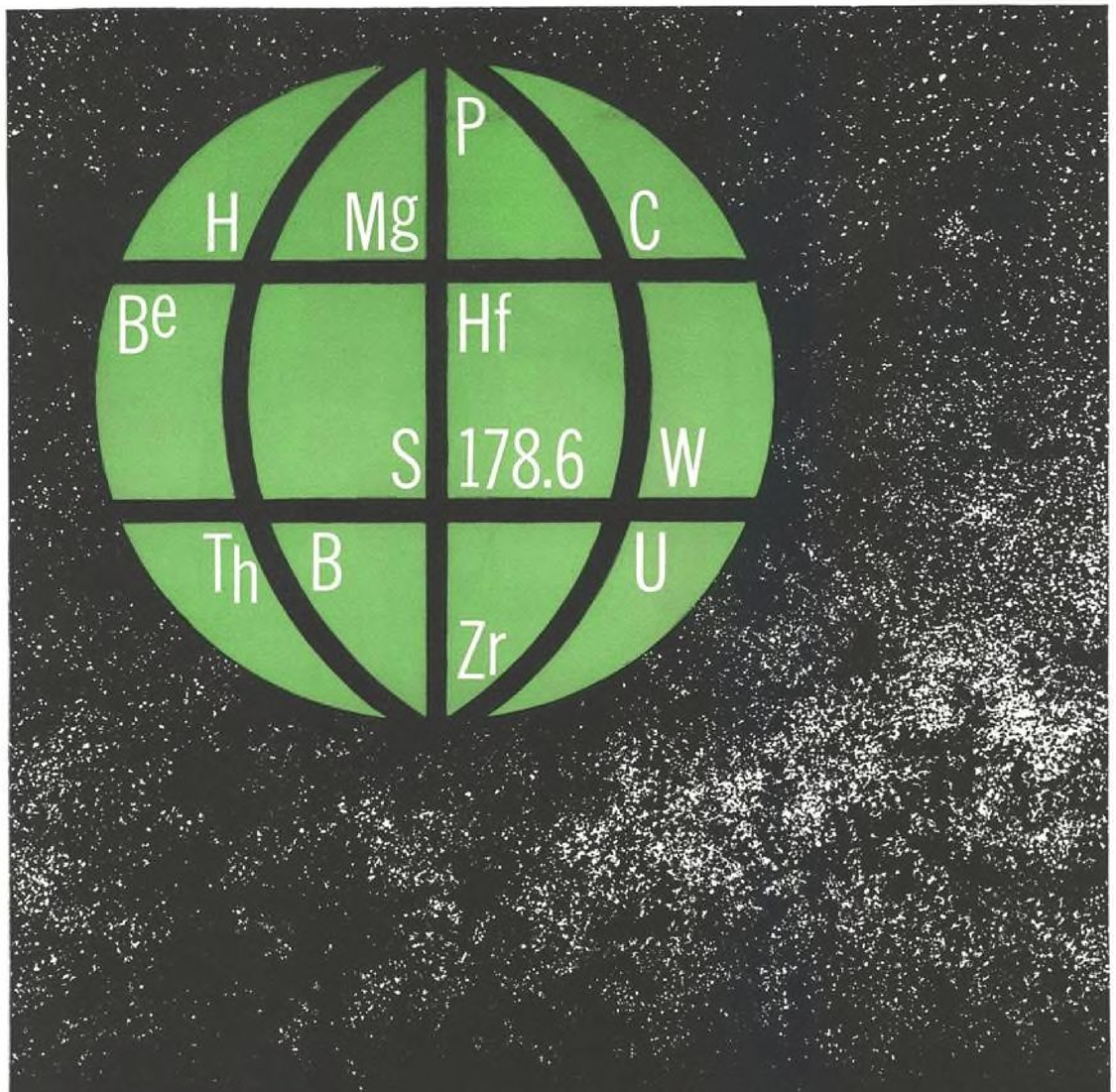
To give the kind of low-cost, rugged reliability necessary for ground troop environments, the LTV Michigan division of Ling-Temco-Vought is developing *Lance* around a pre-packaged, storable, liquid propulsion system. The resulting accuracy, reliability and transportability of the weapon is expected to give it outstanding battlefield advantages.

*Lance* is mounted on its own self-propelled, tracked launcher which can take it where the trouble is — matching the sure-footed maneuverability of other tactical military vehicles, including the ability to swim rivers and lakes.

The design simplicity of *Lance* which is intended to permit minimum reaction time in combat, maximum mobility and high reliability is the result of LTV's sound, versatile engineering.

LTV LEADERSHIP THROUGH VERSATILITY






Anything on Earth can be put into J-M Thermomat . . . the most versatile asbestos-phenolic molding mat available

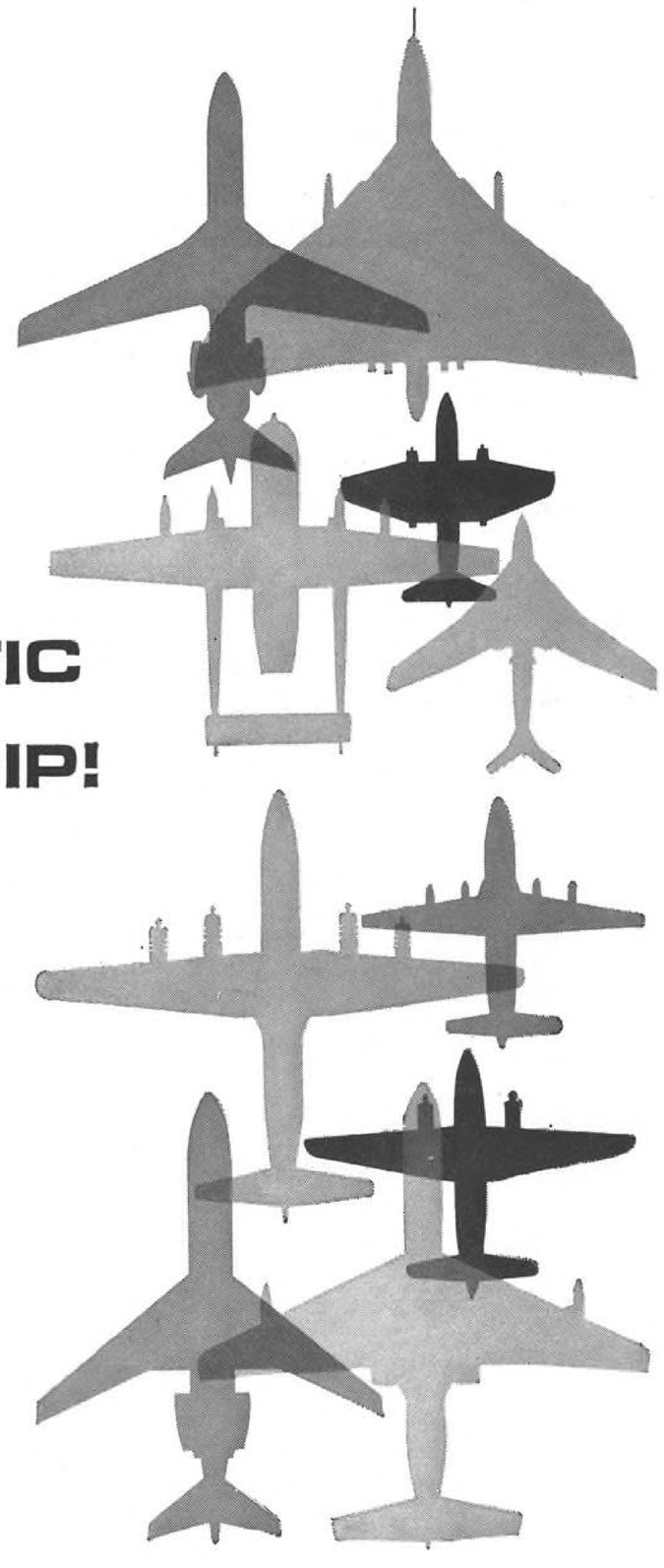
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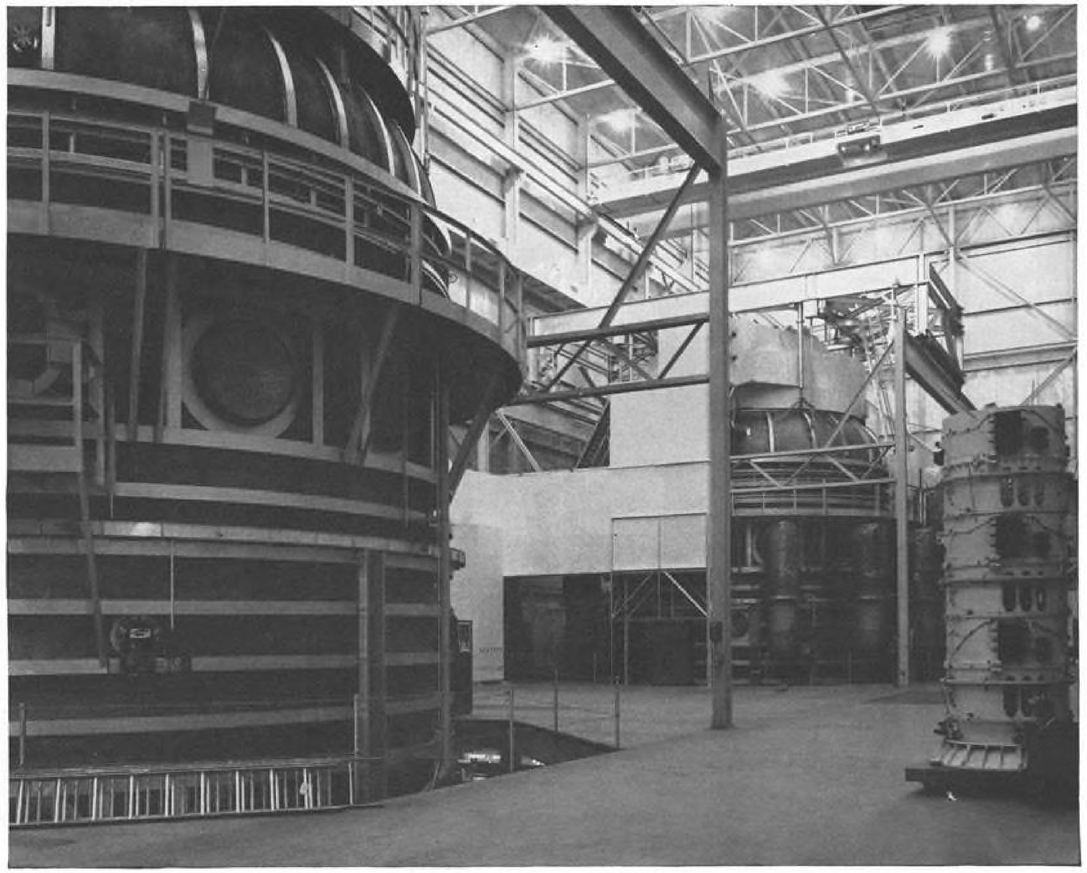
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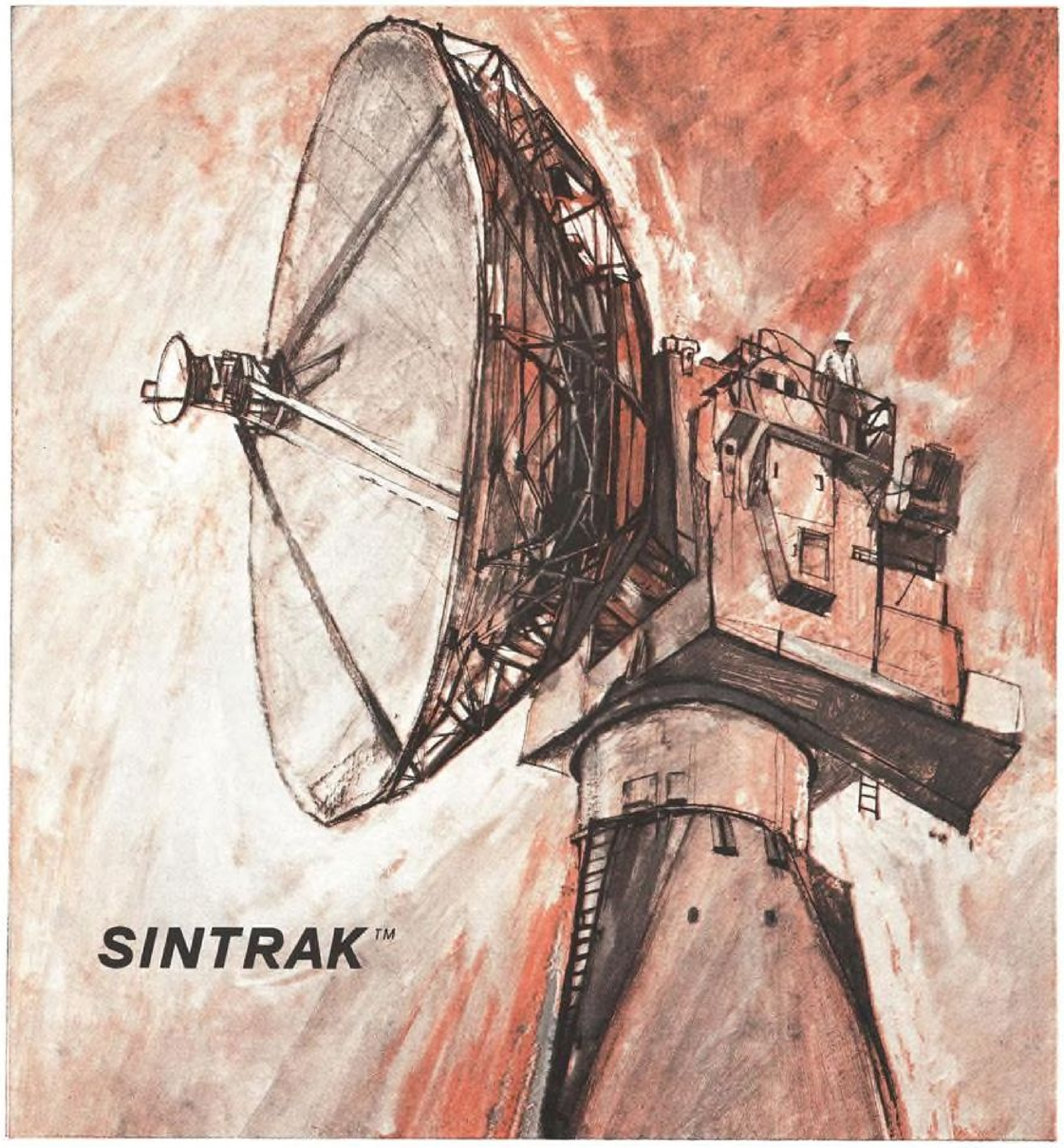
The SES chamber, to be equipped with a collimated solar simulator, is capable of operation in the $10^{-9}$ Torr range under full load conditions. During acceptance testing, it attained the $10^{-10}$ Torr scale.

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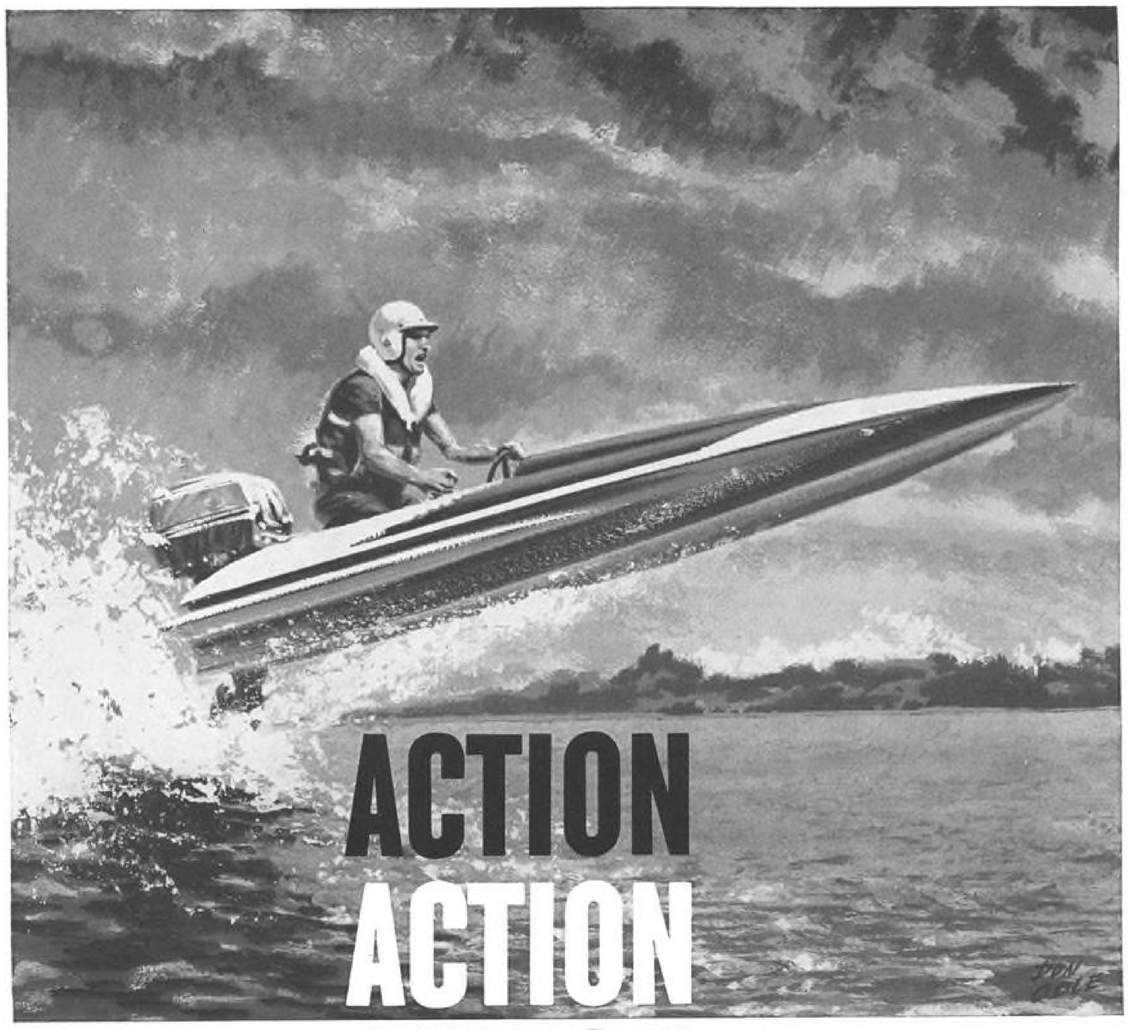
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# Aviation Week & Space Technology

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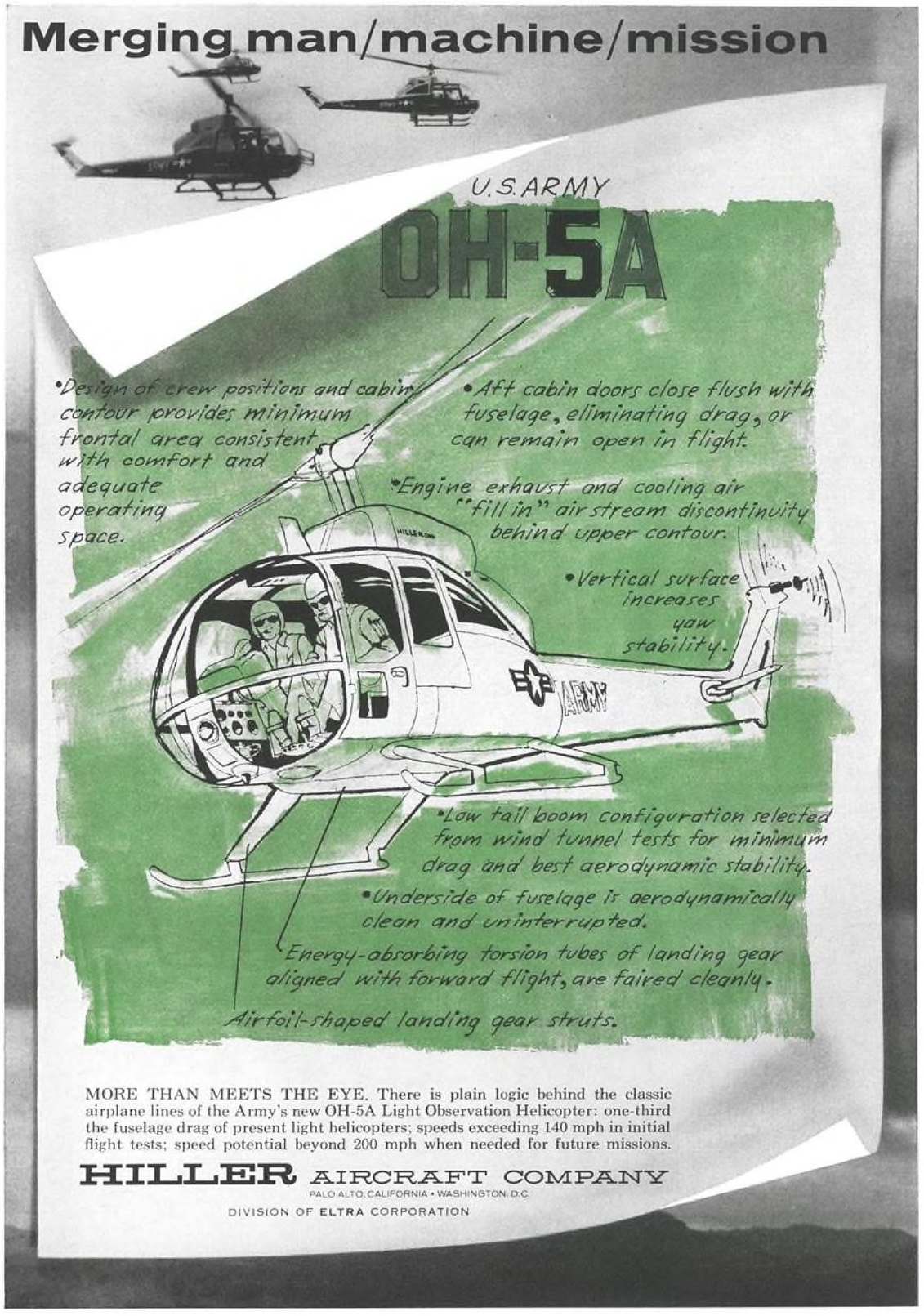
New National Space Policy Needed .... 21


COVER: Bell Helicopter's Model 207 Sioux Scout attack-fighter helicopter is shown prior to tests at Army's Field Artillery School, Ft. Sill, Okla. Two-seat helicopter has gunner seated forward with unobstructed field of view and pilot located on raised rear seat. Aircraft cruises at 100-105 mph. Stub wings increased rate of climb and maneuverability and can carry additional armament. For additional Sioux Scout photos and details, see pp. 66-67.

PICTURE CREDITS
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# EDITORIAL

## New National Space Policy Needed

The national space policy established by President Kennedy in May, 1961, with his announcement of the Apollo manned lunar landing program has been so badly shredded in recent weeks that a fundamental re-appraisal of what this nation can and should do in space is urgently needed.

Both the Congress and the American public have been jarred and confused by a variety of conflicting statements, including President Kennedy's ill-conceived and hasty proposal for a joint lunar program with the Russians and the Soviet Chairman's well-timed attempt to torpedo the Fiscal 1964 NASA appropriation with his implication that the USSR has withdrawn from a race to land men on the moon.

### Questionable Economy

Already, this confusion has had some bad effects on the pace and scope of the U. S. space program. The cutback in early Saturn and Apollo test vehicles (see p. 27) will undoubtedly prove to be false economy. This reaction charts a course that ultimately will be much more costly in money, experience and knowledge.

We believe that there is sufficient non-essential activity in NASA that could be cut instead of the Apollo hardware. But apparently NASA Administrator James Webb intends to make good his previously announced threat to put the burden for slowing the manned space flight program back onto Congress because it dared to cut his Fiscal 1964 budget request.

The furor following the Kennedy-Khrushchev statements and the congressional budget-cutting should make it apparent that a sound U. S. space program cannot be based on momentary reaction to Soviet statements or space feats. Instead, it must be based on a realistic appraisal of what possibilities space technology offers for furthering the national interests, both civil and military. Since the initial jolt of Sputnik in 1957, the U. S. space program has been operated primarily as a fluctuating reaction to Soviet fact and fiction. The development of a truly national space program to meet U. S. requirements is long overdue.

We think that there are several basic flaws in the present U. S. space policy that must be eliminated to obtain the sustained level of national support required for a long-term development of space technology capability.

Most serious flaw is the lack of an adequate military research and development program in space and the lack of significant military participation in the NASA experimental development programs.

The Soviets have made no secret of their military aims in manned space flight. They are obviously concentrating on developing their technical capability in earth-orbital space station operations which offer the most promise for a militarily useful space system. One of the many advantages the Soviets obtained from the nuclear test ban treaty was the assurance that these experiments will not be threatened by U. S. high-altitude nuclear test explosions. The military objectives of the Soviet space program will become more and more apparent as its flight capability in earth orbits expands into rendezvous, docking and space station assembly. Neither Congress nor the American people are likely to support a sizable national space program for Fiscal 1965 and beyond unless they are convinced that it will protect their military interests in space.

### Confusion in Goals

The second serious flaw in current space policy has been the over-emphasis on the goal of a manned lunar landing and the lack of understanding of the broad space capability this program entails. The Apollo program is a sound focal point for developing all of the major elements that will provide this nation with a broad capability in space which can be applied to meet any specific requirements that may develop.

The Saturn boosters, the Apollo space vehicles, the lunar bug and the guidance, life support and propulsion systems being developed for the lunar landing mission will be the basic elements of any operational space system of the next several decades. This point is not yet sufficiently clear to either Congress or the taxpayers.

It is too late to salvage much from the Fiscal 1964 NASA budget fiasco. But the Fiscal 1965 space budget, which must appear on Capitol Hill in a few months, must be accompanied by a new appraisal of the space program based on solid elements of national self-interest, or it will founder fast.

—Robert Hotz



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# WHO'S WHERE

## In the Front Office

**Dr. Joseph A. Boyd,** president and chief executive officer of Radiation, Inc., Melbourne, Fla., succeeding **Homer R. Denius,** who continues as board chairman. Also: **Harold E. O'Kelley,** vice president-Operations of Radiation-Melbourne, a division of Radiation, Inc., succeeding **Eric J. Isbister,** now vice president and assistant to the executive vice president. **Dr. A. W. Sissom** succeeds Mr. O'Kelley as director, Surface Systems Engineering Div. of Radiation-Melbourne.

**Fred K. Godfrey,** president, Weber Aircraft Corp., Burbank, Calif., succeeding **Karl Weber,** now board chairman.

**R. W. Lee,** president, Information Systems Group of General Precision, Inc., Glendale, Calif., succeeding **W. E. Bratton,** resigned. Also: **Francis J. Alterman,** president of the Commercial Computer Div. of the Information Systems Group.

**Warren G. Woodward,** vice president in charge of American Airlines' Washington, D. C. office.

**Dr. Donald B. Sinclair,** president of General Radio Co., West Concord, Mass., succeeding **Charles C. Carey,** deceased.

**Perry A. White,** president of Baldwin-Lima-Hamilton Corp., Philadelphia, Pa., succeeding **William S. Ginn,** resigned.

**Dr. Arthur L. Aden,** a corporate vice president and associate technical director, Electro-Optical Systems, Inc., Pasadena, Calif.

**J. Walter English,** vice president-finance, Simmonds Precision Products, Inc., Tarrytown, N. Y.

**John L. Higgins,** vice president-sales, Slick Airways.

**W. A. Hardenstine,** vice president-sales, World Airways, Inc.

**Rear Adm. Lawrence B. Richardson** (USN, ret.), associate director for Washington, D. C., for International Associates, Inc., Geneva, Switzerland, and **S. S. Hanley,** associate director for New York.

**Richard J. Hanschen, Ronald F. Keener, Howard Moss** and **James R. Reese,** assistant vice presidents of Texas Instruments, Inc., Dallas, Tex.

**Charles E. Balbach,** assistant to the president of Moog Servocontrols, Inc., East Aurora, N. Y.

**John F. Walrath,** controller, Univac Div. of Sperry Rand Corp., New York, N. Y.

**R. W. Hardesty,** assistant to the senior vice president-marketing and services, United Air Lines.

## Honors and Elections

**Karel J. Bossart,** technical director of General Dynamics/Astronautics, has received a Medal of Honor from the University of Brussels. The special scientific medal was presented for his outstanding contribution to science.

**Igor I. Sikorsky,** aviation pioneer, has been selected by The American Society of Mechanical Engineers to receive the 1963 ASME Medal for "his outstanding leadership in the design and timely application of the helicopter as an essential commercial and military transportation medium."

(Continued on page 108)

# INDUSTRY OBSERVER

► Army's White Sands Missile Range may be favored by USAF as the prime recovery area for manned spacecraft if Edwards AFB does not get the designation. Air Force apparently would prefer White Sands to the Texas-Gulf of Mexico area proposed by National Aeronautics and Space Administration. With White Sands as the prime recovery area, Edwards could serve as the undershoot area and Holloman AFB as the overshoot area. Support for White Sands is increasing in Congress.

► **Thrust of the Titan 2 cores in the Titan 3 configuration will be increased 35,000 lb. each for a net gain of 70,000 lb. thrust in the first stage. First-stage thrust now will be 500,000 lb. instead of the 430,000 lb. thrust in the Titan 2 weapon system and the Gemini launch vehicle. Second-stage engine thrust will remain at 100,000 lb., but the two engines of the third stage (transtage) have been running above the nominal design level of 8,000 lb. each at Aerojet-General's test facility.**

► Proposals for a new Launch Enabling System (LES) for the Minuteman ICBM, which would function as a foolproof backup of the existing launch system, will be submitted by industry competitors by Nov. 8 to AFSC's Ballistic Systems Div.

► **Navy BuWeps has issued requests for proposals for the study of advanced sea-based weapons. Companies expected to submit proposals include Douglas, Lockheed, Ling-Temco-Vought, Northrop, Space Technology Laboratories, North American Aviation, Aerojet-General and General Dynamics/Astronautics. Navy has intensively analyzed this advanced requirement, which anticipates weapons for fleet protection in the 1970-80 period (AW Apr. 1, p. 23).**

► Multi-million-dollar flight test program of a re-entry vehicle adapted to make programed maneuvers after re-entry is being conducted by General Electric's Missile and Space Vehicle Dept. for USAF's Ballistic Systems Div. Program is in addition to the company's study of a maneuverable, ballistic re-entry vehicle (AW Sept. 16, p. 23).

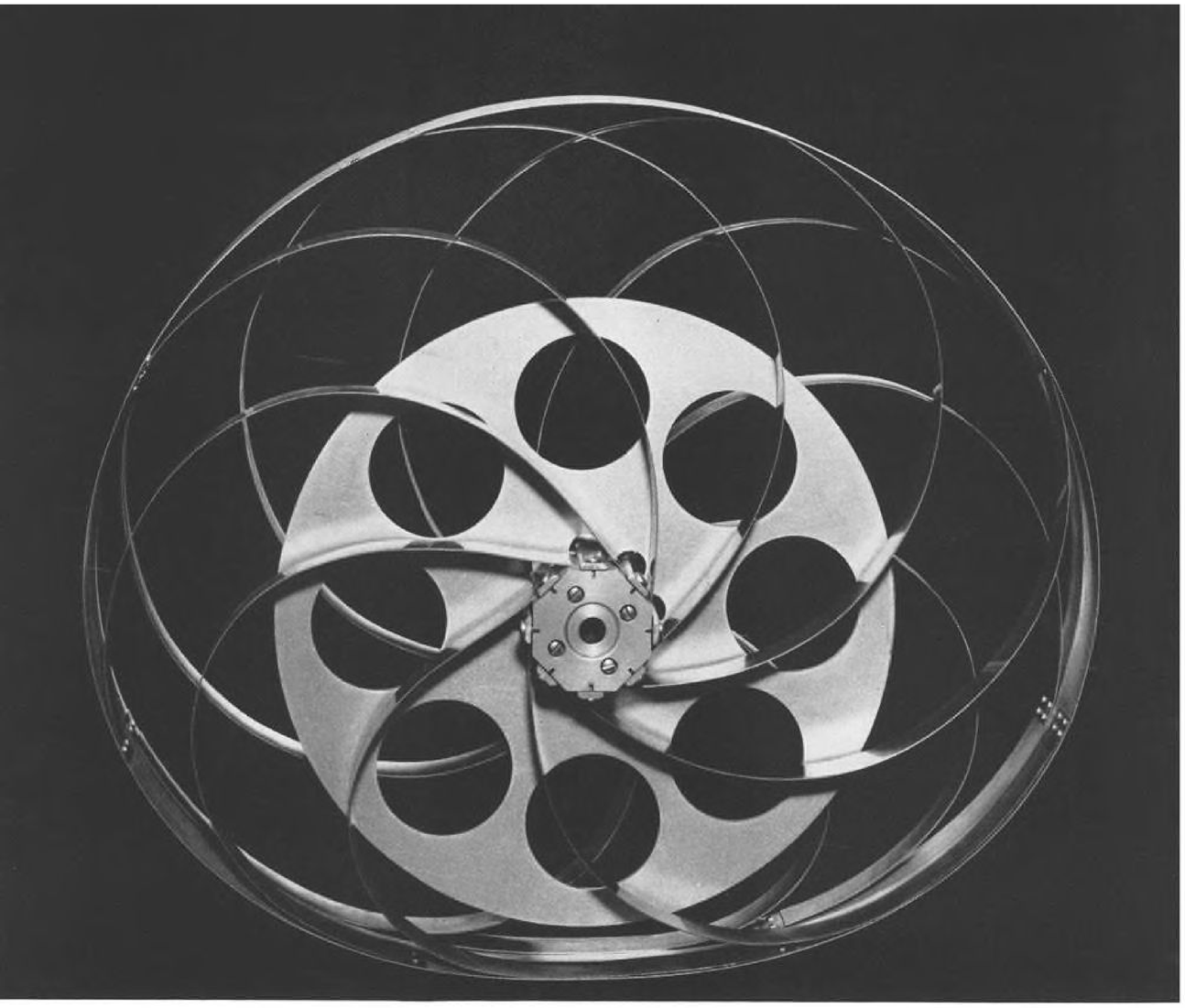
► **Czechoslovakia has dropped plans to market its L-29 two-place jet trainer (AW June 10, p. 175) in Western countries because of heavy competition. Instead, it will concentrate on Communist nations and members of the Comecon trade group.**

► Defense Dept. favors turning development of the full-length, 260-in.-dia., solid-propellant motor over to NASA if there is to be a follow-on to basic feasibility demonstrations. Demonstrations of short-length versions are to be conducted by Thiokol and Aerojet-General under a current Air Force program (AW Feb. 11, p. 50). There is little likelihood that any Fiscal 1965 funds will be applied to the development of the full-length version of the 260-in. motor, since DOD feels there is no military requirement for the booster.

► **Industry proposals to Navy BuWeps for Sea Star ship-launched, multi-purpose probes (AW Oct. 28, p. 24) will be submitted by Nov. 25. Bidders probably will have to recommend a second stage to complement the Terrier booster for the probe.**

► Gravity gradient stabilization system for the military medium-altitude communications satellite (MACS) now is to be used first on the fourth launch (AW Oct. 28, p. 25). Earlier MACS payloads will be spin-stabilized. Army satellite communications agency will issue a new proposal request for the mobile ground terminals to provide MACS communications links. Request will go to the three companies—Hughes Aircraft, Radio Corp. of America and Sperry Rand—which conducted earlier funded studies of the terminals. Work statement probably will combine the best features of the three studies.

► **Air Force will announce soon award of a definitive contract to International Electric Corp., a subsidiary of International Telephone and Telegraph Corp., for the avionics package for the Strategic Air Command's second-generation airborne command post.**



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# Washington Roundup

## Secrecy in Government

**Protests against the way the Kennedy Administration handles public information are giving impetus to a Senate bill which would enable citizens to go to court** when federal bureaucrats conceal the facts.

**A Senate Judiciary subcommittee opened hearings on the measure last week as the Sigma Delta Chi journalism society charged that "genuine freedom of information** is at its lowest ebb today in the history of our Federal Government."

**The society's information committee said Defense Secretary Robert S. McNamara and Arthur Sylvester, his public affairs chief,** "have created an oligarchy of control over the release of all news emanating from the Dept. of Defense and which led to its boast of 'management of the news' in the Cuban crisis late in 1962. All of the rest of the Federal Govt. falls back on the mushy claims of 'confidential' and similar excuses in spreading the blanket of secrecy over the records of government. . . ."

**American Newspaper Publishers Assn. and the National Assn. of Broadcasters are among the groups which have endorsed the freedom of information bill** sponsored by Sen. Edward V. Long and 16 other senators. The measure would give federal district courts jurisdiction over complaints about withheld public information; require federal agencies to keep detailed records of their transactions and make the file available to the public; and require Defense Dept. and other government officials to publish their informational procedures in the Federal Register.

**Sen. Long, a Missouri Democrat, plans to spend this year holding extensive hearings and writing the report, postponing the Senate vote** on the bill until next year.

## Misinformation Charged

**House Armed Services investigating subcommittee also had harsh words about McNamara's information policies as it sent him its top-secret report** on the closing of six semi-automatic ground environment (SAGE) direction centers and 17 long-range radars (AW July 8, p. 24).

**Chairman Porter Hardy said his subcommittee's investigation revealed that the Defense Dept.'s Apr. 26 announcement about the closing was "both misleading and inaccurate."** The announcement, he said, inferred that the Air Defense Command concurred in the move "whereas in truth and in fact the changes as proposed by the Secretary were opposed strenuously by that command." The announcement "was inaccurate in that it stated that the proposed changes would 'provide the best possible ground environment operating capability' whereas in truth and in fact the changes have resulted in a degradation of this capability. . . ."

**Rep. Hardy said that although he may not have intended to do so, McNamara "incorrectly informed the President as to the manner in which the proposed** changes would be carried out." The Air Force paper opposing the step, Rep. Hardy said, "was briefly evaluated by a 28-year-old employe on a 60-day detail to DOD from the Bureau of the Budget," who told McNamara there was nothing new worth considering.

## Navy Procurement

**In reorganizing its procurement structure, Navy has designated three additional programs as special projects: surface-to-air missiles** (Talos, Tartar, Terrier and Typhon); General Dynamics-Grumman F-111B tactical fighter, and anti-submarine warfare. Polaris missile program already is so designated.

**Vice Adm. William A. Schoech, as chief of naval material—the new office consolidating the activities of the bureaus of weapons, ships** and supplies and accounts—will supervise all four special projects. His staff of a vice chief and four deputies is slated to be: Rear Adm. Ralph L. Shifley, who will serve both as vice chief and deputy for programs and financial management; Rear Adm. Bernhard H. Bieri, Jr., material and facilities; Rear Adm. Edward A. Ruckner, research and development, and Capt. John K. Leydon, organization and management.

**All the designated deputies are line officers except Adm. Bieri, who is from the Supply Corps. The appointments, if approved** by the Navy secretary, will become effective Dec. 2.

## Small Craft Warning

**Forthcoming disclosures about the entertaining former Navy Secretary Fred Korth did on the Naval yacht Sequoia promise to make it the most discussed vessel since Cleopatra's barge.**

**USAF Col. Charles A. Gayle, F-111 (TFX) project officer and long-term witness in the Senate F-111 investigation, is retiring in the spring** to the peace and quiet of a cattle ranch in Greatland, Tex., and may write a book about his experience. USAF Brig. Gen. John L. Zoeckler will succeed him with the title of assistant F-111 project officer at Aeronautical Systems Div.

—Washington Staff

# Redefinition of U.S. Space Goals Planned

**End is sought to stimulation of program by Soviet moves; larger military role in Apollo is considered.**

By Alfred P. Alibrando

**Washington**—White House and space program advocates in Congress are planning a sweeping redefinition of the nation's manned space flight program in order to end its dependence for funds on reaction to Soviet space achievements and announcements.

The redefinition could include increased military participation in the Apollo program, because both National Aeronautics and Space Administration and congressional leaders in recent statements have revived the security benefits of the space program.

A new look at the U.S. space program received impetus from Soviet Chairman Nikita Khrushchev's statement on Oct. 26 that Russia is "not at present planning flights by cosmonauts to the moon."

"From our point of view," a leading space official said, "it was the most harmful statement (to the U.S. space program) Khrushchev could have made. It was even more damaging than an announcement that the Soviets had landed a cosmonaut on the moon."

In his Oct. 31 news conference, President Kennedy said he is not convinced that Russia has withdrawn from the moon race, and labeled Khrushchev's statement as "guarded" and "cautious." He said he "would not make any bets at all on Soviet intentions."

The President called the space program "essential to the security of the United States." He said Russia has made "intensive efforts in space and there is every indication they will continue. . . . we should stay with our program" and not react to Khrushchev's statements to newsmen. He noted that two Russian cosmonauts "said the Soviets have begun preparations to go on a lunar expedition."

Space spending ran into real trouble for the first time this year when NASA asked for $5.72 billion for Fiscal 1964—two-thirds of it for manned flight.

The element of competition in what was generally believed to be a race to the moon with the USSR, though discounted by some foes of space spending, had been a leading argument on behalf of the Apollo manned lunar landing program. Khrushchev's disclosure took away an argument of Apollo supporters and gave new ammunition to opponents of space spending.

A statement by Rep. Louis C. Wyman (R.-N. H.) was typical of the reaction of Apollo's opponents. Rep. Wyman, who introduced a bill and led a fight on the floor of the House to cut the NASA budget to $4.4 billion (AW Oct. 14, p. 37), said Khrushchev's statement "leaves no valid reason for the U.S. to continue any aspect of a crash program to get to the moon."

The White House has assured some congressional space leaders that the nation's manned flight program is being studied with the aim of evolving a stronger justification for it.

A Republican member of the Senate space committee, Sen. Margaret Chase Smith (Me.) said it is past time for the Kennedy Administration to reaffirm the urgency of the program if the goal of placing a man on the moon by 1970 is to be achieved.

She said we should not be forced to reappraise our position each time Khrushchev makes a statement on space.

There are indications that the Administration may seek to put down criticism of Apollo by increasing military participation in it, primarily those earth orbital missions which could be related to a space station program.

One of the main arguments of those opposed to Apollo is that the U.S. should be spending more on military space stations.

Rep. Olin E. Teague (D.-Tex.), chairman of the House manned space flight subcommittee, said he would attempt to have top Administration officials meet with the Senate and House space committees as soon as the Fiscal 1964 NASA budget is finally approved by Congress. He said the Administration will never get a reasonably adequate budget out of the next Congress unless it presents a more convincing and vital justification.

Rep. Teague said he feels that the most important justification for Apollo is the contribution of the project to possible military applications. He said it is of little importance to him whether the USSR has a manned lunar landing program and dismissed the "prestige" factor of landing a man on the moon first as inconsequential.

In his statement, Khrushchev said:

"We are not at present planning a flight by cosmonauts to the moon. Soviet scientists are working on this problem. It is being studied as a scientific problem and the necessary research is being done. I have a report to the effect that the Americans want to land a man on the moon by 1970-1980. Well, let's wish them success. We shall see how they will fly there, how they will land . . . and, more important, how they will start off and return home. We shall take their experience into account. We do not want to compete . . . without careful preparation.

". . . no benefits would be derived from such a competition . . . it would be harmful as it might result in the destruction of people . . . much more work will have to be done and good preparations made for a successful flight to the moon by man."

Although the Khrushchev statement was the subject of many interpretations, most observers agreed that:

- **Soviet Union** is still working on a circumlunar flight and a space station.
- **Khrushchev's statement** was timed to cause confusion in the U.S. space program.
- **Temporary abandonment** of a lunar landing program was a concession to anti-space factions in the USSR who are pressing for greater expenditures on chemical fertilizers and other means of increasing farm production.

Dr. Edward C. Welsh, executive secretary of the National Space Council, said Khrushchev's statement indicates the Russians still intend to make manned lunar landing flights. Dr. Welsh attached special significance to the fact that Khrushchev said the USSR did not plan manned lunar landing flights "at present."

He also pointed out that Khrushchev admits the USSR is working on a manned lunar landing as a scientific problem and is conducting the "necessary research" to accomplish such a mission if it desires.

Skepticism with which U.S. officials received the Khrushchev statement was also due to the recent statements of high Soviet officials, scientists and cosmonauts that Russia planned a manned lunar landing (AW Oct. 21, p. 28). Anatoli Dobrynin, Soviet Ambassador to the U.S., said in New York on Oct. 15 that the USSR would land men on the moon by 1970. Maj. Yuri Gagarin said in response to a question on Russia's space plans that the USSR would accomplish this "by the end of the decade."

Soviet technical literature indicates that the Russians are working on both circumlunar and lunar landing flights, using earth-orbit rendezvous.

NASA's search for a satisfactory justification for Project Apollo has been a difficult one. The agency's congressional charter emphasizes the peaceful character of NASA's program. Participation in international space programs further fostered a desire to avoid involvement with the military.

About mid-1961, NASA first sought to stress the technological fallout from space-related research which would benefit the economy and American consumer. Some of the early specific claims proved false and others hard to identify.

About a year ago, as opposition to the civilian space program began to mount, the agency started to mention the contribution of space research and exploration to the military. These references are now more frequent. In a speech last week at Montana State University, NASA Administrator James E. Webb listed "our security" as the first of the most important reasons for undertaking a space program, and added:

"The value of the space program . . . depends on . . . five factors: the defense potential, the strengthening of our international leadership, the new scientific and technological skills we gain, the practical uses of . . . such as communications and weather satellites and the fulfillment of the desire of the American people to push back the frontiers of space."

## Kennedy Sees U.S.-Soviet Air Agreement

**Washington—President Kennedy believes there is a "good chance" that the U. S. and Russia will sign a bilateral air transport agreement that will result in an air route between New York and Moscow. At his Oct. 31 news conference, the President said a bilateral agreement "has been initialed, but there are some technical matters to be settled." This was a reference to the fact that Russia is not a member of IATA or ICAO and details must be worked out on tariffs, communications, position reporting and weather data exchange.**

**There is considerable speculation here that the New York-Moscow air route agreement is imminent, and probably will be signed before the end of this year. The countries had nearly reached an agreement two years ago, but talks were broken off because of the Berlin wall crisis (AW Aug. 28, 1961, p. 39).**

## Saturn 1 Is Cut, First Manned Apollo Delayed

**Washington—National Aeronautics and Space Administration has reacted to the cut in its budget authorization by chopping six vehicles from the Saturn 1 program and delaying the first Apollo manned orbital flight by nine months until the fall of 1966. Cut in the Saturn 1 program had been forecast by Aviation Week & Space Technology (Oct. 28, p. 21).**

**Space agency spokesmen say the delay in the program is not a result of Soviet Chairman Nikita Khrushchev's statement that Russia is out of the manned lunar landing race (see p. 26). Instead, they contend, it is an attempt to live within the $5.35 billion authorized by Congress (AW Sept. 2, p. 18). NASA said the Saturn decision was made before Khrushchev's announcement on Oct. 26.**

**Elimination of the six vehicles—four of them earmarked to carry manned Apollo command modules and the other two backups—will save $50 million, NASA said.**

**NASA said the space flight training and experience which pilots would have received in the Saturn 1 flights will be obtained in Gemini missions.**

**The action in effect will result in an acceleration of the Saturn 1B program, because the engineering and manpower related to the operational Saturn 1 vehicles, designated the 100 Series, now will be shifted to the 1B. Both Saturn 1 and 1B booster stages are fabricated by Chrysler Corp. at the Michoud, La., facility. There will be some reduction in the Chrysler work force at Michoud, but it is not expected to be large.**

**Reduction in the number of Saturn 1 vehicles also means that Douglas will build only six S-4 stages, rather than 12 as had been previously planned. This will not cause a layoff at the Douglas plant, however. The S-4 is powered by six Pratt & Whitney RL10 hydrogen-oxygen engines.**

**Full development program of 10 Saturn 1 flights is still planned, because it will provide vehicle development data for both 1B and Saturn 5 vehicle programs. In addition, two of the Saturn 1 flights will carry large-area micrometeorite detection satellite payloads. Saturn 5 is the vehicle that will launch Apollo on the manned circumlunar and lunar landing missions.**

**Next Saturn development flight, designated SA-5, will be the first to include a live S-4 second stage. There was some concern that the flight would be delayed considerably beyond its scheduled December launch because adhesive used to attach insulation on the inner dome of the hydrogen fuel tank flaked off and adhered to the inside of an elbow fitting.**

**It was feared at first that the RL10 engines would have to be removed and the entire tank cleaned, but the problem was solved by replacing the elbow.**

**A sample of fuel run through the tank was used in test firing at Pratt & Whitney's West Palm Beach facility and was found to be free of contaminants.**

**Boosters for the 1 and 1B versions of Saturn are essentially the same, except that a program aimed at reducing the weight of the stage by about 18,000 lb. is under way for the 1B (AW Sept. 16, p. 54). Work on the 1B booster so far has been confined to design, with no actual fabrication yet begun. Rollout date for the first 1B, before the elimination of six Saturn 1s, was May, 1965. Although NASA said this date was not changed by its recent action, there is some hope that it can now be moved up.**

**Chrysler's Saturn 1 booster contract was for eight stages—two to be flown in the development program, one to carry a manned Apollo command module on a ballistic flight, and three to launch manned orbital Apollo modules.**

**As a result of the Saturn 1 cutback, Chrysler now will build only development boosters No. 8 and No. 10.**

**Saturn 1 in its two-stage configuration is capable of placing about 20,000 lb. into orbit, and therefore could test the Apollo modules only individually. Saturn 1B can place all three modules—command, service and lunar excursion—into orbit in what NASA called the "all-up" testing concept. This means the complete configuration is tested on each flight.**

**The Saturn 1B second stage, also built by Douglas and designated S-4B, consists of a single Rocketdyne J-2 hydrogen-oxygen engine with 200,000 lb. thrust.**

**Under present planning, there will be only four development flights in the 1B program before the first manned mission.**

**Congressional authorization of $5.35 billion for NASA is a cut of $350 million in its request for Fiscal 1964 spending. House actually appropriated $5.1 billion (AW Oct. 14, p. 37), but despite Khrushchev's statements regarding the Soviet lunar program, NASA is conducting a spirited compaign in the Senate to restore some of the $250 million difference between the authorization total and the House appropriation.**

**The Senate Independent Offices Appropriations subcommittee is now considering the bill but final action, including full Senate approval and probably a Senate-House conference committee action, is not expected until next month.**

# IMP Will Warn of Dangerous Solar Flares

By Roderick D. Hibben

**Greenbelt, Md.**—Key support vehicle for a manned lunar landing, an interplanetary monitoring platform (IMP) to warn astronauts of dangerous solar flare activity, is scheduled for launching next week from Cape Canaveral.

Solar proton flux and energy information would presumably be sent to the astronauts from earth so that they could take measures to protect themselves after IMP had telemetered data to earth communications centers.

Designated S-74 by the National Aeronautics and Space Administration's Goddard Space Flight Center, IMP is the first of seven satellites to be launched in very high-apogee earth orbits both before and during Apollo.

Although monitoring high energy protons over a significant part of the 11-year solar cycle is a prime objective, IMP contains seven other scientific experiments.

The universities of Chicago and California, Massachusetts Institute of Technology, NASA's Ames Research Center and Goddard Space Flight Center designed the experiments.

Major categories into which the eight experiments can be grouped are:

- **Interplanetary magnetic fields.**
- **Solar winds.**
- **Cosmic rays.**

In terms of previous scientific satellites, excluding weather satellites, IMP represents a big step forward. It has much more sophisticated and versatile instrumentation. It is heavier (about 140 lb.) and is expected to be in orbit much longer than Explorers 10 and 12, which were designed to do many of the same things IMP will do.

Explorers 10 and 12 were launched in 1961. Both weighed about 80 lb. Explorer 10 transmitted for 52 hr. as planned, then quit. Explorer 12 exceeded that by 2,516 hr.—almost four months—before becoming silent. Apogee for Explorer 10 was 186,000 mi. It was 47,800 mi. for Explorer 12. Perigees of the two were 100 and 180 mi., respectively.

Explorers 10 and 12 made several important discoveries which now need more extensive investigation.

Explorer 10 discovered the geomagnetic cavity which the sunlit earth's magnetic field cuts out of the impinging solar wind. Earlier pictures of the earth's magnetic field had shown it to be symmetrical about the earth with no day-to-night change.

Although much quantitative data is still lacking and all regions haven't been mapped, the earth's magnetic field is now thought to be compressed by the solar wind during the day. At night, however, the magnetic field appears to change—bulging outward to very great distances to interact with solar proton streams also carrying magnetic fields.

IMP will attempt to map in detail such discoveries.

Solar flare warning and determining the interplanetary magnetic field are closely related. The reason is that charged particles bursting out of the sun during solar flares carry their own individual magnetic fields with them into space. The total interplanetary magnetic field then becomes the sum of the individual fields.

Success of the Apollo mission depends greatly on the interplanetary magnetometer readings which will be recorded on the IMP series of satellites.

### IMP Details

**Orbital data: 33-deg. inclined orbit. Period—150-160 hr. Apogee-150,000 naut. mi. (nominal), 115,000 and 217,000 naut. mi., low and high limits. Perigee—110 naut. mi. (nominal).**

**Weight—about 140 lb.**

**Lifetime—6-12 months (optimum).**

**Launch vehicle—Douglas modified Thor-Delta.**

**Attitude control system—spin stabilized (20 rpm.).**

**Telemetry—4-w. pulsed frequency modulation at 136 mc. Three-month data recording capability—one month continuously.**

Three magnetometers, a rubidium vapor and two fluxgate types, will measure the interplanetary magnetic field. The rubidium vapor magnetometer records the total magnetic field regardless of how the spacecraft is oriented. The two fluxgate magnetometers measure the magnetic field component along the sensor axes.

The fluxgate magnetometers are capable of indicating the direction of magnetic fields below 30 gammas (one gamma—$10^{-5}$ gauss). The spacecraft background is about one gamma.

The sensitivity of the magnetometer instrumentation to low fields was brought about by careful attention to IMP's structural parts. IMP is made of aluminum, stainless steel and magnesium. Use of iron was limited to cable. Non-ferrous transistor casings eliminated current loops.

There will be four separate solar wind experiments conducted onboard IMP. One of these is to determine proton concentration outside IMP during certain selected portions of its orbit. Protons in the 200 ev. to 20 kev. range that pass through a slit in the satellite's skin can be measured by a variable curved-plate electrostatic analyzer and an electrometer circuit.

Low-energy, positively-charged particles traveling at low to high velocities will be admitted into IMP by a plasma probe which rejects all other particles. A similar probe was used on Explorer 10.

Finally, one sensor—a dual-purpose, charged particle trap—will measure concentrations and temperatures of thermal ions and electrons (a few ev. or less) throughout IMP's orbit. The same trap will also make mass determinations of the thermal ions picked up during the satellite's orbit.

## FAA Seeks DC-3 Replacement Designs

**Washington—Federal Aviation Agency announced a new program to spur industry interest in a DC-3 replacement last week by asking airline manufacturers to bid on a $300,000 design competition for a short-haul aircraft.**

**Three manufacturers will be chosen next spring for one-year detailed design studies on the aircraft, under objectives outlined by FAA in its request for proposals. Detailed design specifications will be due in the latter party of the year, after which FAA will select the most promising design. Government financial participation will be limited to $100,000 per design study, with all further development costs assumed by the manufacturer (AW Sept. 16, p. 49).**

**FAA also will analyze the market potential for the new aircraft in a joint program with the Commerce Dept. and the Civil Aeronautics Board. Current estimates range from 700 aircraft to more than 1,000. FAA has outlined these objectives:**

- **Capacity of 14 to 24 passengers with provision for fast conversion to partial- or all-cargo configuration.**
- **Added payload capability ranging from 500 to 800 lb.**
- **Cruise speed of 200 mph.**
- **Range permitting operation over four 100-mi. route segments without refueling.**
- **Propulsion system of at least two turbine engines of minimum size, noise and cost, and maximum reliability.**



Several cosmic ray experiments are planned on the S-74. Equipment onboard is designed to send information back to earth if alpha particles (helium nuclei) and protons coming from solar flares in the 100 kev. to 200 mev. range should strike the satellite sensors while it is transmitting.

The equipment to do this is a range-energy loss telescope similar to the one built for Mariner A. It consists of 25-40 solid-state detectors. Along with the detectors, particle energy losses in passing through the detectors are measured with a 64-channel pulse-height analyzer. A logic circuit in the telescope calculates the particle's range.

One difficult problem in cosmic ray studies, particularly in space where space and volume restrictions are so stringent, has been to determine and then record whether a particle striking the detector is an electron, proton, alpha particle or a heavy primary cosmic ray. Another problem is that the equipment must be sensitive to very small particle fluxes.

A scintillator on IMP does this by emitting a certain amount of light, depending on what kind of particle strikes the thin crystal detector connected in coincidence with it.

Two other experiments related to the cosmic ray studies are designed to measure how much ionization by solar particles takes place in a standard air density sample onboard the satellite, and to find out whether solar protons and cosmic rays strike the spacecraft at preferred angles. The latter experiment will be done by mounting two Geiger-counter telescopes at right angles to each other. One will be aligned to the spacecraft's spin axis.

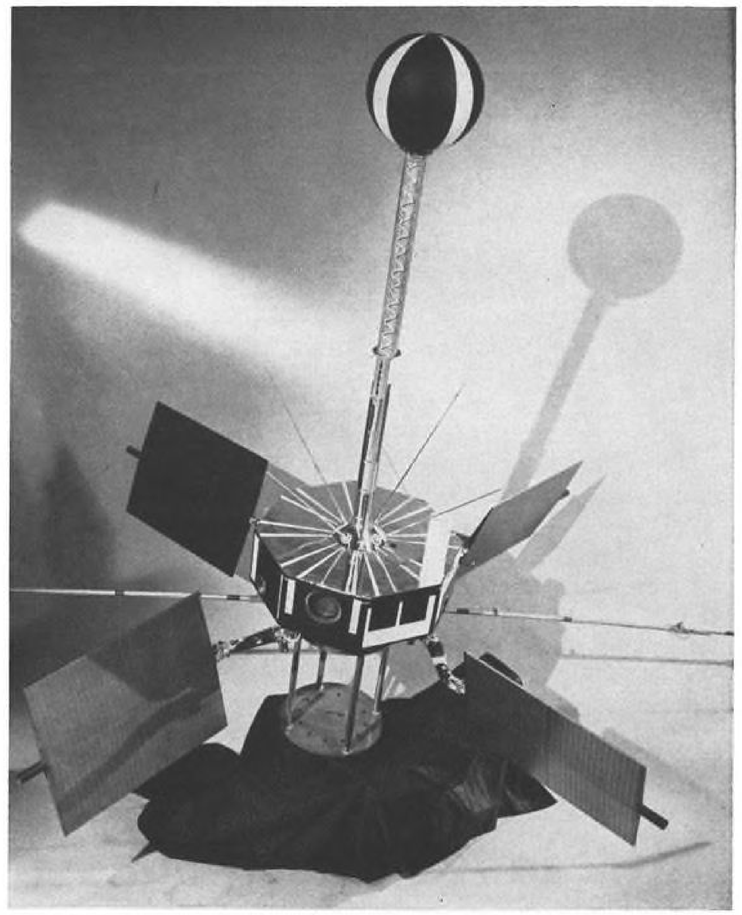
Third stage of the Douglas Thor-Delta launch vehicle which will send the IMP into orbit has about twice the 2,800-lb. thrust developed by the standard ABL X248 solid-fueled rocket used in the standard Delta.

Designated ABL X258-A5DM, the new third stage engine will develop 5,500-5,700 lb. thrust. Modification of the Thor-Delta launch vehicle was needed to boost IMP into its highly eccentric orbit—one with a 150,000-naut. mi. apogee and 110-naut. mi. perigee.

That orbit will put IMP into the earth's dark side one-half hour at most of its 150-160 hr. period.

IMP's small time out of the sun helps reduce temperature cycling which cuts down reliability of spacecraft components considerably.

Silicon P-N solar cells—11,520 of them covering 24.8 sq. ft. of area—provide primary power for IMP. Initial power per paddle side at normal incidence of sunlight will be 33.7 w. The solar cells generate 44.8 w. in the most unfavorable spacecraft to sun angle—30 deg. The solar cells will supply 37 w. of power on the average and 47.4 w. maximum. A 12-mil-thick, radiation-resistant cover glass with an optical filter will protect the cells against damaging solar protons.



**INTERPLANETARY MONITORING PLATFORM** shown was designed and built at NASA's Goddard Space Flight Center. Rubidium vapor magnetometer above central instrument capsule, which supports the solar panels, telescopes vertically from 3 to 6 ft. Fluxgate magnetometers extend out horizontally from the same capsule 14 ft. over-all.

Thirteen sealed silver-cadmium batteries connected in series and rated at 5 amp-hours will supply 30% of their rated power to back up the primary power system. Total battery weight is 6.75 lb. An automatic undervoltage protection circuit turns off the batteries and allows an 8-hr. charge time.

Transmitter power onboard IMP will be 4 w. Necessity for a long-range transmission capability resulted in slower bit rate telemetry. Allowing for a 6-db. deterioration factor, the signal-to-noise ratio of the spacecraft's communications output is expected to be about 13 db. Pulsed-frequency modulation of the spacecraft's signal at 136 mc. was dictated by IMP's long distance from earth and the 327F average background noise temperature of the sky. Both analog and digital information will be recorded continuously for a one-month period.

Ground stations at Woomera, Australia, Johannesburg, South Africa, and Santiago, Chile, have the 22-db. gain antennas and global positions needed to record telemetry from IMP most of the time it will be in orbit.

Major industry contractors were:

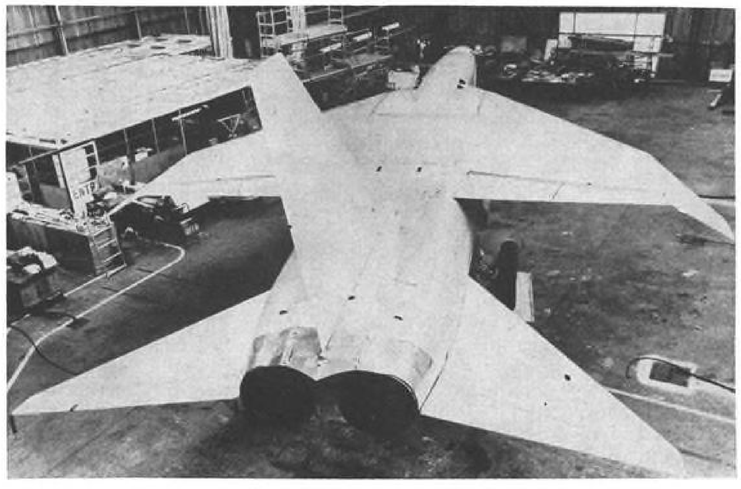
- **Spacecraft integration services**—Electromechanical Research Inc.
- **Rubidium gas tube**—Varian Associates.
- **Fluxgate magnetometers**—Schonstedt Instrument Co.
- **Solar panels**—Helitech Corp.
- **Silicon cells**—Spectralab.

Motorola designed and built the range and range rate telemetry. Radio Corp. of America built the radiation-resistant cover glass used to protect the silicon cells from damage caused by solar protons.



**TSR.2 STRIKE-RECONNAISSANCE** aircraft for Royal Air Force, in first photos, is shown in advanced stage of construction at British Aircraft Corp.'s plant at Weybridge. Note second TSR.2 in main jigs directly behind prototype (above). Nose gear is double truck for landings and takeoffs on rough fields. Strut can be extended by pilot to gain nose-up attitude early in take-off run.

# TSR.2 in Advanced Stage of Construction



**FULL SPAN FLAPS** have blown-air feature to improve take off performance on unimproved airfields. Anhedral wing tips improve low-speed handling characteristics. Fin and horizontal stabilizer are all-moving units. Note ports forward of leading-edge wing roots, possibly for cameras or outlets for conditioning air. Nose section (opposite) contains forward-looking radar which is tied in with terrain-following automatic pilot for use during low-level operations. Fuel is contained in wing and in fuselage tanks forward of Olympus engine intakes. First airplane probably will fly with pilot only. Navigator's compartment, directly behind pilot's cockpit, will be used to house in-flight test gear.

By Herbert J. Coleman

**London**—First official details of Britain's new TSR.2 strike reconnaissance aircraft, released by Air Ministry here last week, indicate it to be a highly automated, all-purpose airplane capable of operating from unimproved forward airfields, and with an operational life of 10-15 years.

Airplane is due to roll out late this month or in early December from British Aircraft Corp.'s production plant at Weybridge. First flight will be made next spring, with Roland Beamont, English Electric Lightning chief test pilot, at the controls.

The TSR.2 was designed for a low-level attack and reconnaissance role at Mach 2-plus speeds. Later in development, its specifications were to be stretched to qualify it as a strategic nuclear bomber. As such, it probably would eventually replace Britain's now-aging V-bomber force.

Features of the TSR.2 include:

• **Two Bristol Siddeley** Olympus 22R powerplants, which, with afterburning, will provide nearly 38,000 lb. of thrust. Engines are a military development of the powerplants for the Anglo-French Concorde supersonic transport (AW July 1, p. 66).

• **Range of "several thousand miles,"** according to a spokesman for the British air staff. Flight refueling capability will be built in for the strategic bomber role.

• **Forward and side-looking radar** tied in with terrain-following automatic pilots. The latter has a fail-safe device which puts the airplane into a climb to safe altitude if any portion of the radar or automatic pilot fails. The terrain-following feature is tied into the forward-looking radar. Side-looking radar can be selected to identify only moving targets if desired.

• **Target computer system,** in which a target can be preselected before takeoff and the plane flown automatically to bomb or rocket release point, and returned by automatic control.

• **Airborne television transmitter,** a line-scan system, which can transmit front-line pictures to a mobile ground receiver stations assigned to army command units.

• **All-weather and night capability,** including an automatic blind landing system which has been tested in V-bombers. The system also includes a new heads-up display for the pilot, in which data is projected onto the cockpit windshield during the blind landing phase.

• **Martin-Baker rocket-powered** ejection seats which can eject the pilot and navigator from runway level if necessary.

Precise specifications were not revealed, but the airplane is about 90 ft. long, with a 30-ft. wingspan. Navigator-pilot arrangement is tandem seating.

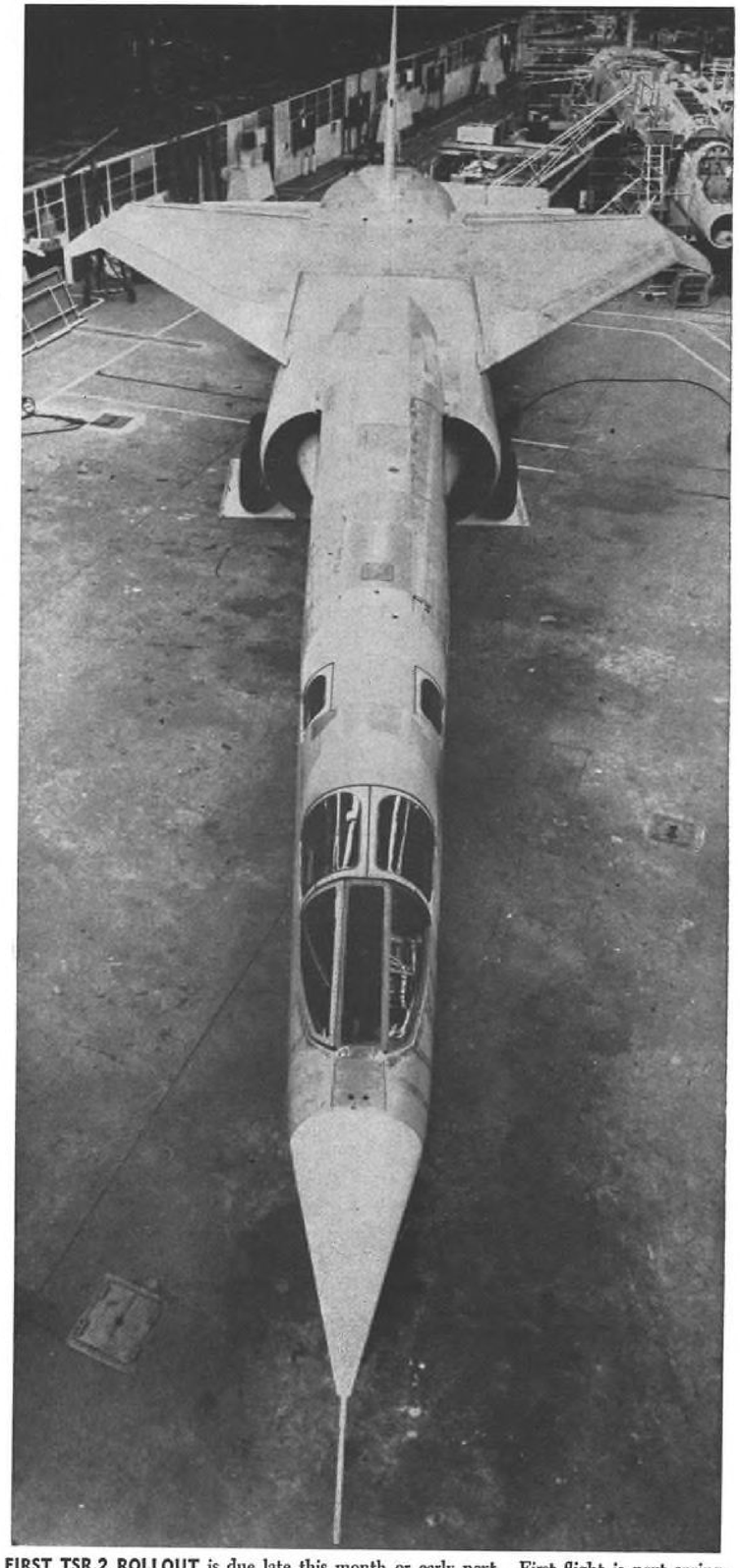
The TSR.2 is a "shoulder-wing" monoplane featuring an all-moving fin and all-moving tailplane in which surfaces move in unison to act as ailerons and elevators. Wing has turned-down tips for better control at low speeds. They are fixed and do not move to a horizontal position in high-speed flight.

Full-span blown flaps have been provided to increase the short-field capability. In addition, the main strut of the nose gear can be extended by the pilot on a takeoff run to improve the angle of attack during the first stage of the roll.

Air for blown flaps is bled from Olympus engine intakes on the fuselage side of a bullet intake. The clean wing contains fuel, and weapons stores can be hung underneath if desired, according to an air staff spokesman.

The Ministry declined to specify the actual weaponry, but it is known that the Defense Dept. is well-advanced in design of a nuclear bomb, probably powered and possibly radar-controlled. The TSR.2 will carry a "wide range of weapons," including air-to-ground missiles and nuclear bombs in the megaton class.

Other features:



**FIRST TSR.2 ROLLOUT** is due late this month or early next. First flight is next spring.

• **Bomb bay runs from area** bordered by air intakes to the flap section.
• **Two speed brakes** extend hydraulically from the bottom fuselage, just aft of the bomb bay.
• **Main landing gear** retracts into nacelles, and both main and nose gear have been stressed for rough-field operations.

In setting the low-level and forward-area flight profiles, designers centered on a low aspect ratio wing, a delta planform, to minimize pilot problems in areas of high turbulence. The wing also was kept thin for Mach 2 performance at high altitude.

The airplane is fitted with an air-conditioning system and refrigeration capability for supersonic flight.

For use in forward areas, the TSR.2 will be fitted with an automatic system checkout device to enable it to operate with a minimum of technical backup. Another feature is an internal turbine which will provide power for starting and the cooling systems. Another operations factor is that the weapons systems will be pre-packaged for easy transport and installation in rugged combat areas.

Under its present role, an air staff spokesman said, the airplane can accomplish widely varied missions such as tank-busting and a long-range nuclear strike with minimum changeover time.

TSR.2 systems, he continued, are effective at all altitudes. A digital computer is provided for pre-selected target data. A Doppler-inertial mixed dead reckoning navigation system will be installed. All subsystems have been flight tested for more than 100 hr. The crew can override any automatic phase if necessary.

Batteries of high-speed cameras are fitted to the belly, just under the navigator's compartment, for reconnaissance.

British Air Ministry said the initial order for new TSR.2 strike-reconnaissance aircraft for the Royal Air Force will be for 50 airplanes—20 pre-production for evaluation and operational testing, and 30 for squadron use.

Total order probably will increase to about 150 airplanes when the V-bomber fleet finally phases out. Development costs have reached about $1 billion.

The Ministry departed from its past practice of announcing details of military aircraft only after first flight, mostly because of highly critical comment in Parliament from members of the opposition Labor Party. Renewal of that controversy is expected when Parliament reconvenes for winter session Nov. 12 (AW Oct. 21, p. 23).

A less immediate reason is potential overseas sales of TSR.2, which received a major setback when Australia ordered 24 USAF General Dynamics F-111A (TFX) tactical fighter bombers (AW Oct. 28, p. 21).



**POLARIS A-3 BREAKS SURFACE** after launching from USS Andrew Jackson 40 ft. below surface in first successful A-3 firing from a submerged submarine off Cape Canaveral.

# Submerged Sub Fires Polaris A-3

Cape Canaveral—Polaris A-3, the 2,500-naut. mi. fleet ballistic missile, entered a new phase in its development here Oct. 26 with the first successful firing from a submerged submarine.

The Lockheed A-3X was fired by the Navy from the USS Andrew Jackson, lying about 40 ft. below the surface and about 30 mi. offshore from the Cape. The 31-ft.-long, 54-in.-dia. missile broke water and, triggered by the simultaneous closing of an accelerometer and a pressure-sensitive switch, ignited a fraction of a second later.

The Aerojet-General first stage burned for about 62 sec. and the Hercules Powder Co. second stage for about 58 sec. Guided by a GE all-inertial guidance system, the Polaris A-3X flew 2,000 mi. down Atlantic Missile Range into an instrumented ocean area.

Hydrophones detected the detonation of a Sofar bomb released from the nose cone after impact. The impact point was determined by the arrival of sound waves at different phones. The nose cone was said to have landed within the specified area, although impact accuracy was not a major objective.

For this first submerged firing, the Polaris carried a special tape recorder. It was turned on 1 min. before the missile was ejected from its tube to record both acceleration forces and angular deflections experienced by the missile as it rose through the water.

This data then was transmitted over regular telemetry links to the nearby Navy surface vessel, the USS Observation Island. Data was to be examined later to determine the adequacy of the compressed-air technique for ejection of the heavier A-3 missile.

Rear Adm. I. J. Galantin, director of the Navy's special projects office, witnessed the launch from the submarine. Later, he told a conference that there would be a total of 40 research and development firings of the Polaris A-3 in its test program and that there would continue to be launches both from land pads and from the Observation Island vessel.

The Oct. 26 launch was conducted by the Jackson's gold crew under the command of Cdr. James B. Wilson. The same crew attempted Oct. 29 and 30 to launch the second of two A-3X missiles loaded aboard the submarine Oct. 25, but difficulties with the missile and downrange instrumentation forced a delay.



# India's Experience Reveals MiG Problems

By James R. Ashlock

New Delhi—Indian Air Force experience with its MiG-21 interceptors and An-12 troop transports has revealed major problems in performance and operational reliability.

As a result, India is unlikely to build the MiG-21 under license, and will instead rely on its own HF-24, which Indians believe can be brought up to Mach 2 capability with Russian engines.

Despite their problems with the Soviet equipment, Indian defense officials said it is still the best alternative in view of what they term continued U.S. refusal to sell India aircraft such as the Lockheed F-104 Starfighter and C-130 Hercules.

The MiGs, of which India now has two squadrons of 12 aircraft each, are based at two key defensive points. One force is in Northern India, near the cease-fire line where the Chinese invasion was halted last October. The other is farther south, defending New Delhi, Bombay and Calcutta.

The Russians guaranteed a Mach 2.3 performance by the MiG-21 and gave India 30 years to pay for the aircraft. These conditions were favored by the Indian government, which wants to preserve neutrality by buying defense equipment rather than accept it through such devices as the Military Assistance Sales Program, under which the U.S. government would subsidize part of the purchase price.

With the MiGs on hand, deficiencies have appeared which are causing concern within the Indian Air Force. Although pilots credit the MiG with easy handling characteristics at all altitudes and at speeds up to Mach 2, they criticize the 22,000-lb.-thrust engine.

The powerplant is not equipped with an anti-surge device, and pilots report that the engine's response to throttle advancement is extremely slow. Like most Russian engines, the MiG-21 engine has a low overhaul life.

The MiG-21 is also criticized as having an inferior communications system, an action radius of only 90 naut. mi., and no search radar or fire control system.

India feels the action radius should be at least 150 naut. mi., but Russian technicians say that fuel capacity can be raised only enough to permit a 120-naut. mi. radius at most.

If its fuel capacity were increased, the MiG-21's single cannon would have to be removed, Indian officials were told. Loss of this armament isn't considered too serious, since the MiG carries air-to-air missiles guided by heat sensors, like the U.S. Sidewinder.

Russia has also offered to equip the MiG-21 with search radar equipment, but Indian inspection of the proposed installation showed it to be inferior to the systems on aircraft produced by Western nations. Consequently, it is now proposed that the MiG-21 be guided to visual target contact with mobile ground radar equipment recently obtained from the U.S.

One reason for the current air exercise in India involving U.S. F-100s, British Javelines, Australian Canberras and India's Hawker Hunters and Folland Gnats is to determine the efficiency of the new radar units. The MiG-21s aren't participating in the exercise, probably in deference to the Soviets, who wouldn't want Western military sources get a close look at the aircraft.

The problems with the MiG-21 are instrumental in India's reluctance to produce the aircraft under license. Both the defense ministry and the air force are now in general agreement that they should rely on India's own interceptor, the HF-24, built at the Hindustan Aircraft, Ltd., facility at Bangalore.

The HF-24 can attain Mach 1.1 with the two Bristol-Siddeley Orpheus 6 engines it is presently designed to carry. India believes the Russian RD-9F engine now used in the MiG-19 can be adapted for the HF-24 by moving all engine accessories from the top to the bottom of the power plant. No major airframe modifications would be involved. The total thrust of about 16,000 lb. from the dual RD-9F installation will give the HF-24 a top speed of nearly Mach 2, Indian sources said.

Originally, the Bristol-Siddeley Orpheus 12 was earmarked for the Mach 2 HF-24. The English firm was building the engine for a NATO aircraft, and defense alliance funds would have covered development costs. But when NATO rejected the powerplant, Bristol-Siddeley told India that it would have to put up $2.1 million in development costs if the Orpheus 12 were made available for the HF-24.

While Indian Air Force officials were in favor of taking the Orpheus 12, those controlling government finances balked. India has already paid Russia $1.2 million toward development of the RD-9F, and has an agreement to provide approximately $3.1 million more. To switch plans at this point would further burden India's defense budget, and one government spokesman said definitely that "we are going with the Russian engine."

If so, this could lead to production of the RD-9F in India. One question that will have to be solved, however, is maintenance of the engine. The Russians have a practice of running their engines hard, then discarding them rather than relying on overhauls. But India's economy cannot stand such practice, and it is believed by defense sources that the RD-9F's life can be extended through overhaul, provided the Russians can provide parts readily.

However, problems may arise if the Indians obtain U.S. or British electronics gear for the HF-24. Russia may object to having Western technicians associated with an aircraft carrying a Soviet engine.

Production of the Orpheus 6 under license at the Hindustan plant will probably continue for some time. The engine powers the Folland Gnats which are also built at the facility.

As for Gnat production, indications are that India is not planning long-term production of this aircraft. While they won't specify the reasons, Indian officials say the Gnat has not proved to be effective for India's defense needs.

It is evident that what the Indian Air Force wants, and what the government feels it can provide, are divergent.

If it were left up to the Indian Air

## Northrop Develops VTOL Autogyro Drone

**Northrop-Ventura has developed an autogyro drone with vertical takeoff capability which it plans to demonstrate to military representatives later this month after completion of preliminary flight tests at the company's Newbury Park, Calif., plant.**

**Northrop has built two vehicles with its own funds, using OQ-19 drone fuselages and powerplants. The free-wheeling rotor is attached atop the fuselage by a spindle.**

**Vertical takeoff is achieved by holding down the vehicle and initially spinning the rotor with tip-mounted rockets. The 72-hp. McCulloch front-mounted engine powering the forward propeller is brought up to full 7,200 rpm., which sustains the rotor's rotation. Vehicle then is released and springs vertically into the air.**

**Predicted performance includes horizontal speeds of 20-140 mph. and operation at altitudes from sea level to 20,000 ft. with 300-lb. payloads.**




## Cessna YAT-37D COIN Fighter Makes First Flight

**USAF YAT-37D, a modified version of the Cessna T-37 jet trainer (AW Feb. 25, p. 29), made its first flight recently at the company's Wichita flight test facility. Aircraft is powered by two General Electric J85-J2 engines of 2,400-lb. thrust each, and carries three weapons for fuel pods under each wing. Aircraft gross weight is about 10,500 lb., approximately 4,000 lb. heavier than the trainer version. YAT-37D will carry up to 3,000 lb. of armament and has redesigned engine compartments and air intakes for the larger engines. Landing gear has been strengthened and the wheels increased in diameter to allow operation from unimproved fields. The aircraft also has armor plate around the two-place cockpit and communications, navigation and target acquisition avionics equipment.**

Force, F-104s and C-130s would probably already be operational in India. Continuous contact has been maintained between Lockheed and Indian defense planners for several years.

Opposition exists in Washington to selling India U.S. aircraft. There are those who still object to dealings with the Nehru government, if for no reason other than that India has never joined SEATO.

One Indian official, after a recent trip to Washington, where he reiterated the desire to buy the C-130, said he was amazed at the reason given him for India not needing the transport.

"They said we already had the An-12, and that there was so little difference in it and the C-130 that we didn't need the Hercules," he said.

He regarded this as a joke. It is true, he acknowledged, that the An-12 can perform under good conditions. But it doesn't hold up under as rough treatment as the C-130 can endure. This was demonstrated, he said, in last year's border clash with the Chinese.

The An-12's landing speeds were too high in the thin air and on the short, unimproved strips near the Himalayan battle area. The Russian engines took a severe beating through the high power settings required in the high atmosphere and under prop reversal for landings. The nose gear collapsed repeatedly, damaging not only the aircraft but also the sod landing strips, delaying landings by other transports.

The C-130, on the other hand, performed well under the same conditions after it arrived on the scene.

# Korth Urges All-Nuclear Line Fleet

**Washington**—Defense Secretary Robert S. McNamara's decision to make the next aircraft carrier conventional rather than nuclear powered is being assailed by several members of Congress as a great leap backward from a nuclear Navy.

Navy Secretary Fred Korth, in a farewell appearance before the Joint Congressional Atomic Energy Committee last week, urged that Congress abide by the carrier decision and concentrate instead on winning endorsement "of the Navy's policy of nuclear propulsion for all new major combatant surface ships."

Korth, who was slated to leave his Navy post Nov. 1 (AW Oct. 28, p. 32), disclosed that the life of a ship's reactor core has increased from three to seven years "and the day is in sight when a core will last the lifetime of a ship;" that "more than four times" as much power is generated by modern reactors as those used on the Enterprise nuclear powered carrier, and that a nuclear carrier costs "only 25%" more to construct than a conventional version and 3% more to operate with its own air group.

Although congressional critics of the carrier decision see little chance of changing McNamara's mind, several members of the joint congressional committee are considering making the effort anyway.

Sen. Henry M. Jackson (D.-Wash.), a joint committee member and early champion of nuclear-powered submarines, is among these.

McNamara's decision to build a conventional carrier, Sen. Jackson said, "represents an effort to buy up-to-date obsolescence" and is a step away from a nuclear-powered Navy. He challenged Defense Dept. contentions that the more expensive nuclear carrier should not be built until the fundamental question of just how nuclear the Navy should become is answered. Another nuclear carrier, Sen. Jackson said, would justify its extra cost by providing up-to-date tactical, cost and technical data applicable to surface ships.

McNamara's carrier decision was announced officially by the Defense Dept. Oct. 25 in a release which said: "Secretary McNamara informed the Navy that this decision was motivated by a desire to avoid further delay, and does not prejudge the larger question of the application of nuclear power to the Navy's surface vessels in the future. A Navy study of this question is under way."

Rep. Chet Holifield (D.-Calif.), ranking House member of the joint committee, told AVIATION WEEK & SPACE TECHNOLOGY that he was apprehensive that Defense Dept. strategy is now to rely largely on a conventionally powered surface Navy.

"I don't believe a step away from nuclear propulsion is a step forward," he said of the carrier decision. "I believe it is a step backward," Holifield said.





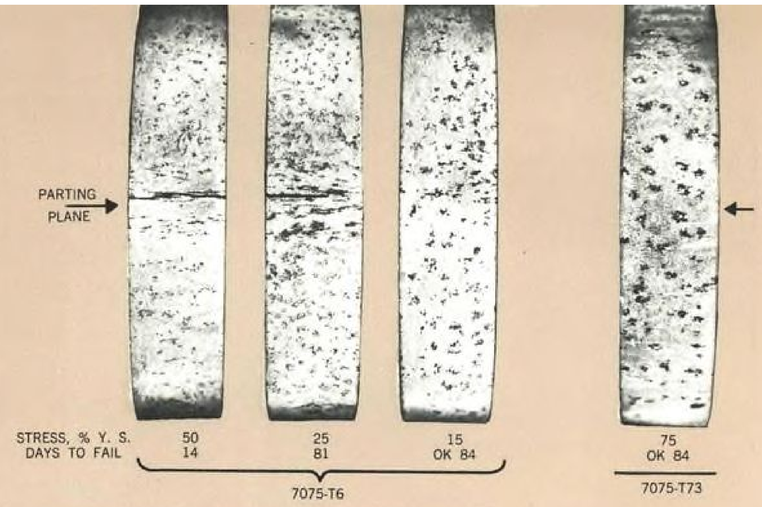
Alcoa's Don Sprowls speaks with authority on stress corrosion of aluminum

This man found the answer to stress-corrosion cracking in high-strength aluminum alloy structures...

ALCOA

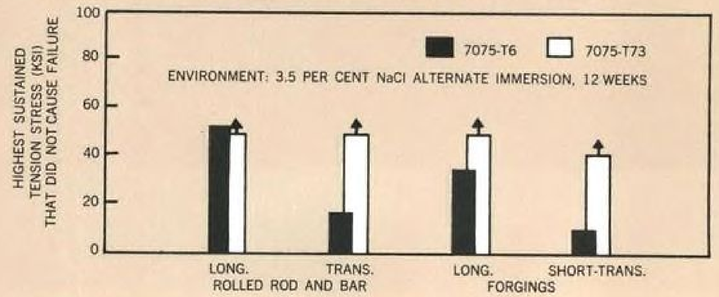


Alcoa's
Don Sprowls
speaks
with authority
on stress corrosion
of aluminum




(Above) Slightly enlarged photograph of ring stress-corrosion specimens exposed to 3½% NaCl solution by alternate immersion. Corrosion products were chemically removed after exposure. Note the directional nature of the attack in the parting plane area of the 7075-T6, absent in the -T73 material.

(Below) The bar graphs represent a summary of stress-corrosion cracking tests of many specimens exposed under various magnitudes of sustained tension stress. Arrows indicate that no failures occurred at the highest stress employed (75% of the yield strength).




## Alcoa's Don Sprowls has the answer to stress corrosion of aluminum... 7075-T73

Don Sprowls has specialized in corrosion problems at Alcoa's Research Laboratories since 1936. His work has included studies of the mechanism of stress corrosion, applied research and customer service problems, particularly as related to aircraft and missile applications. Three years ago, working with other specialists, he came up with a breakthrough in a problem that had been plaguing the aerospace industry—stress-corrosion cracking of parts when continuously stressed in a critical direction. The answer: a new heat treatment that virtually eliminates stress-corrosion cracking for high-strength, wrought aluminum alloy 7075.

Designated -T73, the new thermal treatment greatly increases the alloy's ability to withstand high, sustained surface-tension stresses. Extensive testing by Alcoa and its customers showed that 7075-T73 will withstand stresses greater than 75 per cent of its yield strength in seacoast and industrial atmospheres without failing. This has been proved to apply to all sustained surface stresses regardless of the grain orientation.

Stress-corrosion cracking can result in the brittle failure of an otherwise ductile material. Almost any metal or alloy can be made to fail under conditions involving applied or residual tensile stresses and specific environments. In the stress-corrosion-cracking process, there is a greater deterioration in strength through the simultaneous action of static tension stress and the environment than would occur as a result of the separate but additive action of the two. The first service incident occurred back in the '30s with a U.S. Navy airplane, and was identified and the problem resolved by Dix and Keller of Alcoa. There were few serious problems with aluminum until a few years ago when isolated instances began to occur in the more demanding structures of advanced aircraft and space vehicles.

7075-T73 has proved a satisfactory answer in many such problems to date, and Alcoa expects to introduce higher strength alloys with comparable corrosion resistance in the near future. The -T73 temper is included in Specification MIL-A-22771 and QQ-A-282A, Amendment I, issued by the Bureau of Weapons. We have already shipped a considerable tonnage in forgings and rolled rod and bar in 7075-T73. Sheet, plate, extrusions and fasteners in the alloy are also available.

Developments such as this—and men like Don Sprowls—are what set Alcoa apart from its competitors. Since the day research gave birth to Alcoa 75 years ago, we have pursued new alloys and applications at an accelerating pace. The resultant accumulation of knowledge makes Alcoa your most likely source for the right answers on aluminum. Access to the advice of hundreds of specialists like Don Sprowls is yours simply by contacting your local Alcoa sales office. If you'd like to receive Alcoa literature on stress-corrosion cracking and 7075-T73, simply write Aluminum Company of America, 1868-L Alcoa Building, Pittsburgh, Pa. 15219.

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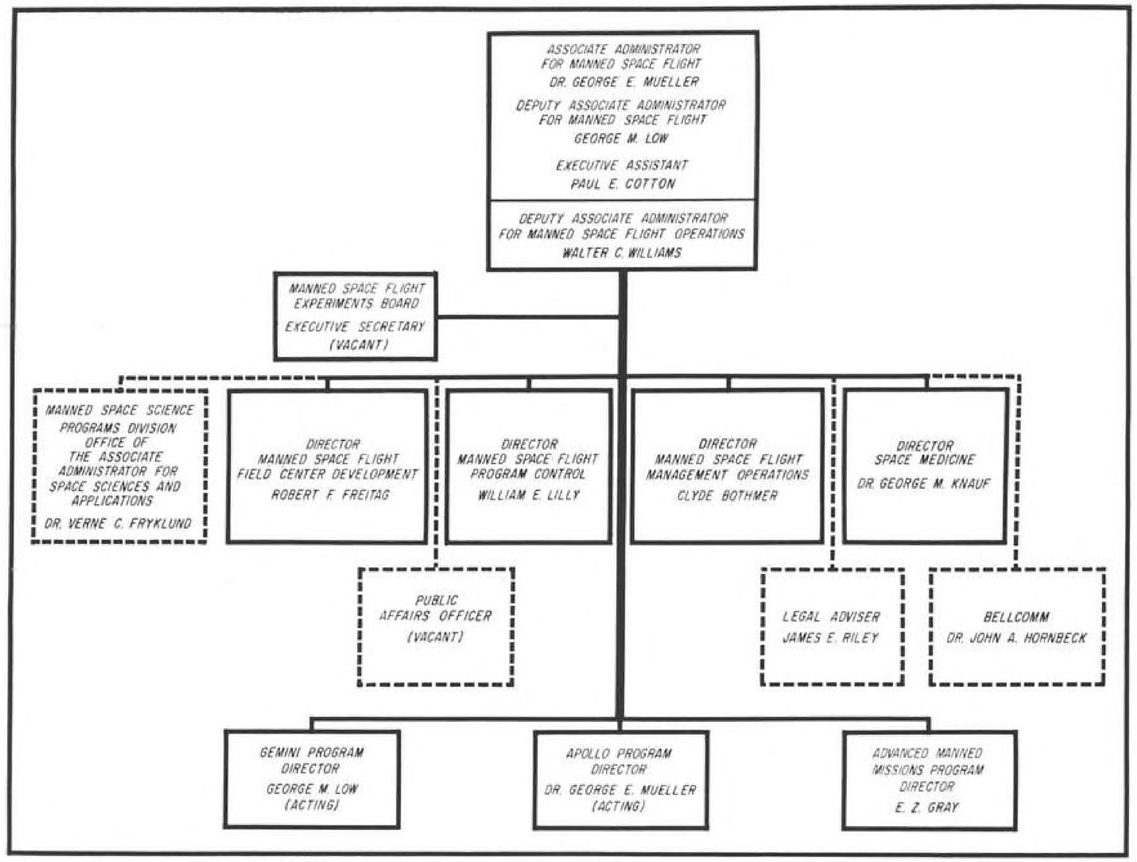




**CHART SHOWS TOP MANAGEMENT** in new NASA headquarters manned flight organization. Dotted lines show staff office functions.

# Manned Space Flight Reorganized

**Washington**—National Aeronautics and Space Administration last week reorganized management of its manned flight programs, further consolidating headquarters control of Projects Apollo, Gemini and advanced programs in one of the most far-reaching and significant changes since the Office of Manned Flight was created in 1961.

Management changes also were made in the Offices of Space Science and Application and Advanced Research and Technology, essentially completing the reorganization forecast by AVIATION WEEK & SPACE TECHNOLOGY (Sept. 30, p. 25), part of which the agency announced three weeks ago (AW Oct. 14, p. 28). Reorganization was effective Nov. 1.

All manned flight activities will be directed by Dr. George E. Mueller, associate administrator for manned space flight. He is responsible for activities related to manned flight at the Marshall Space Flight Center, Manned Spacecraft Center and the Launch Operations Center. Dr. Mueller also is directing the Apollo program office. Although he has chosen to assume the title of acting director, he said he would personally fill this job "for an extended period."

George M. Low, who has been a member of the top management tier in manned flight since the beginning of the Mercury program, is the next in line of authority as deputy associate administrator for manned space flight and acting director, Gemini program office.

Walter C. Williams, also a deputy associate administrator, will supervise flight operations for all manned flight missions (AW Oct. 28, p. 33).

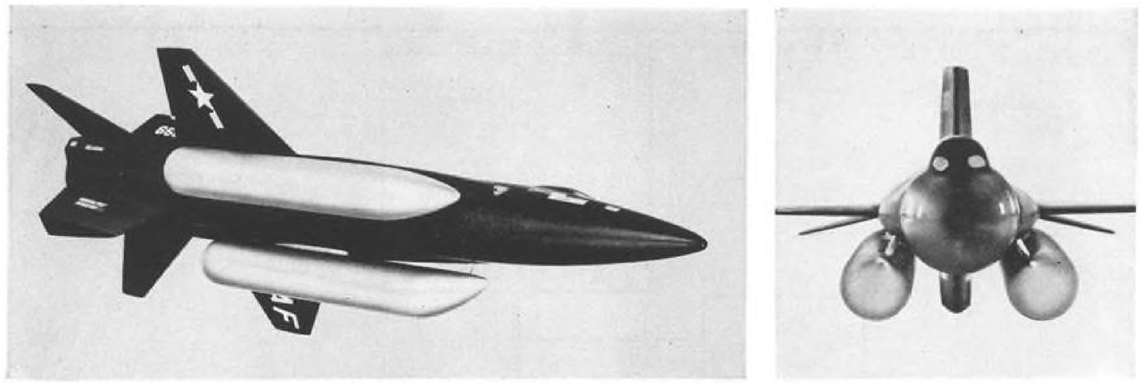
Organization of the offices of the three headquarters program directors (see chart) will be matched by similar organizations in the program offices at the Manned Spacecraft Center. It is intended that corresponding headquarters and center offices will have more direct contact.

The reorganization eliminated separate headquarters launch vehicle offices. Instead, technical direction is integrated within five functional offices under the Gemini and Apollo directors. Two offices—one for the S-1 and one for the S-1B—are being established at the Marshall Space Flight Center to accommodate the new organizational lines at NASA headquarters and the Manned Spacecraft Center.

Under the new organization, the center program director also is expected to have more direct contact with the headquarters program director, although the center director is to be consulted and kept informed on technical decisions by the center program directors. Also, directives from the headquarters program directors are to be sent to the center program directors through the center directors.

In the Office of Advanced Research and Technology (OART), Boyd C. Myers, 2nd, has been appointed deputy associate administrator for center activity in advanced research.

P. M. Lovell, Jr., has been appointed as the director of OART's new division handling programing and resources management.



**INSTALLATION OF TWO EXTERNAL** propellant tanks, slung below fuselage, as shown on model, is a major X-15A2 modification.

# X-15 Modified for Hypersonic Research

**Los Angeles**—Delivery of North American X-15A2, a modified version of the second X-15 which crashed last year, is now scheduled for Feb. 7, 1964. The aircraft is now being rebuilt by North American's Los Angeles Div. under contract to USAF's Aeronautical Systems Div.

Official designation of the plane remains X-15A although it is commonly referred to as X-15A2. It will be used by the National Aeronautics and Space Administration's Flight Research Center and USAF as a hypersonic research vehicle and will have provisions built in for testing externally mounted ramjet engines.

A decision to rebuild the No. 2 X-15 (AW Apr. 15, p. 23), was based on USAF's desire to test aerospace plane hardware. The No. 2 X-15 was damaged when it overturned during an emergency landing at Mud Lake, Nev., Nov. 9, 1962, after the flaps failed to extend.

The predicted Mach 7.5 to Mach 8.0 speed capability of the X-15A2, compared with Mach 5.92 for current X-15 aircraft, is achieved by increasing the burning time of the Thiokol LR-99 engine from an average maximum of 85 sec. to approximately 145 sec. at 100% thrust. Nominal thrust of the engine will remain at 57,000 to 59,000 lb.

Provisions to increase the speed and utility of the X-15A2 as a research vehicle include the following modifications:

• **Addition of two external** propellant tanks. Up to 13,500 lb. of fuel and oxidizer (anhydrous ammonia and liquid oxygen) will be carried in external tanks slung below the aircraft on either side of the fuselage. The cylindrically shaped tanks will be 38 in. in diameter and 20 ft. long and will weigh 900 to 1,000 lb. each. They will have an upward-swept forward end rather than symmetrically-pointed tips to facilitate attaching the tanks to the fuselage. The tanks will be recovered after being jettisoned at approximately 70,000 ft. during the climb using a parachute system installed in the forward end of the tank. Helium will be used as a tank pressurizing agent.

• **Extension of skid-type** landing gear. To permit landings with ramjet engines attached to the underside of the empennage section in place of the lower ventral fin, the landing skids have been lengthened to provide an additional 19-in. vertical clearance between the aircraft and the ground. Both nose wheel and main gear have been strengthened to accommodate the increase in aircraft weight of 3,000 to 3,500 lb. The basic launch weight of the X-15A2 will be increased from 33,300 lb. to approximately 50,500 lb.

• **Lengthening the fuselage** 29 in. This provides sufficient room for the installation of two 50-gal. spherical liquid hydrogen tanks at the center of gravity near the mid-section of the fuselage. The liquid hydrogen will be used to fuel the ramjet engines. Extensive rework and strengthening of the fuselage was also accomplished.

• **Increased windshield protection.** An additional outer layer of fused silica glass will be added to the two panels of the windshield for greater heat protection against increased heating and thermal stresses.

• **Installation of means** of attaching ramjet engines or other experimental packages in place of the lower ventral fin. Provisions have been made for easily interchanging the lower ventral fin with ramjet engines ranging in diameter from 18 to 36 in. This includes plumbing and attachment points.

• **Removable wing tips.** To provide capability for such things as aerodynamic and thermal research and upper air sampling, provisions have been made for removing the wing tips so that experimental packages may be mounted in their place.

• **Installation of an instrumentation** bay. Located behind the cockpit on the top portion of the fuselage, two clamshell-type doors will be opened to a vertical position during the high-altitude portion of the ballistic trajectory to allow unobstructed operation of ultraviolet stellar photographic equipment and other instrumentation.

In addition, North American is developing techniques to apply ablative material to those portions of the plane subject to high heat fluxes (AW Oct. 14, p. 28). A thermo-lag material, developed by Emerson Electric, has been tested on the last two X-15 flights flown by Air Force Capt. Joe Engle (Oct. 7) and NASA Pilot Milton Thompson (Oct. 29). Material was applied to the speed brake and lower ventral fin areas.

North American is rebuilding and modifying the plane under a 39-week contract calling for delivery of the plane with heat shield applied by Feb. 7, 1964. Contract amount is $4,999,430. Minor modifications also are being made to the Boeing B-52 which will be used in the conventional manner to drop the X-15A2, although possibly at a lower altitude than the current 45,000 ft.

## COIN Competition

**Washington**—Navy has issued its requirements for a light counter-insurgency (COIN) aircraft that it will develop for the use of foreign air forces and the U.S. Marine Corps. The move is preliminary to issuing requests for proposals (AW Oct. 7, p. 33).

Aircraft must be able to take off from a short, unprepared field with a 1,200-lb. payload, loiter on station at a 50-naut. mi. radius, drop its payload and return to the field.

Four prototype aircraft will be built. The proposals will call for development only. However, a production rate of 24 aircraft per month is planned after the development period.



# First Titan 2 Booster for Gemini Delivered to NASA for Checkout

**Cape Canaveral**—Martin Co. and USAF delivered the first Titan 2 booster for the Gemini program to National Aeronautics and Space Administration last week. The vehicle will undergo 10-12 weeks of test and checkout before launching the first Gemini spacecraft—an unmanned boilerplate capsule—late next January or early next February.

A Titan 2 weapon system was scheduled for a ballistic flight down the Atlantic Missile Range last week to carry some elements of the Gemini launch vehicle for flight test evaluation, including an early version of the malfunction detection system (AW, Sept. 3, 1962, p. 38) and devices designed to reduce the magnitude of the missile's natural vibration.

These vibration dampers are surge chambers and mechanical accumulators (AW July 22, p. 192) mounted on the engine actuators of the first stage.

Lt. Col. John G. Albert, chief of USAF's Gemini Launch Div., Lee du Goff, Gemini launch vehicle project engineer with NASA's pre-flight operations division of the Manned Spacecraft Center, and Eugene J. Mommer, Titan 2/Gemini operations director for the Martin Co., stressed here last week that the Gemini version of the Titan 2 is a different vehicle than the Titan 2 military weapon system.

They emphasized that the accordion-like vibration of the latter, which does not impede its military usefulness, may or may not show up on the man-rated booster.

Peak gravity loads in excess of 2g during a 20-sec. period about 100 sec. into the flight have been reduced to 0.8g. NASA wants it reduced further to a maximum of 0.5g.

Modifications include redesign of the engine turbopump subsystem (AW July 15, p. 23)—focusing on the pump impellers, surge chambers and mechanical accumulators on the engine actuators—increasing tank pressures from 18 to 22 psi., and variations in propellant load quantities.

The Air Force, which is providing the Titan 2 for the Gemini program as it did the Atlas for the Mercury program, also is substituting the heavier first-stage engine mounts of the Titan 2 core in its Titan 3 configuration for the frames normally used in the weapon system. These mounts are about 1.5 times stronger than those used by the Titan 2 ICBM.

Low thrust generated by the Titan 2's second stage on several occasions was said to have been corrected by more stringent cleaning procedures for the gas generator, which drives the engine's turbopumps, and redesign of the generator's inlet-outlet orifices.

Even small quantities of impurities in the generator were said to affect its performance, which reduced rpm. speeds of the pumps. They in turn delivered less fuel at lower head pressures to the engines. Thrust of the nominally rated 100,000 lb. second-stage engine was reported to have been off by 5 to 10% on some flights.

For the next several weeks, the launch vehicle will be subjected to a series of subsystem functional checks with a spacecraft simulator. The two stages of the Titan 2 will be mounted side by side on the two positions of Complex 19 here. Upon completion of these tests, the stages will be static-fired for sequential compatibility. The first stage will burn for about 30 sec., then shut down. After simulated stage separation, the second stage also will ignite and burn for another 30 sec.

The two stages then will be mated and be run through another several weeks of subsystem functional testing. A flight readiness firing of the first stage only will be conducted, followed by another round of subsystem functional tests and, finally, by a dry mock simulated flight test which will simulate the entire mission. Titan 2 and its Gemini spacecraft then will be ready for launch.

## French Launch Second Cat

**Paris**—Second of two French biomedical ballistic flights with a cat aboard ended in failure when the Centre d'Enseignement et de Recherches de Medecine Aeronautique (CERMA) was unable to recover the animal after launching from France's Hammaguir facility in the Algerian Sahara.

Despite this failure late last month, CERMA says it does not plan another suborbital shot with a cat. Results obtained from the launch and recovery of the first cat, Felix, were excellent, according to CERMA's physician-general, Robert Grandpierre, and will provide sufficient data. The second attempt involved a repetition of the same experiments. Launch vehicles used in both cases were Veronique 2 sounding rockets developed by Sud Aviation.

Felix was housed in an environmental capsule in the rocket's nose cone, which separated at the 120-mi. apogee and descended by parachute. Surgically implanted electrodes in the animal's skull picked up neurological impulses, which were then telemetered to the ground station.

Data is being analyzed to determine how a cat's brain receives and integrates sensor impulses in space and its reaction to that environment (AW June 17, p. 26).

Next phase of the CERMA program, which was inaugurated a year ago with the launching of two rats, will be the suborbital shot of an instrumented monkey using the Vesta sounding rocket. It is scheduled for next summer, possibly in June. A later launching of a monkey, using the Diamant 1 vehicle, is under study but no decision has been made.

## News Digest

**Air Force**-General Dynamics Astronautics Atlas F, carrying an experimental ABRES (advanced ballistic re-entry systems) nose cone (AW Dec. 10, p. 27) failed at Cape Canaveral last week when the missile lost all hydraulic fluid on the sustainer engine's actuator subsystem, after slightly more than 3 min. of flight. The engine then flipped freely back and forth and the missile cork-screwed through the sky.

**First production model** of the Rocketdyne F-1 engine was delivered to National Aeronautics and Space Administration last week for ground static firing tests at Marshall Space Flight Center. The propulsion unit for the first stage of the Saturn 5 rocket consists of five 1.5-million-lb. thrust F-1 engines using high-grade kerosene.

**British West Indian Airways Ltd.** is expected to announce an order for three Boeing 727s within the next two weeks. Boeing President W. M. Allen indicated that the order had already been placed, however, when he told a Senate aviation subcommittee recently that 140 of the 727s had been ordered. Previous number of announced orders was 137 (see story, p. 50).

**Army has awarded** Bell Helicopter Co., Ft. Worth, a $108,320,407 contract for turbine-powered Iroquois helicopters that will require a build-up in UH-1B and UH-1D rates to approximately 80 aircraft monthly and extend production on these types to November, 1965. Initial deliveries on the new contract are scheduled to begin in December.

# Congress Awaits Solution of SST Dispute

**Legislators unwilling to approve long-term funding until FAA, industry agree on development financing.**

By Robert H. Cook

**Washington**—Congress is not yet willing to commit itself to long-term funding for development of a U.S. supersonic transport because the Federal Aviation Agency and aircraft manufacturers are still unable to agree on how the development will be financed.

Senate aviation subcommittee hearings on the transport ended last week amid continuing clashes between manufacturers, who contend they cannot pay 25% of the $1-billion program, and FAA, which labels the industry position "premature and exaggerated."

Chairman A. S. Monroney (D.-Okla.) feels he must have firm government-industry agreement on financing the project so that he will be able to sell the long-term program to the Senate. It now appears that although FAA will get the $60 million that President Kennedy requested for the transport in Fiscal 1964 (AW Oct. 14, p. 37), a firm, long-term funding schedule for succeeding years cannot be developed until next year at the earliest.

Until Jan. 15, when airframe and engine manufacturers are scheduled to submit proposals on the program to FAA, "we won't really know what we are talking about," FAA Administrator N. E. Halaby said. He noted that the manufacturers have several months yet in which to arrive at accurate cost estimates based on "hard detail work." He surmised that most of the objecting testimony was an intentional effort to avoid revealing any competitive secrets and advantages in public.

In addition to the cost-sharing formula, Halaby indicated he thought the industry was confused over the intent of FAA's program guidelines as spelled out by the requests for proposals to the manufacturers. Determination of the aircraft's design speed, production tooling and rate all will be left to the discretion of the chosen airframe and engine manufacturers. It is mandatory that the entire program be contained within the $1-billion limit and overruns be avoided. Wording of the FAA requests was intended to emphasize these points and "warn" the manufacturers to make a "hard study" based on the FAA guidelines, he said.

Noting that the manufacturers favor complete government funding of the program, Halaby said that without the cost-sharing formula, the program would amount to a "give-away," subjecting the government to much the same criticism as arose from the F-111 (TFX) tactical fighter and Communications Satellite Corp. situations.

He urged the "earliest and fullest authorization" of the program by Congress, plus any needed legislation, before FAA awards the first contracts for detailed designs next May.

Sen. Monroney cited the manufacturers' claims that their costs will be far higher than predicted by FAA, conceivably resulting in an eventual $40-million sales price per aircraft. He expressed concern over the apparent refusal of either industry witnesses or FAA to give any quarter in the argument.

"I have misgivings that the government can meet the full cost," he said, "and no one is lined up in Congress yet to put up the $750 million."

Later, he told a conference of the Air Transport Assn. that the controversial cost-sharing formula is a "firm figure that must be considered final," and "to expect more from the government would be wishful thinking indeed." If the risk appears too great for any single company, consideration should be given to a joint effort of several airframe and engine manufacturers, he said.

Halaby replied that FAA can "only wait and see" what happens on Jan. 15, since what the industry said and what it offers under the "intense competition" of proposals may be far different. They may continue to balk at the cost sharing, but in any event, Halaby said, FAA is not overlooking the possibility of arriving at a "better formula."

Beyond the immediate rewards of conquering new technological problems and improving the U.S. balance-of-payments problem in such countries as Italy, Holland, Australia and Japan, the aircraft industry will have a needed source of income to replace its reduced support from the military, Halaby said.

Testimony of Boeing Co. witnesses typified that of most manufacturers, who contended that the financial risk of the program was beyond their capability.

Boeing President W. M. Allen said that 385 of the Boeing 707 series have been sold for $1.9 billion, the company is still short $40-$50 million on break-even need and will require more than $1 billion in orders for the Boeing 727 before it can realize a profit on the smaller aircraft.

Based on FAA's guidelines, Allen said the sales price of a Boeing-produced supersonic transport would be about $30 million, and the U.S. could expect to capture 60% of the world market. On a production run of 200 aircraft, manufacturing costs would exceed $25 million per aircraft with an eventual peak investment of $900 million, with a delivery rate of 2½ aircraft a month. Allen said he thought it likely this delivery rate should be five aircraft a month to meet airline demands, and on this basis an inventory investment of $1.2 billion would be required. In contrast, he said, Boeing had a net peak investment of $225 million for the less risky 707 program.

Under the company's present accounting system, development costs and interest on the investments in the supersonic program would amount to more than $500 million between 1964 and 1971. The company could not show a net return on the program before 1975, he added.

Two supersonic models, one for transcontinental and the other for intercontinental service, should be produced to meet varying airlines needs, Allen said, but introduction of the second model would require an additional investment of $400 million. A flying prototype of the aircraft should be constructed first and thoroughly tested before commitment to production, and unless this system is accepted, the entire supersonic program is "inadvisable," he told the subcommittee. The prototype should require a minimum of tooling expense and be a compromise design between a "quick one and a production prototype," he added.

As an alternative to the FAA development program, Allen suggested the government fund a design competition for an initial order of supersonics which would be used for military transport and for test purposes in advance of airline deliveries. The government could then guarantee the production of an additional order of aircraft for airline use, and thus reduce the investment risk of the manufacturer.

Whatever course is chosen, he said, government financing will be required both during the development phase and during the initial production phase of the program, when the manufacturer's financial risk is at a peak.

Donald W. Douglas, Jr., president of Douglas Aircraft Co., largely agreed with Allen and suggested the program involve two or three prototypes.

Because of the company's losses on the DC-8 program, Douglas will not participate as a major airframe manufacturer in the supersonic transport program, but might become a subcontractor, he said.

Douglas called for full government support of the program, and pointed out that foreign governments are subsidizing the building of such aircraft as the BAC 111, Caravelle and Concorde.

"We just have to face this problem. We must have this program," he commented.

Douglas said he feels the reported $10-million price of the Concorde is "fantastic" compared with $8 million for a 707 or DC-8, and "if they want to give away the aircraft we can't beat them completely with technology." He said he doubted that the proposed supersonic aircraft could achieve seat-mile costs comparable to the DC-8 because of their structural weight and proposed fuel consumption.

Lockheed Aircraft Corp. President C. S. Gross raised a new problem by warning that the magnitude of hull insurance costs have not been determined and could further affect the aircraft's earning power.

"We've talked to the insurance people on this and they're tough. It's a real problem," Gross said. The high cost of the aircraft raises the problem that insurance companies may not have the financial capacity to cover the entire program, he explained.

Gross generally agreed with Boeing's investment estimates, and further cautioned that determining the actual production volume to avoid the problem of overruns will be a problem.

As opposed to FAA's estimate of a 200-aircraft market, Lockheed feels that 100 aircraft at a sales price of $35-$40 million is more realistic.

Gross said the company also favors the prototype course as opposed to FAA's program, which would start a production line "too soon on the heels of the prototype." The company favors limited tooling, with a long period between the prototype flight testing program and actual production.

Engine manufacturers backed the airframe manufacturers demands for greater government funding, and expressed concern that FAA has failed to provide enough money for engine development.

Pratt & Whitney Div. of United Aircraft estimated that total engine costs could reach $1.1 billion, of which the company would have to pay $810 million, according to H. M. Horner, United's board chairman.

Horner said the estimate was based upon a 200-aircraft order with development through type testing, and after tooling and interest expenses. The company feels it could meet the airframe deliveries, but has a basic problem in avoiding use of any special type fuels in a desired turbofan engine. The company is developing the JT11 (J58) which it feels might be suitable for a supersonic transport, he said.

T. R. Berner, president and chairman of Curtiss-Wright, termed the FAA program inadequate, "wholly loaded in favor of the government" and requiring too large a financial participation from the industry.

The company's cost for engine development could be under $350 million, he said, and an engine could be produced with a longer life than today's powerplants, for a sales price of $1 million. At this time it is estimated the engines will be designed for a Mach 2.5 speed, with the capability of being modified later to a Mach 3 performance. The same engine could be used on either domestic or international supersonic transports, with 50-hr. test engines available for use on the prototypes.

General Electric, manufacturer of the J93 engine developed for the North American B-70 supersonic bomber, called for complete funding of the engine program through certification and production, in testimony by Vice President J. S. Parker.

Unless this is done, he said, the "program will grind to a halt." GE feels it "can't live" with the FAA program, since it believes development of the engine through certification may run $525 million, as compared with the FAA estimate of $350 million. If only 100 aircraft are built, the company will be forced to price the engines on the basis of a breakeven need of 50, he said.

Gordon Bain, deputy administrator of FAA's supersonic program, warned against overpricing the supersonic transport, and contended that design of the airframe and engine specifically for supersonic use should avert any need for later production line changes, as were undertaken with the Boeing 707 program. FAA has not demanded a set production rate from the manufacturers so that the high and varying sales prices and investments claimed by them could be significantly reduced by scaling production to a lower rate, he said.

Emphasizing the need to keep the supersonic transport sales cost low, Bain suggested that if the industry feels it is being asked to assume a "catastrophic" risk, they might explore the idea of forming a consortium to share the program cost.

## Merger Plan Denied

Trans World Airlines last week denied that it is discussing or has discussed recently merger plans with Continental Air Lines. Continental top officials declined to comment on the merger prospects.

Replying to an article in Aviation Week & Space Technology (Oct. 28, p. 34), which stated there was a possibility of Hughes Tool Co. selling at least a part of its holdings in TWA to Continental, TWA said it understood that "Toolco told the Securities Exchange Commission that it has no intention of selling any TWA holdings other than the debentures and warrants now being offered."

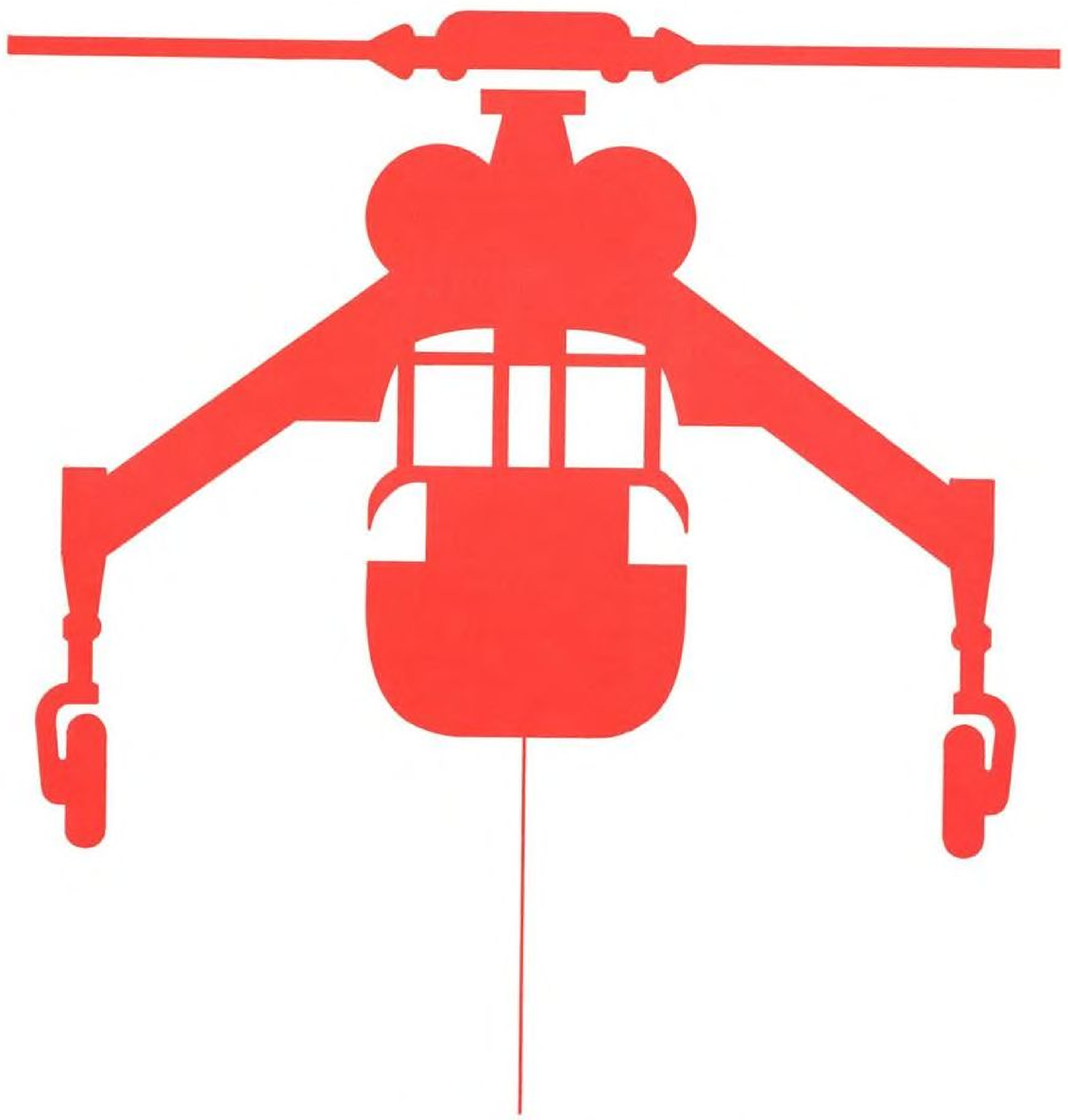
## Puget Disputes TWA on Concorde Delivery

Gen. Andre Puget, head of the joint Sud-British Aircraft Corp. Concorde project, last week took sharp issue with a statement made by Trans World Airlines' Charles Tillinghast, Jr. that the combine told the airline it could purchase only four of the supersonic transports (AW Oct. 28, p. 39).

Gen. Puget expressed surprise at the statement made by Tillinghast before a Senate subcommittee. In a letter also sent to Sen. A. S. (Mike) Monroney (D.-Okla.), Gen Puget outlined this sequence of events covering the negotiations with TWA:

- TWA was informed on June 18 that delivery positions comparable to Pan American's could not be granted because of earlier commitments to Air France, BOAC and Pan American.
- Draft contract for six aircraft with delivery positions 21, 24, 26, 29, 30 and 33 was offered to TWA but declined by the airline.
- Continental and American were then awarded positions for three and four aircraft, respectively. When a TWA official visited Sud-BAC Oct. 9, TWA was granted the best possible delivery positions. Positions reserved for TWA are now 22, 32, 34 and 38.

In reply to the letter, Tillinghast indicated that TWA would reopen negotiations, since the letter indicated that the airline would be given an opportunity to buy the number of airplanes it wanted with favorable delivery positions, on an equal right with other airlines and without discrimination.



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# Carriers May Protest SST Delivery Policy

By L. L. Doty

**Washington**—Federal Aviation Agency plan for assigning delivery positions of the U.S. supersonic transport may be protested by some airlines on grounds that it intrudes on the Civil Aeronautics Board's regulatory authority and it places the U.S. government in direct competition with foreign business.

The delivery plan, which was outlined Oct. 25 to seven selected U.S. airlines for comment, contains these provisions:

• **Federal Aviation Agency** will be directly responsible for allocation of delivery positions on the supersonic transport production line, even though the agency will have terminated its fiscal participation in the program when production begins. FAA will supervise the position placement of the first 50 aircraft and then withdraw from the merchandising phase of the program. Presumably, the manufacturer will then assign his own priorities.

• **U. S. flag carriers** will be given top priority on the production line, with foreign flag airlines allotted second position. U.S. domestic trunk airlines will rank third in the delivery priority rating.

• **FAA will consider** the value of markets to be served by the ordering airlines as a principal factor in the final determination of delivery positions, and the above categories can be dove-tailed or even merged.

It is this latter point that has stirred the controversy in airline circles, particularly among domestic trunklines that indirectly compete with foreign flag carriers on some route segments. Under the plan, it is conceivable that a foreign flag carrier could be operating a U. S. supersonic transport in U. S. markets served by domestic airlines that still operate subsonic transports.

Significance of the FAA-proposed delivery plan is that it invades the economic prerogatives of the CAB, some feel. Under the Federal Aviation Act of 1958, the Board is responsible for regulating competition in U. S. markets. Under adequacy-of-service provisions, it is responsible for capacity, frequency of schedules and, as was brought out in the classic Toledo Adequacy of Service Case, the quality of equipment operated in the various markets.

In effect, the FAA plan would usurp this CAB authority. For example, if the New York-West Coast market is established as the most important U. S. market from the standpoint of supersonic operations, Continental Air Lines, one of the first U. S. carriers to show an active interest in the transport, could be forced into a later delivery position.

Continental could argue before the CAB that it had been placed at a competitive disadvantage by the FAA decision. The Board has the authority to determine the character of air travel markets and then decide the character of service that should be provided those markets.

The FAA plan puts the agency and therefore, the U. S. government, in direct competition with Sud Aviation and British Aircraft Corp., the manufacturing team building the French-British Concorde supersonic transport. This team has been given full responsibility by its governments for allocating delivery positions and is taking orders on a first-come first-served basis.

Because of the flexibility provided by market evaluation, the FAA plan permits the U. S. to establish arbitrarily any position for any potential buyer because of the large number of carriers operating into most major markets.

FAA assumed delivery position authority because U. S. manufacturers are reluctant to assume the responsibility of allocating positions. As of late last week, American, Continental and Pan American reportedly were ready to protest the FAA plan. Other carriers attending the meeting were Flying Tiger Line, Northwest Airlines, TWA and United Air Lines.

Analysis of the FAA plan emphasizes that while it will aid the U. S. balance of payments and broaden sales markets for the manufacturer, it could create a serious competitive imbalance.

TWA and Pan American would receive the first transports to come off the production line if, as is highly likely, the U. S.-Europe route is deemed the most valuable overseas market.

It is conceivable that a foreign flag carrier could operate a U. S. supersonic transport on the San Francisco-New York-Europe route well before an American flag carrier could place similar equipment in operation on the San Francisco segment of that route.

Japan and Australia also are interested in the U. S. supersonic transport. It is possible that the flag carriers of these nations serving the Pacific area could be awarded delivery positions ahead of U. S. domestic airlines desirous of operating a supersonic transport between the West Coast and Hawaii.

**Alitalia Wants U. S. SST**

**Alitalia is offering to place an order for 3-4 U. S.-built supersonic transports with a down payment on the same terms as those offered by U. S. carriers (AW Oct. 21, p. 38). Besides the Italian airline, which is insisting on a U. S.-built airplane, KLM Royal Dutch Airlines also is showing interest in the U. S. program.**

# Senate Backs Helicopter Subsidies

**Washington**—Senate Appropriations Subcommittee defended local service airline and helicopter subsidy payments last week, indicating that it may restore $8.7 million slashed earlier from the Civil Aeronautics Board's Fiscal 1964 appropriation request by a House subcommittee.

An estimated $2.7 million of the restored funds would be earmarked for helicopter subsidies, for a total of $5.7 million to be shared by the three subsidized carriers, as opposed to a House-imposed limitation of only $1 million for each operator, CAB indicated (AW Oct. 14, p. 37).

CAB Chairman Alan S. Boyd told a Senate subcommittee that, "if the helicopter operators do not wind up with more than $3 million, you'd probably be better off just to kill them outright." By 1966, both New York Airways and Los Angeles Airways should be able to operate without subsidy if their payments are not cut sharply now, he added.

Chicago Helicopter Airways has "two strikes against it," Boyd said, in that it is currently involved in a certificate renewal before the Board and has suffered heavy losses because of curtailment of service at Midway Airport.

At the same time, Boyd stated that CAB will not certificate any new subsidized helicopter operations, since "there is no point in having half a dozen in other cities with operations going through the same problems as New York Airways and Los Angeles Airways are today." Subsidy limit for the three operators this fiscal year stands at $5.7 million.

Boyd said he wants the same amount for next fiscal year, and would even prefer $6 million.

Referring to the House cut as an "arbitrary limitation" on helicopter subsidy, Sen. Allen Ellender (D.-La.) predicted that the Senate would "get into a hassle" with the House over the issue.

Sen. Warren G. Magnuson (D.-



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Wash.) observed that if the Senate subcommittee restores the full $8.7-million cut, it would have to word the language of its report so that the actual subsidy for the helicopter operators is clearly defined.

The Board's proposal to reduce local service airline subsidy by one-third over the next five years brought strong objections from Sen. A. S. Monroney (D.-Okla.), who criticized the pace of the Board's subsidy reduction under the class mail rate system. During the first half of last year, the total subsidy projection for the 13 local service airlines was $69.5 million, and by the end of the year this figure had been reduced to only $67 million and the Board's Fiscal 1964 request for this purpose is only $65.6 million, he pointed out.

Restoration of the House cut would bring CAB's Fiscal 1964 subsidy appropriations to $84 million for local service, helicopter, Alaskan and Hawaiian operations, but would not include an estimated $2.8-million additional subsidy which may be required for Northeast Airlines at a later date under a supplemental appropriation, according to Boyd.

## TWA, Pan American Report Record Profits

**New York**—Heavy traffic volumes through the summer have pushed the nine-months earnings of Trans World Airlines and Pan American World Airways to record levels.

Pan American's profit through Sept. 30 was $20,874,000, or $3.29 a share, after payment of $22,482,000 in taxes. This compares with a net profit of $9,271,000, or $1.38 a share, for the same period in 1962.

Net income for the third quarter was $16,099,000, a 61% increase over the same three months a year ago. Pan American paid $17,275,000 in taxes on its third-quarter earnings this year. The airline carried 421,000 transatlantic passengers during the first nine months, a 22.5% increase. Its transpacific volume rose 16.2% with 344,000 passengers carried.

TWA's losses in the first six months were wiped out by a record $16,867,000 in after-tax earnings for the third quarter. This amounted to earnings of $2.53 a share.

The third-quarter performance gave TWA a $12,013,000 profit, or $1.80 a share, for the first nine months. This compares with a $7,293,000 deficit in the same period a year ago. TWA's earnings came on $353,672,000 in total revenues for the first three quarters, as against $299,855,000 recorded in the like period of 1962. TWA's figures include tax credits carried forward on previous losses.

# IATA Traffic Meeting Recesses; Early Fare Solution Is Unlikely

Disagreement that caused the second collapse of the International Air Transport Assn. traffic conference at Salzburg is deep-rooted, and could deteriorate into an inter-governmental row similar to that which followed the Chandler traffic conference decision (AW May 27, p. 34).

When the second phase of the Salzburg traffic conference recessed after four days of bargaining, it was clear that North Atlantic carriers were still far from reaching any unanimity on a fare reduction plan. Officially, three airlines have been marked as holdouts against a generally-agreed-to fare reduction, but there were signs that several airlines were secretly happy to have action on the proposed fare structure shelved in favor of a recess.

### Welcome Escape

The recess came too easily and appears to have been a welcome escape from what now looks like an insoluble tariff problem. A working group has been formed as a means of reaching some compromise. However, a similar group, called the "vice presidents' group," formed in the final days of the first Salzburg conference (AW Sept. 30, p. 38), failed to bring about an agreement.

With both the Canadian and U.S. governments determined to bring about a lower fare structure, even at the risk of straining international relations, there is every possibility that the issues at stake will be moved back to the governmental level. Unfortunately, the dissension displayed at the Salzburg conference was a direct reflection of the basic disagreements between governments, so that any negotiations between nations must begin with the deadlock that brought an end to the traffic conference.

The harmony attained at the Ottawa meeting of governments last summer (AW July 21, p. 28) was short-lived, and another clash over different philosophies of airline operations may be in the offing. The battle grew so bitter last spring prior to the Ottawa settlement that the North Atlantic fare problems were debated in the British House of Commons and discussed on the U.S. Senate floor (AW May 27, p. 34).

There was little if any attempt to iron out these basic differences at the IATA Annual General Meeting, although several airline presidents stressed that the meeting's organizational structure does not permit the handling of specific issues during the week-long meeting. This raises the question: What is the purpose of the general meeting?

Trans-Canada Air Lines, rigid in its stand for low fares, was again directly responsible for the conference breakdown. The carrier held that the general fare level acceptable to most airlines was too high.

Irish International Airlines also dissented because the "peak season basic fare level proposed was too high." The airline also objected to the proposed abolishment of the group fare plan. The third dissenter El Al, also favored retention of the group fare discount.

Here are the details of the fare structure that drew the largest supporting vote from the delegates at the second phase of the conference:

- **One-way New York-London** first-class fare would be cut from $475 to $400.
- **One-way New York-London** economy class fare of $263 would be reduced to $255 during peak season months and to $210 during off-season periods.
- **Excursion fare** good for 21 days at a round-trip cost of $300 between New York and London would be available during nine months of the year. Currently, a $350 excursion fare is available only in the winter months.

### IATA Weakened

Failure of the traffic conference to reach an agreement, coupled with the walkout of the African delegation during the Rome meeting (AW Oct. 14, p. 41), has weakened IATA and has drawn that weakness into the public eye. The two issues may not appear to be interrelated at this time, but they could converge into a major problem at a later date.

Chief O. L. Dafe, head of Nigeria Airways (WAAC), who led the walkout that included Middle East and Communist bloc airlines, has declared that the action is just the beginning of attempts to expel South Africa and Portugal from international bodies. As a result, a similar disruption could occur at a composite meeting of the traffic conference which, in the past, has been noted for its ability to negotiate on fare problems with complete impartiality and tolerance on racial and religious matters.

At this stage, it now appears that North Atlantic fares will be reduced, but the amount of that reduction will be dictated to the airlines by the governments. It is also possible that the Canadian government, with legal power to fix the rates of its flag carriers, may be the agent that will dictate the amount of reduction to other governments.




## Through the wringer

Since September, 1961, when the U.S. Army began a gruelling series of tests on their CH-47A Chinook helicopter, they have really put it through the wringer.

When the Army completes development testing on it this fall, the Chinook will be as thoroughly tested as a helicopter can be. They have flown it in desert heat where the aircraft was hovered continuously for four hours in a dust cloud at an outside air temperature of 116°F. The Chinook has been operated at temperatures down to minus 65°F, it has been subjected to severe static tests and many of the environments it will encounter. They've packed it full of troops and weapons, and with Pershing missile components and vehicles such as Gama Goat in compatibility tests. They have carried heavy loads and punished it to see if Chinook can take it.

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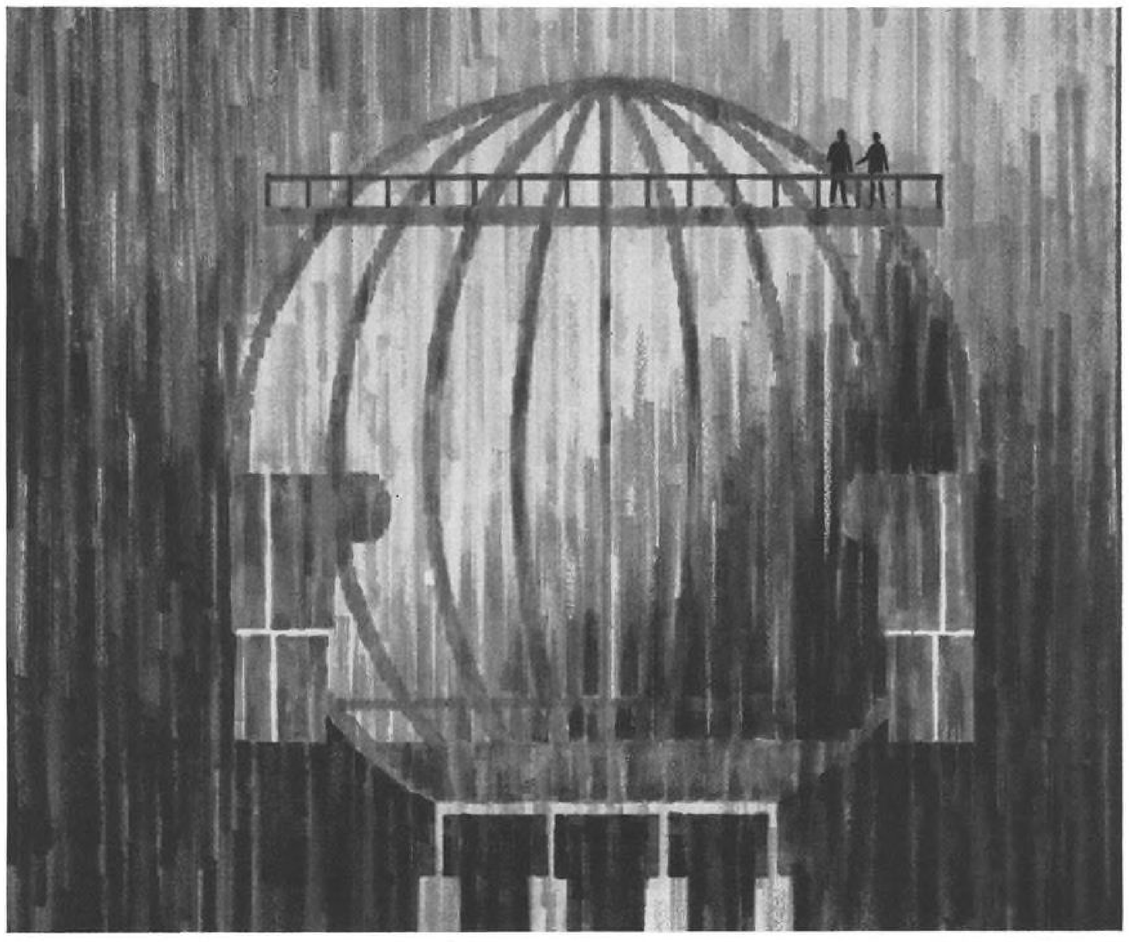
# Airline Traffic—August 1963

| | Revenue Miles (000) | Originating Passengers (000) | Revenue Passenger Miles (000) | Revenue Passenger L/F (%) | Total Revenue Ton Miles (000) | Average Over-all Load (Tons) | Scheduled Miles (000) | Performance Factor (%) |
|---|---|---|---|---|---|---|---|---|
| **DOMESTIC TRUNKS** | | | | | | | | |
| American | 11,829 | 797.2 | 710,211 | 65.1 | 86,146 | 7.28 | 11,793 | 99.1 |
| Braniff | 2,685 | 226.3 | 113,603 | 56.5 | 12,771 | 4.76 | 2,669 | 99.3 |
| Continental | 2,421 | 172.5 | 132,521 | 61.3 | 14,512 | 6.00 | 2,425 | 99.1 |
| Delta | 5,261 | 429.1 | 278,811 | 64.9 | 31,196 | 5.93 | 5,273 | 98.5 |
| Eastern | 9,126 | 837.7 | 410,679 | 52.2 | 44,844 | 4.91 | 9,085 | 97.9 |
| National | 2,750 | 194.5 | 153,004 | 54.7 | 16,677 | 6.06 | 2,764 | 99.4 |
| Northeast | 1,510 | 136.5 | 53,412 | 48.1 | 5,391 | 3.57 | 1,548 | 96.4 |
| Northwest | 2,918 | 228.9 | 157,555 | 60.2 | 17,780 | 6.09 | 2,923 | 99.3 |
| Trans World | 8,896 | 530.5 | 544,905 | 60.8 | 61,881 | 6.96 | 8,852 | 99.6 |
| United | 16,592 | 1,173.8 | 882,216 | 61.0 | 101,064 | 6.09 | 16,613 | 97.5 |
| Western | 2,350 | 279.2 | 153,779 | 63.7 | 15,674 | 6.67 | 2,403 | 97.7 |
| **Domestic Trunk Total** | **66,338** | **5,006.2** | **3,590,696** | **60.3** | **407,936** | **6.15** | **66,348** | **98.5** |
| **INTERNATIONAL** | | | | | | | | |
| American | 164 | 10.6 | 10,466 | 60.2 | 1,295 | 7.89 | 162 | 100.0 |
| Braniff | 281 | 11.2 | 14,395 | 53.6 | 1,806 | 6.43 | 282 | 99.5 |
| Caribair | 186 | 70.1 | 5,571 | 65.9 | 576 | 3.10 | 178 | 95.3 |
| Delta | 112 | 3.8 | 6,472 | 68.2 | 739 | 6.62 | 112 | 100.0 |
| Eastern | 1,163 | 68.7 | 99,660 | 63.0 | 9,714 | 8.35 | 1,124 | 97.2 |
| Mackey | 171 | 15.1 | 5,550 | 46.2 | 547 | 3.20 | 79 | 98.7 |
| Northwest | 1,212 | 30.3 | 91,075 | 65.0 | 12,759 | 10.52 | 942 | 99.7 |
| Panagra | 360 | 13.9 | 23,190 | 66.0 | 3,451 | 9.58 | 339 | 96.7 |
| Pan American | 10,965 | 490.3 | 881,784 | 63.8 | 115,642 | 10.55 | 10,392 | 98.0 |
| South Pacific | 27 | 0.7 | 1,858 | 72.0 | 188 | 6.87 | 27 | 100.0 |
| Trans-Caribbean | 501 | 26.3 | 52,401 | 67.6 | 6,304 | 12.59 | 378 | 88.7 |
| Trans World | 2,735 | 64.9 | 206,852 | 58.0 | 26,684 | 9.76 | 2,621 | 99.2 |
| United | 1,000 | 36.8 | 92,347 | 77.6 | 10,148 | 10.14 | 984 | 98.5 |
| Western | 189 | 10.1 | 15,392 | 78.3 | 1,642 | 8.69 | 189 | 100.0 |
| **International Total** | **19,066** | **852.8** | **1,507,013** | **63.7** | **191,495** | **10.04** | **17,809** | **98.1** |
| **LOCAL SERVICE** | | | | | | | | |
| Allegheny | 1,013 | 102.6 | 20,592 | 44.3 | 2,240 | 2.21 | 1,011 | 98.8 |
| Bonanza | 516 | 48.1 | 12,384 | 63.2 | 1,227 | 2.38 | 516 | 99.4 |
| Central | 624 | 37.0 | 7,695 | 44.7 | 814 | 1.30 | 624 | 99.4 |
| Frontier | 1,095 | 55.2 | 16,230 | 45.2 | 1,728 | 1.58 | 1,097 | 99.0 |
| Lake Central | 582 | 41.6 | 6,798 | 40.9 | 738 | 1.27 | 582 | 98.8 |
| Mohawk | 1,072 | 112.7 | 23,549 | 51.2 | 2,424 | 2.26 | 1,066 | 98.8 |
| North Central | 1,376 | 114.8 | 21,722 | 46.7 | 2,334 | 1.70 | 1,351 | 99.9 |
| Ozark | 880 | 70.7 | 13,553 | 52.5 | 1,442 | 1.64 | 881 | 99.6 |
| Pacific | 464 | 52.0 | 11,328 | 57.9 | 1,122 | 2.42 | 466 | 99.1 |
| Piedmont | 973 | 76.8 | 17,998 | 47.8 | 1,871 | 1.92 | 967 | 99.4 |
| Southern | 833 | 55.7 | 10,678 | 40.0 | 1,128 | 1.35 | 813 | 98.9 |
| Trans-Texas | 662 | 39.8 | 9,510 | 45.2 | 996 | 1.50 | 669 | 98.4 |
| West Coast | 539 | 33.6 | 8,008 | 47.7 | 809 | 1.50 | 587 | 91.6 |
| **Local Service Total** | **10,629** | **840.6** | **180,045** | **47.9** | **18,873** | **1.78** | **10,630** | **98.8** |
| **ALASKA & HAWAIIAN** | | | | | | | | |
| Alaska Airlines | 212 | 9.1 | 7,295 | 49.4 | 1,317 | 6.23 | 169 | 91.5 |
| Alaska Coastal | 220 | 15.3 | 1,239 | 64.9 | 147 | 0.67 | 130 | 96.1 |
| Aloha | 292 | 66.6 | 9,817 | 76.5 | 790 | 2.70 | 230 | 95.5 |
| Cordova | 153 | 3.8 | 441 | 49.8 | 139 | 0.91 | 71 | 93.6 |
| Hawaiian | 405 | 78.8 | 11,731 | 69.8 | 1,143 | 2.82 | 318 | 94.6 |
| Kodiak | 72 | 2.4 | 147 | 39.8 | 16 | 0.22 | 28 | 100.0 |
| No. Consolidated | 216 | 4.2 | 1,313 | 48.4 | 395 | 1.83 | 132 | 98.5 |
| Pacific Northern | 432 | 22.2 | 20,300 | 52.6 | 2,921 | 6.76 | 398 | 99.7 |
| Reeve Aleutian | 146 | 2.2 | 2,104 | 48.3 | 566 | 3.86 | 77 | 93.0 |
| Western Alaska | 38 | 1.3 | 74 | 69.2 | 9 | 0.23 | 16 | 95.8 |
| Wien Alaska | 435 | 8.0 | 2,901 | 48.3 | 635 | 1.46 | 212 | 95.1 |
| **Alaska & Hawaiian Total** | **2,621** | **213.9** | **57,362** | **57.7** | **8,078** | **3.08** | **1,781** | **96.0** |
| **HELICOPTERS** | | | | | | | | |
| Chicago | 20 | 4.4 | 90 | 49.2 | 9 | 0.44 | 18 | 99.8 |
| Los Angeles | 71 | 18.8 | 719 | 54.6 | 75 | 1.07 | 76 | 90.4 |
| New York | 45 | 28.5 | 554 | 53.6 | 56 | 1.24 | 44 | 85.8 |
| **Helicopter Total** | **136** | **51.7** | **1,363** | **53.8** | **140** | **1.03** | **138** | **90.2** |
| **CARGO & OTHERS** | | | | | | | | |
| Aerovias | Not Available | | | | | | | |
| Avalon | Certificate Expired June 13, 1963 | | | | | | | |
| Flying Tiger | 1,368 | 13.5 | 46,413 | 85.6 | 19,954 | 14.59 | 311 | 100.0 |
| Riddle | 1,117 | 6.3 | 22,013 | 96.1 | 8,737 | 7.82 | 242 | 96.8 |
| Seaboard | 703 | 8.5 | 32,310 | 98.5 | 12,232 | 17.39 | 358 | 84.3 |
| Slick | 691 | 0.8 | 2,437 | 62.5 | 10,629 | 15.39 | 178 | 98.8 |
| **Cargo & Other Total** | **3,879** | **29.1** | **103,173** | **90.6** | **51,552** | **13.29** | **1,089** | **93.9** |
| **Industry Total** | **102,669** | **6,994.3** | **5,439,652** | **61.0** | **678,074** | **6.60** | **97,795** | **98.3** |

Prepared by Ray & Ray

What will man's problems be in the vast emptiness of outer space? How will the materials and systems he will use stand up? Will his communications with earth work properly? □ At the new Douglas Space Systems Center in Huntington Beach, California, many of the required answers will be found. Part of the Center is an environmental laboratory where space "hardware" up to 30 feet wide can be tested at vacuum levels and temperatures which would be encountered 500 miles out. Other units can produce deeper space conditions down to a vacuum of $10^{-14}$ torr and with any required radiation and gravity situations. □ Such research facilities are basic for the development of manned and unmanned satellite systems, launching and space vehicles, earth to moon communication devices, lunar housing and vehicles, life support systems, and similar projects in which Douglas is involved.

**FAR OUT FACT FINDING**
**...AND WHAT DOUGLAS IS DOING ABOUT IT**



Other research programs covering some 23 broad technological areas are under way in the major Douglas divisions located at Santa Monica and Long Beach, California, Tulsa, Oklahoma, and Charlotte, North Carolina.

DOUGLAS

## SHORTLINES

► **Air Cameroun** last month began a domestic air operation serving Douala, Tchang, Kumba, Yaounde and Tiko.

► **Allegheny Airlines** has reported an 11% increase in the number of passengers carried during the first three quarters of 1963, compared with the same period last year. Cargo volume rose 18% during the first nine months of 1963.

► **Braniff Airways** President Charles E. Beard last week predicted that the next big business and tourist travel boom will be to South America. He spoke to the annual convention of American Society of Travel Agents in Mexico City.

► **Continental Air Lines** last week announced the purchase of a Boeing 720B fan-jet transport, bringing the carrier's total fleet to four Boeing 707 and six Boeing 720B aircraft. Aircraft will be paid for from internally generated funds.

► **Flight Engineers** International Assn., at its annual convention last week in Washington, named William A. Gill, Jr., as its president to replace Ronald A. Brown, who resigned from the post after four years in service. Gill is a flight engineer for Pan American World Airways.

► **Mitre Corp.** has established a 25-man engineering team in Arlington, Va., near Washington, D. C., to assist the Federal Aviation Agency in the implementation of a national airspace system under a $3.13-million contract extension. Original contract of $2.7 million called for the operation and maintenance of an experimental facility to test the system.

► **Pacific Southwest Airlines** late last month exceeded its record-setting 1962 passenger total of 1,032,514. The California intrastate carrier expects to carry more than 1.25 million passengers for all of 1963.

► **Trans-Caribbean Airways** reported a 43% increase in revenue passenger miles for the first nine months of 1963, compared with the same period last year. Revenue ton miles rose 50.4% in the first three quarters of 1963.

► **Zantop Air Transport** has received a 99.9% rating for on-time performance with its Hawker Siddeley Argosy turboprop cargo transports in Logair scheduled service during July and August. Rating was made by USAF Logistics Command.

## AIRLINE OBSERVER

► Soviet-owned airline, Aeroflot, eager to carry some of the traffic to be generated by the Olympic Games in Tokyo next year, is seriously considering a proposal by Japan that Japan Air Lines charter Tu-114 turboprop aircraft flown by Russian crews for a Tokyo-Khabarovsk-Moscow service. Charter operation, which would remain in effect for the duration of the Olympics, would make Moscow a European gateway for the Olympic Games, give Japan a wedge in its continuing drive for a Tokyo-Moscow route and yet bypass Russia's rigid opposition to foreign aircraft overflying Siberia.

► **U. S. trunklines and three all-cargo carriers flew 72.9 million ton miles of air cargo in domestic operations in September, a 9.9% increase over the volume handled in September, 1962.**

► British Overseas Airways Corp. has begun testing an advanced VHF radio range system that stretches the present 200-mi. range to 450 mi. for North Atlantic jet flights. System was developed by Pye, Ltd., and involves construction of a new transmitter on a hill near Dublin, 560 ft. above sea level. The transmitter is linked to BOAC's control center in London by land-line. System may be extended beyond 450 mi. after effects on Dublin airport radio services are evaluated. Federal Aviation Agency is testing similar troposcatter extended range stations on Cape Cod and in San Juan (AW June 24, p. 103).

► **Growing interest by factions within the Civil Aeronautics Board in reducing excessive competition by cutting back on the number of airlines on certain routes (AW Oct. 28, p. 46) places the domestic trunklines in an unusual dilemma. Voluntary curtailment of schedules and capacity as a protective measure against such action could force the CAB to use its strongest weapon in controlling competition—adequacy-of-service investigations.**

► CAB last week reopened the Southern Transcontinental Service Case to investigate a single issue: whether Eastern Air Lines or Braniff Airways should be awarded the Texas-Florida route. In its original decision (AW May 6, p. 42), the Board found a need for the route and awarded it to Eastern. Braniff went to the Court of Appeals, which remanded the matter to the Board for further proceedings.

► **Air Traffic Control Assn. last week protested the U. S. government's decision to pay 24% of whatever damages are assessed in lawsuits resulting from the 1960 mid-air collision of a TWA Lockheed 1049 Constellation and a Douglas DC-8 (AW Oct. 28, p. 39). ATCA said that if the government had agreed to pay a "nuisance value" to avoid the expense of defending a lawsuit, "the nation's controllers could not regard such a compromise agreement as an admission of negligence. . . ." The association added that 24% indicates more than a nuisance value, thus implying negligence.**

► Sen. A. S. Monroney (D.-Okla.) is questioning the desirability of a plan developed by the Defense Dept. and FAA for concurrent implementation of the FAA's Project Beacon air traffic control system (AW Nov. 13, 1961, p. 34). After more than a year's effort to develop a feasible and concurrent plan for implementing FAA ground equipment and installing a new identification beacon in military aircraft, both agencies were expected to allot sizable amounts of their Fiscal 1965 budget to initiate the program. Monroney's questions were contained in a recent letter to Defense Secretary Robert S. McNamara.

► **Air-India will file next year for CAB authority to fly between Japan and the U. S. If successful, the airline will then seek operating rights between the West Coast and New York to give it an around-the-world service. Japan Air Lines has been unsuccessful in its three-year-old bid for an extension of its Pacific route to New York and beyond to London to complete an around-the-world route.**

► Indian Airlines will inaugurate its first turbojet service in January with three Sud Caravelles. Carrier's 12 Vickers Viscount turboprop transports will operate on regional routes when the Caravelles move into the trunk segments. Majority of the airline's 42 Douglas DC-3 aircraft will be retired.




**STEEP CLIMBOUT** is evident on test flight of Boeing 727. Drag is 5% less than predicted.




**BOEING FLIGHT LINE** at Renton, Wash., is indicative of activity in the production program for the 727 turbofan transport, with three visible here in Eastern and American markings.

# 727 Program

# Entering Production Phase at Boeing Plant

By C. M. Plattner

**Renton, Wash.**—Rapid pace of Boeing's 727 three-engine turbofan transport program calls for its production rate to reach one airplane every four working days by next month, when certification of the aircraft is expected.

To date, 19 of the 727s have been built, and the first airplanes have been delivered to United Air Lines and Eastern Air Lines for pilot training.

Boeing started the $16-million, 11-month flight test program in February. By August it had announced better-than-predicted drag and fuel consumption results—primarily the result of conservative performance estimates in the early design and development phase, rather than from modifications.

Lack of such modifications during the test program is credited by Boeing largely to experience from its 707 jet transport programs. Use of engineering teams familiar with the 707 programs was emphasized to incorporate their experience into the 727's design.

Three 727s in the flight test and Federal Aviation Agency certification program will have accumulated 1,182 experimental flight hours by Dec. 30, when the program is to end. Two belong to United. A third, company owned, will be kept for follow-on tests.

FAA flights included over two weeks of testing at Edwards AFB. No significant obstacles are foreseen by Boeing in the FAA program. An inherent design feature of the 727, however, is the lack of yaw in a flameout of the tail-mounted number two engine. Swerve of the aircraft has been one method of recognizing and confirming engine failure on planes with wing-mounted engines. Boeing claims, however, that proper training of the three-man crew, involving special instrument-monitoring procedures during takeoff and possible installation of a warning device, are an adequate safeguard.

An alternative could be the extension of certified takeoff distance by the FAA, based on the theory that the pilot would require a longer time to recognize a flameout occurring at $V_1$ and delay his decision to stop. This would mean a corresponding drop in the payload which could be carried out of smaller fields.

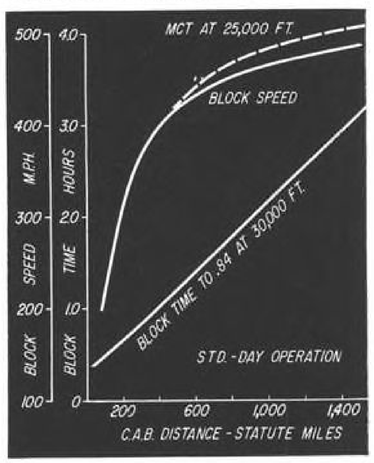
One other area of uncertainty in the certification program is the possible use of a Mach-trim device. It would compensate for trim reversal occuring in a narrow portion of the flight envelope near maximum operating speeds close to 400 kt. None of the 727s now flying has such a system.

The 5% reduction in drag and 2½-4% reduction in fuel consumption over predicted figures essentially will be a windfall to purchasers of the first 131 aircraft. Boeing will guarantee higher performance for future orders, including the six additional 727s recently ordered by TWA (AW Sept. 2, p. 29).

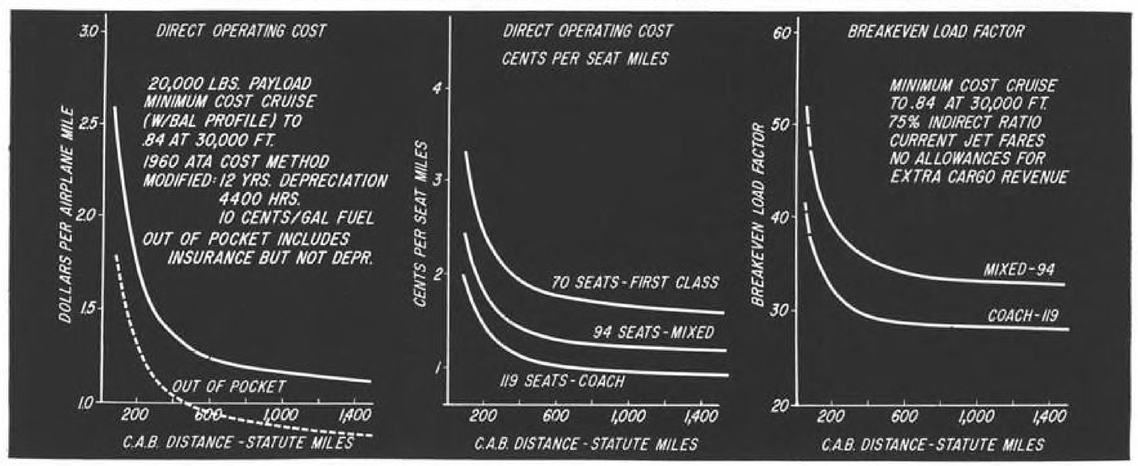
During design, the conservative estimates appeared well founded and were based on past experience in reconciling wind tunnel and actual flight test data. The 727 incorporated many of the drag reduction features applied to the 707-320B as a result of Boeing's program to clean up the plane aerodynamically.

The basic exterior design of the 727 has remained unchanged during the

**CHART** plots miles, speed/time at Mach .84.

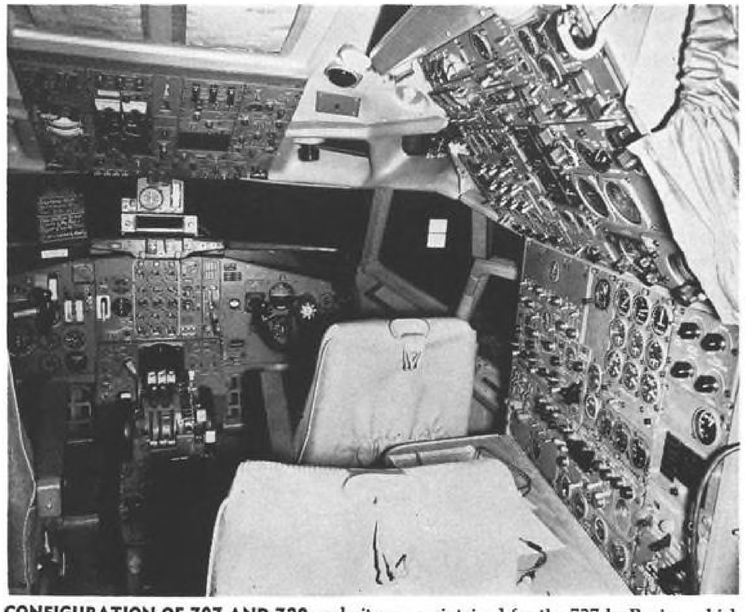



**DIRECT OPERATING COSTS** are plotted in dollars per airplane mile and cents per seat miles. Breakeven load factors are at right.





**BASIC EXTERIOR OF BOEING 727** has remained essentially unchanged during its flight program except to incorporate numerous advances over 707 and 720 based on those programs. Triple-slotted trailing edge flaps and leading edge Krueger flaps, illustrated in landing pictured above, help reduce approach speeds from 118 to 111 kt., performance better than expected.



**CONFIGURATION OF 707 AND 720** cockpits was maintained for the 727 by Boeing, which designed the aircraft as a pilot's airplane. Both pilots and management were interviewed early in the development program for views on such arrangements as cockpit layout (above). Airline pilots also were invited to fly the aircraft and comments from them were requested by Boeing.

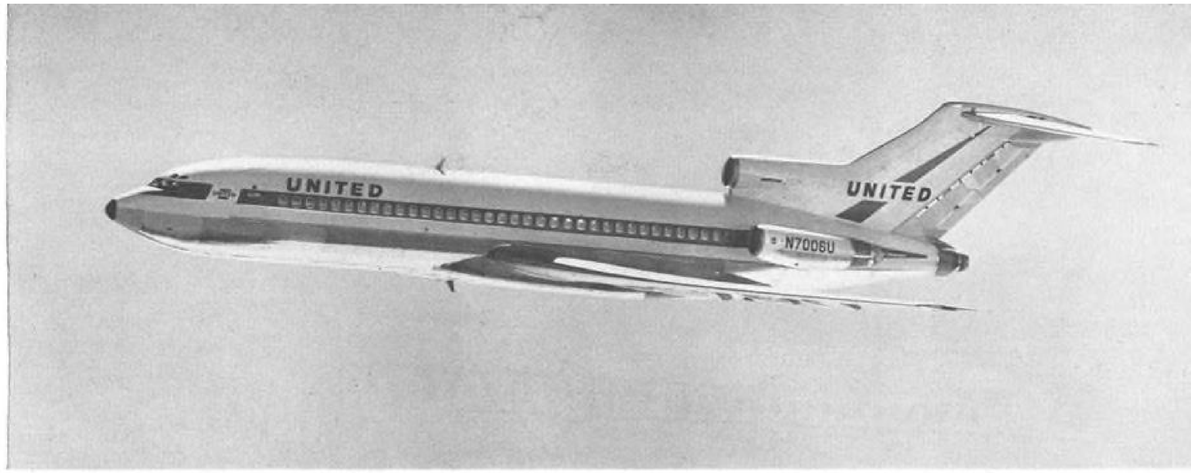
flight test program although a small improvement in performance resulted from fairing small gaps between the rudder and vertical fin. The inlet duct for the number two engine retained its original exterior configuration.

The 14,000-lb. thrust JT8D-1 turbofan powerplant is essentially a new engine developed for the 727. As a result of the fast-paced flight test program, the first engines delivered to Boeing were prototype engines.

Fuel consumption improvement over predicted levels range from 2½% less burned on takeoff to about 4% less on a maximum continuous cruise of Mach .80 at 30,000 ft. Greatest improvement in fuel consumption is in the high-thrust regions but reductions are significant at maximum cruise conditions—approximately 2.8% at 30,000 ft., on a standard day. Fuel consumption for each engine at maximum cruise is slightly greater than 3,200 lb. per hr.

Boeing designed the 727's size to handle the anticipated growth in passenger loads by 1968. Market researchers at Boeing regard passenger density on route segments as the basic parameter in airline operational economy. Cost per seat mile is another influencing factor. They feel that the 727's promised oper-






**SPEEDS OF MACH 0.97** have been reached by 727 in flight test program, although aircraft will be certificated for Mach 0.92. Aircraft above was the first delivered to United Air Lines. Pilots report it is easy to trim and stable when trimmed.




**RETRACTION OF LANDING GEAR** is shown (above) during flight test. Flaps extended in flight (below) show changes in camber produced by slats—outboard two-thirds of leading edge—and front and rear flaps. Wing has a maximum lift coefficient of 2 9 with flaps extended.






**SPECIAL SKID TO PROTECT** tailpipe of Boeing 727's No. 2 engine (under aircraft numeral, above) during maximum takeoff angle tests keeps tail, when extended, from scraping runway.



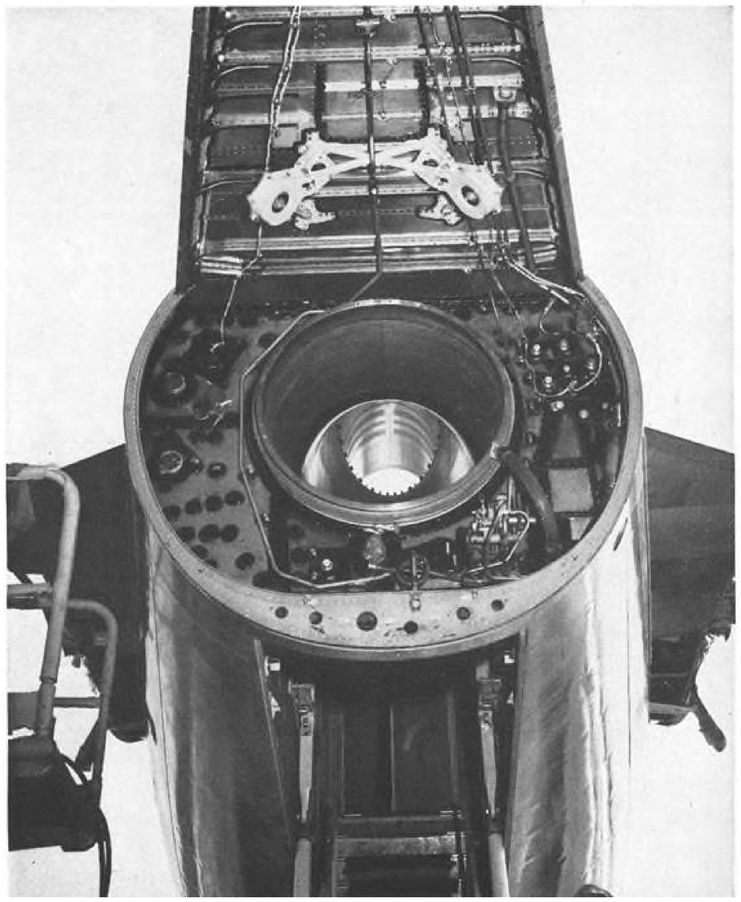

**RELATIVELY SMALL WING AREA** of the 727 helps minimize cruise drag. Boeing aimed at above average, low speed handling characteristics for small field operations. Gear (below) can be lowered on approach without noticeable cockpit noise.



**FIVE-ABREAST SEATING** in typical configuration (below) would be for single class such as United uses. Typical dual class arrangement planned by American and TWA would have 28, four-abreast first class seats and 66, six-abreast tourist seats.



**INTAKE OF ENGINE NO. 2** of 727 in this unusual photograph looking through tailpipe also illustrates one semi-circular row of vortex generators installed to improve air flow.



ating economy will allow airlines to use it on lower density runs, since carriers generally prefer to fly the largest capacity aircraft which they can afford.

Boeing now sees a potential future 727 market of greater than 400 aircraft, but would not bracket the time period. Company officials already are talking, however, of a 15-year rather than a 10-year lifetime.

Break-even point in the 727 program probably will be at least 250 aircraft.

The 727's flight performance recently was demonstrated to this AVIATION WEEK & SPACE TECHNOLOGY pilot on a brief flight from Boeing Field. The plane, one of two test aircraft scheduled for delivery later to United Air Lines, was the first 727 to be flight tested last Feb. 9.

The 727 responded quickly and positively to the controls throughout the flight, which included a high speed run to Mach 0.90 at 20,000 ft., a rapid descent with speed brakes and an approach and landing at Boeing Field.

The only detectable cockpit noise came from the air-conditioning system. Some exterior wind noise at speeds near Mach 0.90 was noticed, but primarily because of the contrast with the extremely quiet and vibrationless operation.

Gross weight of the aircraft at the beginning of the flight was 119,000 lb. including 22,000 lb. of test instrumentation. Gross weight at landing was 111,900 lb. with 6,000 lb. of fuel remaining. Calculated takeoff ground roll was 2,300 ft. Temperature was 72 deg. At the same temperature, ground roll at 147,000 lb. would be about 3,500 ft.

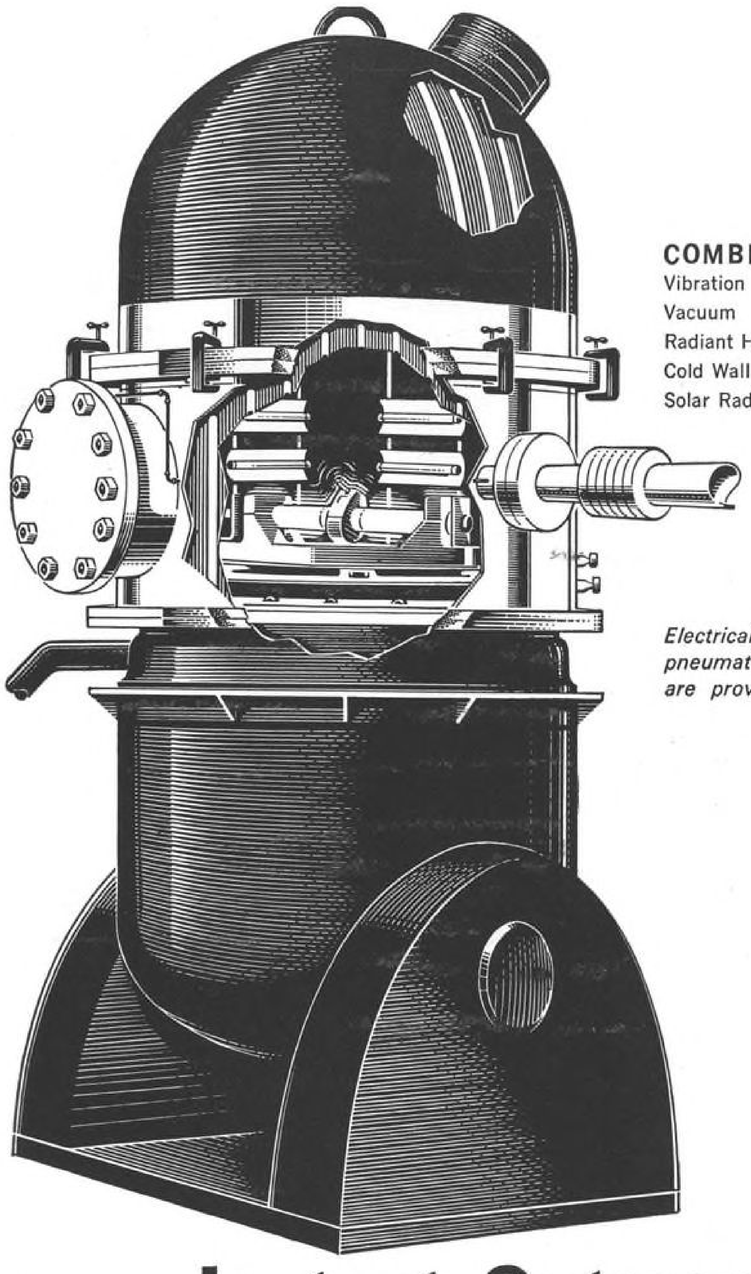
The demonstration followed an FAA handling characteristics flight and was flown with Boeing engineering test pilot Jack Waddell in the right seat.

Climbing to 20,000 ft. at airspeeds between 240 and 300 kt., the 727 responded quickly even to small control deflections. A pilot familiar with single-place jet aircraft easily adapted to the 727. The plane was easy to trim and stable when trimmed. Total flight time to 20,000 ft. was 6 min., including approximately 2 min. of low level flight.

At 20,000 ft., Waddell increased all three engines from idle to the maximum allowable rpm. by retarding the throttles and jamming them forward. The engines responded quickly and smoothly without surging.

Early in the 727 flight program, the number two engine had a tendency to surge at high angles of attack when power was reduced, due to separation of the air from the curved portions of the duct. Installation of two semi-circular rows of vortex generators at each of the two bends in the duct improved air flow characteristics and the number two engine now responds as well or better than the pod-mounted numbers one and three engines.

Waddell performed two power-off stalls—with and without flaps. In a clean configuration, the 727 stalled at 135 kt. at about 21,000 ft. with a strong buffet but no tendency to drop off. The stall warning device vibrated the control column vigorously at 140 kt., giving



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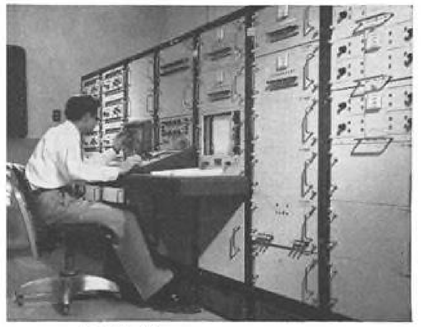
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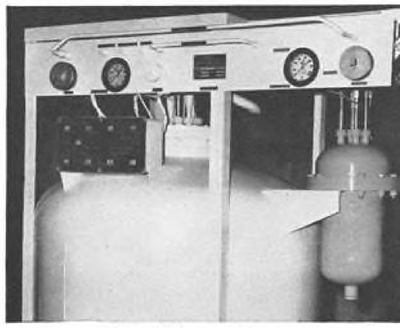
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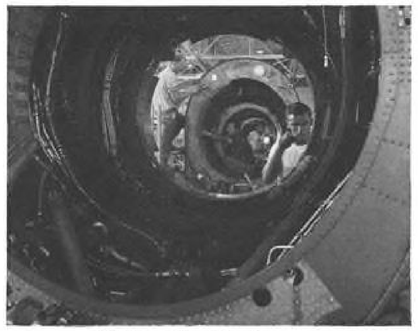
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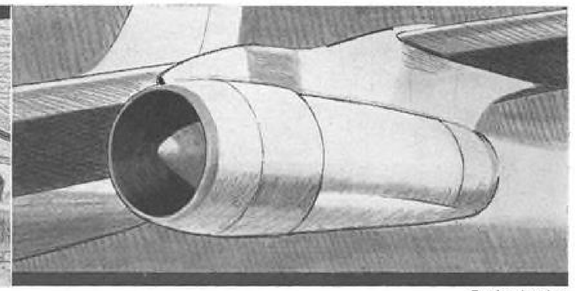


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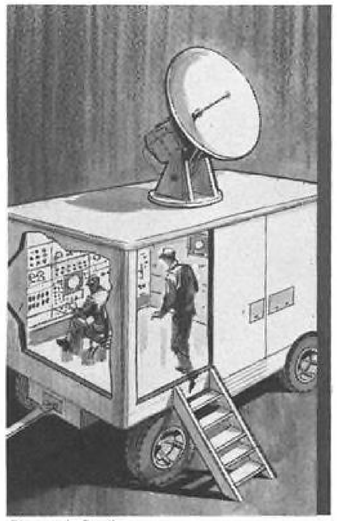
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Aircraft Cabins



Engine Intakes

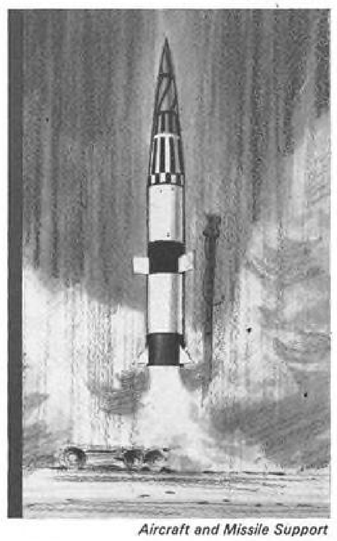


Electronic Cooling

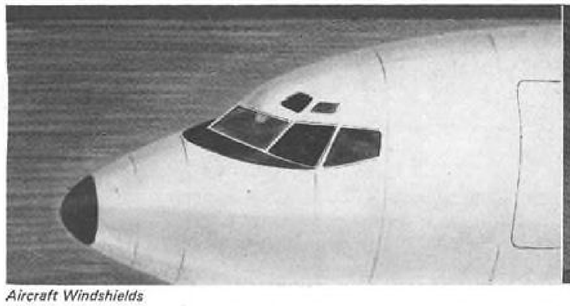
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ample warning. Waddell dropped the nose slightly following the stall and the aircraft recovered quickly with a minimum loss of altitude.

With a takeoff flap setting of 25 deg. the column began vibrating at 103 kt., followed by a strong buffet at 98 kt. The plane stalled completely at 95 kt. and the nose pitched forward. The plane recovered quickly, hands-off, and with a minimum loss of altitude.

The 40-kt. gap between stall speeds indicates the aerodynamically clean characteristics of the 727 wing and the high lift provided by the trailing and leading edge flap devices. The high-speed wing incorporates numerous advances in aerodynamic refinement and drag reductions based on Boeing's 707 and 720 experience. The wing has a maximum lift coefficient of 2.9 when the triple-slotted trailing edge flaps and the leading edge Krueger flaps and slats —outboard two-thirds of leading edge— are extended.

Boeing kept the wing area of the 727 relatively small to minimize cruise drag. Other improvements included minimizing flap leakage in the retracted position, rounding the leading edge of the wing tip and reducing the wing camber in the inboard area.

There is no evidence in the cockpit of vibration with flaps lowered, even in tight turns with positive G-forces. Waddell banked the 727 in turns of 30, 45 and 60 deg., flaps down with power on, at speeds of 115, 120 and 128 kt., respectively. In the 60-deg. turns, the high lift of the wing was evident and made it appear as if the plane was turning about a point on the ground.

The lack of buffet in the trailing edge flaps is due largely to the use of aluminum sheets bonded to a fiber glass core with very smooth exterior surfaces.

On a straight and level acceleration to Mach .90, no difficulty was experienced in trimming the aircraft and holding its altitude and heading. Boeing intends to certificate the 727 for Mach 0.92, but speeds up to Mach 0.97 have been reached in the flight test program.

Waddell said that the 727 is as fast as any of the other Boeing commercial transports. A maximum cruise speed of Mach .88 at 35,000 ft. for the 727 matches that of the other Boeing aircraft.

Low aerodynamic drag was evident by the slight deceleration felt at Mach .90 when Waddell brought the throttles back to near idle.

Still at high speed, Waddell assumed control and wrapped the plane into a 60-deg., 2-g turn without buffet or vibration. Such maneuvers, far in excess of anything likely to be encountered in routine airline flying, pointed up the results of Boeing's efforts to design an aircraft capable of consistent performance under all flight conditions.

A descent from 20,000 ft. was started at an indicated airspeed of 240 kt. At approximately 10,000 ft., speed brakes were extended to increase the rate of descent to over 4,000 fpm. No shudder or vibration accompanied use of the speed brakes, which are the outboard spoilers ordinarily used for lateral control to augment the ailerons. Lateral control with only the high speed aileron was noticeably decreased, however, without use of the spoilers.

During the approach to Boeing Field the plane trimmed easily and when speed brakes were retracted the trim change was barely noticeable. Final portion of the approach was made at 115 kt., over the reference speed of 111 kt. because of moderate turbulence. Lowering of the gear caused no noticeable thuds or vibrations in the cockpit.

With flaps at 40 deg. and a speed of 115 kt., the plane was stable and so responsive to roll commands that there was a tendency at first to overcontrol. After a steep descent the nose was raised at about 75 ft. to flare the aircraft and the plane was flown onto the runway, touching down at approximately 100 kt.

Immediately after touchdown, Waddell assumed control and demonstrated the short field landing capability. The aircraft decelerated quickly, and was stopped within an estimated 900 to 1,000 ft. by full application of the pressure modulated, anti-skid brakes without reverse thrust.

Nose-wheel braking is effective at about half-throw of the brake pedals. Inboard ground spoilers used with outboard spoilers to spill lift and transfer full aircraft weight onto the main gear also contribute to the braking system's effectiveness. That feature and the pressure-modulated brakes give the 727 better-than-average braking on wet runways. The 727 has been stopped in 905 ft. on a dry runway at 114,000 lb. gross weight, and in 1,780 ft. on a wet runway at 123,000 lb. gross weight, both without reverse thrust.

Ground directional control was maintained easily with the steering wheel on the left side of the cockpit. The nose wheel also may be steered with the rudder pedals up to six degrees of turn, which is useful during takeoff and landing. Brakes proved very effective but not overly sensitive and the aircraft was easily slowed down without noticeable jerking.

Ground maneuverability of the 727 was evident during parking. A 120-deg. turn was made practically within half the length of the aircraft. Using the full 78-deg. rotation of the nose gear, a minimum turning radius of 70 ft. 4 in. to clear the tail permitted close-in maneuvering which was not difficult even for the first time. Total aircraft length is 133 ft. 2 in.

After stopping the aircraft, Waddell


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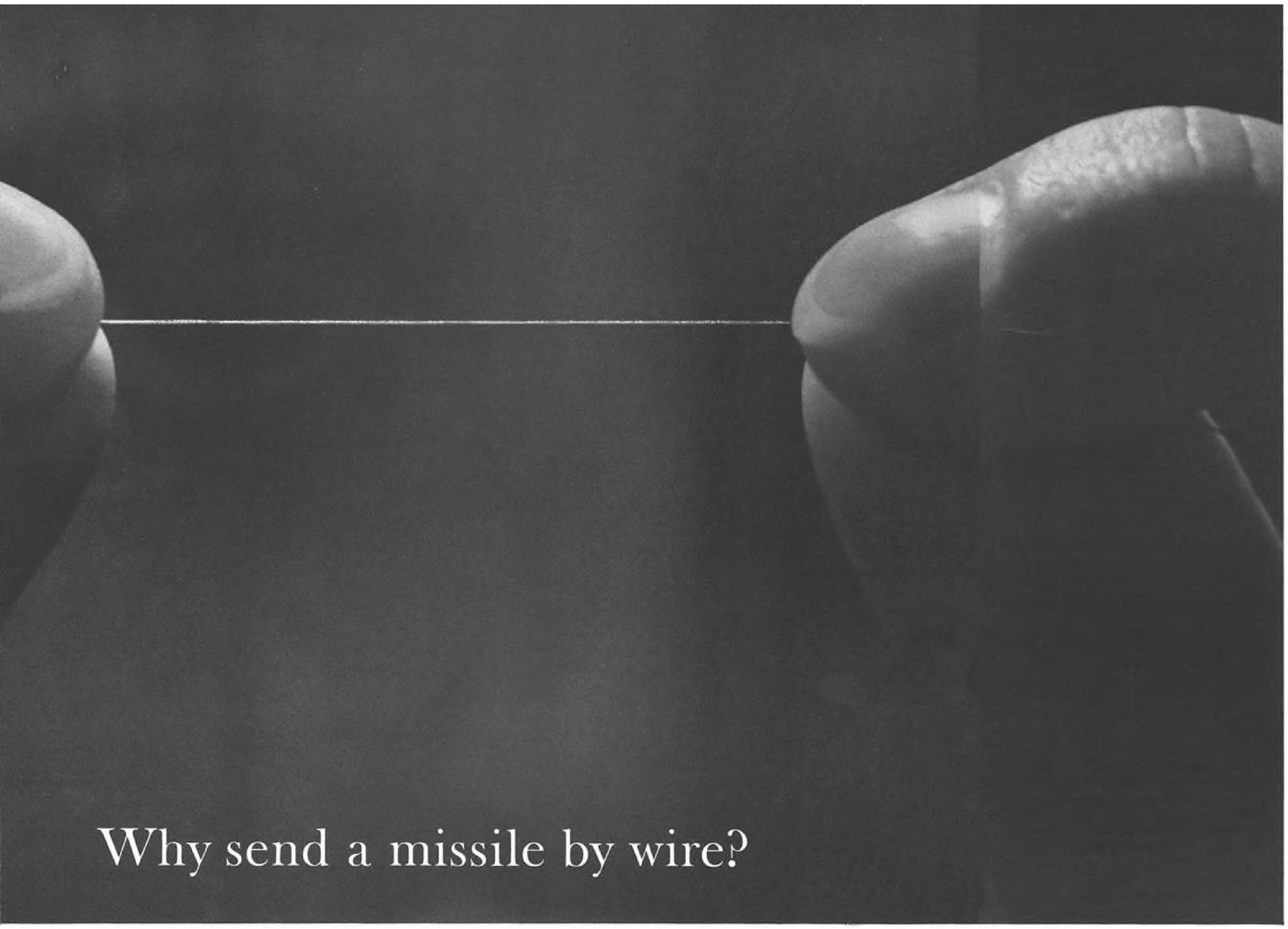
AURORA, ILLINOIS

## The new Lockheed C-141 StarLifter is a national project

When the big Lockheed/USAF StarLifter rolled out last August, people were cheering at Lockheed-Georgia — and, in spirit, in many parts of America. Because the C-141 is truly a national project. In fact, 34 of the 50 states provide parts and systems for the C-141. Altogether, more than 60 per cent of the airplane is built outside Lockheed. The StarLifter is on schedule. First flight is scheduled for late December. Lockheed salutes *the team* that makes it possible.



*Lockheed-Georgia Company: Marietta, Georgia • a division of Lockheed Aircraft Corp.*



# Why send a missile by wire?

**Imagine an infantryman in battle.** In the distance, rumbling into action, is the most dreaded enemy he must face—tanks. They are virtually invulnerable. But his outfit's job is to knock them out.

A tough job. Calling for a unique weapon. One accurate at distance against a moving target. Carrying one-punch lethality—light in weight—rugged. Simple to operate. Easy to carry—on or off infantry vehicles.

This was the scope of the problem faced by Hughes engineers working with the U.S. Army. The solution—almost paradoxically simple in this day of complex weapons—is the new TOW missile system.

With it, the infantryman at last has tactical edge. He can fire from ambush. And surprise is on his side. The gunner aims a telescopic sight at a target then launches the missile which automatically follows his line-of-sight. As the missile travels through the air it unreels two hair-thin wires through which it receives electronic steering signals. Thus constantly "commanded," the TOW missile hits precisely where he aims.

Because these steering commands are sent by wire, they are undetectable. Thus, the enemy cannot use the guidance commands to locate the launcher.

The lightweight TOW anti-tank missile system offers other important advantages. Its simplicity of operation reduces training requirements. It can be used either by dismounted troops or it can be carried on various types of vehicles, such as jeeps and armored personnel carriers, or on helicopters.

TOW is characteristic of Hughes approach to scientific and technological challenge—where every requirement is fully explored and the resultant system offers the optimum answer to the need.

**Engineers and scientists:** TOW is but one of many current Hughes programs such as F-111B Phoenix Missile Systems, Surveyor, Syncom, Polaris guidance & VATE. You are invited to inquire about employment opportunities. Hughes is an equal opportunity employer.

Please write: Mr. S. L. Gillespie, Manager, Employment & Manpower, Hughes Aircraft Company, Culver City 50, Calif.

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backed the plane up several feet with reverse thrust. Reversers on the 727 deliver a thrust equal to 50% of the static thrust.

Boeing designed the 727 as a pilot's airplane, providing control about three axes at all speeds while maintaining the convenience and roominess of the 707/720 cockpit. The company, early in the development program, began obtaining views of both airline pilots and management. Boeing invited airline pilots to fly the aircraft and sought their comments on the plane.

The fast-paced flight test program is part of an over-all test program (AW Dec. 10, p. 60) which began in the fall of 1961. The total obligation to the test program, which includes static and fatigue tests, is $30 million. One contribution to the flight test program from 707/720 experience was the high rate of transcription and reduction of flight test data.

Over 80% of the flight test data is recorded on tape, the majority in final form. Maximum flow time on any data is two days. Boeing has been able to transcribe approximately three times as many data points per aircraft flight hour in the 727 program as in the 707 test program.

One problem encountered with the first production models of the JT8D-1 was during unusual maneuvers such as low-altitude, power-on stalls when titanium compressor blades touched the stator vanes. Back pressure bent the blades forward and the resulting wear decreased air flow efficiency and corresponding thrust levels.

Pratt & Whitney's solution, accomplished in less than a month, was to respace the blades to allow for the bending action. The problem did not arise with the prototype engines since compressor blades were made of stainless steel.

In committing itself to an accelerated reliably, it also has proven more management was aware of the risk it faced in depending on a new engine which had never been in production before. But the engine not only has operated reliably, it also has proven more economical than predicted.

To minimize the risk in using a new engine, Boeing required an early commitment from Pratt & Whitney on specifications. Flight testing of prototype engines began over a year and a half ago. They were mounted externally on the company's 707 prototype, called the Dash-80.

Since the 727 program called for a high initial production rate and early FAA certification, Boeing pinpointed several other areas of risk and took steps to minimize the associated engineering uncertainties. Other key problem areas in the 727 development program included development of the:

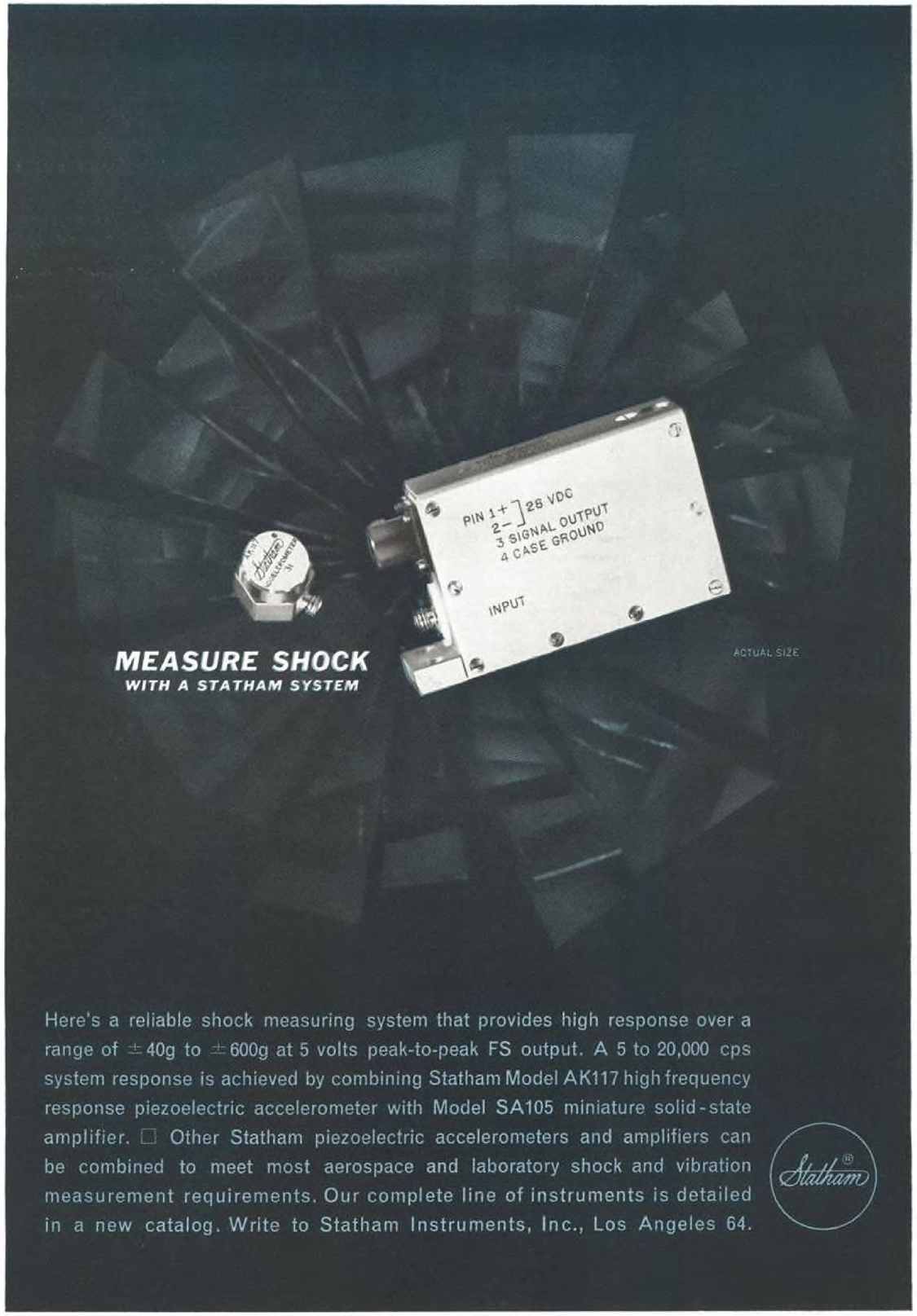
• **High-lift, low-drag wing.** The problem was to build a wing affording minimum drag at cruising speeds with above-average, low-speed handling characteristics for small field operations. With little precedent for these ideal requirements, Boeing devoted considerable effort to checking various wing designs and flap systems in wind tunnels. Promising configurations were flight tested on the Dash-80. In addition to drag reduction, approach speed has been reduced from 118 to 111 kt., indicating better than expected performance at low speeds.

• **T-tail.** Two basic design problems affect T-tails—flutter and airflow interference from the vertical fin. They were overcome primarily by extensive wind tunnel work, second only to wing research in total number of hours. The flutter problem was met by extremely rigid construction in which the vertical fin is an integral part of the aft fuselage. By sweeping the tail 60 deg., interference from the vertical fin was reduced. This effectively moved the stabilizer farther aft than in conventional design and provided, in effect, a longer moment arm for pitch control. Maximum range in center of gravity shift is from 14 to 42% of the mean aerodynamic chord. Fatigue and static tests to destruction of two full-size models of the 727 are expected to further verify the T-tail design.

• **Flight control system.** The problem faced was to integrate the autopilot into the control loop and develop, in a limited time, an efficient system. This traditionally has required more time than has been available to eliminate the bugs. Boeing built a full-scale mockup of the control system complete with cables and control surfaces. These were installed on a platform, shaped like the 727, called the "iron bird." Compressed air bungee devices were used to simulate aerodynamic pressures expected under various flight conditions. The mockup was tested extensively, providing information from a pilot's standpoint on control response as well as pinpointing design problems. As a result, only minor modifications to the control system were required in the flight test program.

Boeing has stepped up its 727 sales campaign, which included a recent tour of the U.S. and Canada with flight demonstrations at major cities. A worldwide trip just ended (AW Oct. 7, p. 125) indicates the company's awareness of its relatively small number of foreign orders for the plane.

The 727 currently is considered a 152,000-lb. transport rather than the 142,000-lb. standard version, since all carriers ordering the 727 have asked for the higher gross weight. The option provides an extra 500 gal. of fuel and maximum ranges of 2,050 stat. mi. for




coach configuration to 2,650 stat. mi. for first class, both fully loaded.

The 727 primarily will be used on lower density routes and off-peak time of day flights. American, for instance, plans to fly 727s into almost all of its prime cities. Average segment range for the 727 will be 350-400 mi., which compares with 1,200-1,500 mi. for the 707-120B.

As largely a replacement aircraft, the 727 initially will take over routes now flown by the DC-7s, Electras and Constellations.

Since the semi-circular upper portion of the 727 fuselage is identical to that of the 707, four or six abreast seating can be provided. The 727's fuselage is shorter than the 707, but Boeing has been able to lower production costs significantly by using the same forward upper sections. Primary reason for utilizing a common fuselage section, however, was in anticipation of greater passenger-carrying capability.

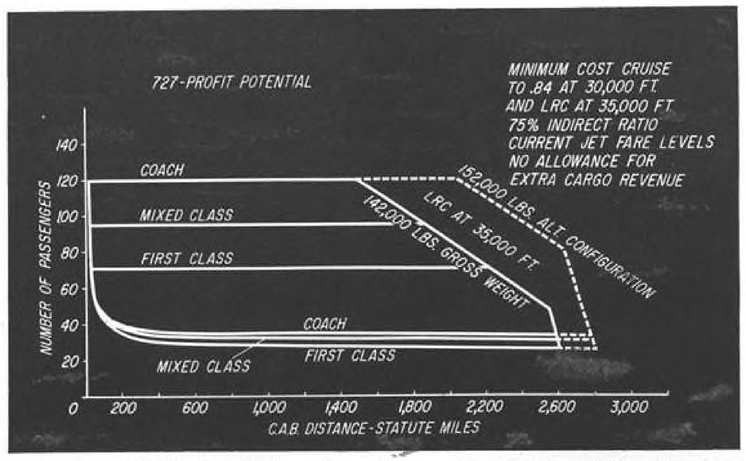
Tentative seating configurations indicated by the airlines are 94-96 mixed-class seats. Boeing has offered high-density arrangements of up to 128 seats, and 131 are theoretically possible. A typical dual-class arrangement planned by both American and TWA is 28 four-abreast first class seats and 66 six-abreast tourist seats. A typical single class seating arrangement planned by United is 92, five-abreast. A central galley serves all seating configurations. One option which has been accepted so far only by Eastern is a retractable forward stair which deploys automatically from its stowed position beneath the floor (AW Sept. 30, p. 42).

The 727 is being sold on a fixed-price basis with the exception of the engines, which have an escalator clause in the contract. Average cost, including buyer-furnished equipment, will be approximately $4.4 million.

Boeing is increasing its production output of all commercial transports at the Renton plant from one aircraft every four working days in September to a two-day cycle in early 1964.

The Boeing plant had turned out 364 commercial jets by the end of August, including 13 of the 727s. Boeing will have built 19 of the 727s by the end of October, including 10 for United, six for Eastern, two for American and one company plane for testing. All of these aircraft will have flown by the first part of December.

The high production rate planned by Boeing is intended to meet the demand for the late 1964, early 1965 time period. Current lag between order and delivery is about 15 months. During the tightly-scheduled manufacturing phase to date, every 727 has come off the production line by or within several days of schedule. First flights generally have been made ahead of schedule.




**PROFIT POTENTIAL** plotted for various seating configurations tentatively planned by Boeing for the 727. High-density arrangements will provide up to 128 seats, and 131 are theoretically possible.

The autopilot of the 727, the Sperry SP-50 (AW Nov. 19, 1962, p. 93), has been tested on a majority of the experimental flights, including the first one. Pilot confidence in the system has built up to the point where the autopilot reportedly has been used to shoot touch and go landings.

Sperry now is forecasting 800 hr. as the mean time between failure for the system, which is more than twice as great as other Sperry autopilots in operation and 200 hr. better than its earlier forecast.

The SP-50 has necessarily played an important role in making the 727 an all-weather aircraft capable of eventually going to the lowest FAA minimums with minor system modification. Boeing's design philosophy was to build an aircraft capable of being flown to the lowest anticipated visibility minimums of 100 ft. and ¼ mi., and eventually at zero-zero. Current FAA minimums are 200 ft. and ½ mi.

In anticipation of lower minimums, and to facilitate operations from fields served by limited navigational aids, Boeing planned the autopilot as an integral system in an all-weather plane. The flight test program to date has satisfied Boeing of the reliability of the system as well as its performance.

Future capability which can be built into the SP-50 includes an automatic flare system which Boeing will evaluate following FAA flight certification of the current version, and provisions for added redundancy along all axes if required. The SP-50 already incorporates a glide slope extension mode which could be required for operation at lower minimums.

Maintenance of the autopilot has been eased through modularization of components and a go, no-go testing system. High reliability required reflects Boeing's general desire to build an airplane with good maintainability of all systems.

Indications that over-all 727 reliability may equal or better that of the 720B, which has a 95% schedule reliability for 82,187 hr., became apparent in the maintenance record established in the flight test program. Boeing is predicting that the 727 schedule reliability may approach 98%. In a recent 8,535 mi. demonstration tour of the U. S., the 727 made 38 departures on time with no mechanical delays, according to Boeing.

In looking for new markets, Boeing has proposed numerous versions of the plane to the military but has received little encouragement. Proposals have been largely directed at the Military Air Transport Service (MATS) for aeromedical flights and special missions such as transportation of high-ranking officers and civilians.

Although the six official configurations of the 727 range from a version with non-stop transcontinental capabilities to plush staff configurations with three cabin dividers, the plane's $4½-million price tag probably will limit military sales.

Boeing also believes that the 727 has potential as an all-cargo aircraft. As a second-generation cargo plane, it would work into service after airlines had operated the first generation of larger jet cargo planes. Airline reaction to an all-cargo version so far has been mixed, with those interested considering it primarily on a long-range basis.

A combination cargo-passenger version, achieved by removing the front seats, is a much more likely prospect. This capability could be achieved with a minimum of modification. The company feels that such a version might have application to low-density routes where the dual configuration would help defray operating costs.



Configuration concept of Sioux Scout (above) could be basis for future tactical helicopter. Operational model would be turbine-powered.



Front-seat gunner swivels sight in cockpit and twin .30-cal. machine gun turret to port (above). Stub-wing planform and rotor mast structure are visible in top view (below). Crew compartment area utilizes reinforced plastic skin.








Pilot sits behind and above gunner in Bell Helicopter Co.'s Sioux Scout, with maximum forward visibility (above, left). Fire control system is similar to that of the UH-1B but is mounted in the floor (above, right). Note gunner with sight head.

# Bell Sioux Scout Tests Attack Helicopter Concepts

Tactical capabilities of Bell's 207 Sioux Scout attack-fighter helicopter "flying mock-up" (AW Sept. 23, p. 30) are getting an intensive work-out on ranges of U. S. Army Field Artillery School, Ft. Sill, Okla. Firepower and handling characteristics of this new configuration are being evaluated under field conditions.

Tests by contractor personnel are aimed at exploiting maximum capabilities of the Scout as part of a research and development program on armed helicopters and to provide a comparison with the tactical performance and capabilities of the conventional OH-13S.

The Scout has accumulated 50 hr. of flight time at Bell Helicopter Co.'s Hurst, Tex., plant. Design cleanup attainable with a tandem-crew layout and other streamlining has made possible a cruise speed of approximately 100-105 mph., comparable to the conventional OH-13S top speed. Weapons in an Emerson Electric Mfg. Co. turret, under the nose, have been fired from every attainable gun angle without adverse handling effects, according to Bell. More than two dozen Bell and U. S. Army personnel have flown the aircraft using side-arm type dual controls fitted in the front gunner's position. They found transition to this system easy, the manufacturer reported.

Ft. Sill trials will also check on the value of tandem seating arrangement of pilot and gunner in maneuvering, tracking and maintaining firepower upon targets.



Stub wings on the Sioux Scout were designed to increase climb rate and maneuverability and for additional armament. Aerodynamic refinements (above) are designed to cut drag.

RAYTHEON AT WORK

# New Raytheon radar-TV helps FAA keep a finger on your flight path

Point by point, minute by minute around the clock, the Federal Aviation Agency's air traffic control system keeps its radar finger on U.S. commercial flights.

Now, with new "bright display" equipment developed by Raytheon, the FAA can follow your flight with even greater efficiency. New TV-like "bright display" will give radar operators a valuable new tool for monitoring your flight.

Conventional radar pictures show each aircraft as a single recurring blip on the screen. In the new system a Raytheon storage tube collects these individual blips and presents them in a series as a clearly visible trail of each plane's exact progress and position.

Such advanced display systems are another example of Raytheon electronics skills at work on behalf of business, industry, science and defense. Raytheon Company, Lexington, Massachusetts.

RAYTHEON





# Camera May Aid Planetary Terrain Study

By Michael L. Yaffee

New, nine-lens Multiband camera developed to detect underground nuclear explosions shows promise for terrain analysis of moon and planets.

Developed by Itek Corp. under contract to the Advanced Research Projects Agency as part of the Vela Uniform program, the camera is designed for aerial photography of land surfaces above sites of suspected underground nuclear detonations.

However, Itek is now using the same multiband photographic technique to take pictures of the moon through ground telescopes and believes that such cameras, with modifications, will prove suitable for use aboard spacecraft such as the planned lunar orbiter.

The new camera is designed to take photographs that enhance the spectral (brightness) differences of land surfaces and ground coverings caused by chemical, physical and biological changes. The principle behind this development, briefly, is that different objects such as clay, sand, moss, corn, asphalt, etc., reflect light in different parts of the spectrum and the light reflected by a given object will shift its dominant wavelength if some change takes place in the object.

The Multiband camera is designed to pick up these changes or shifts in wavelengths, which would probably not be detected by the unaided eye or an ordinary camera.

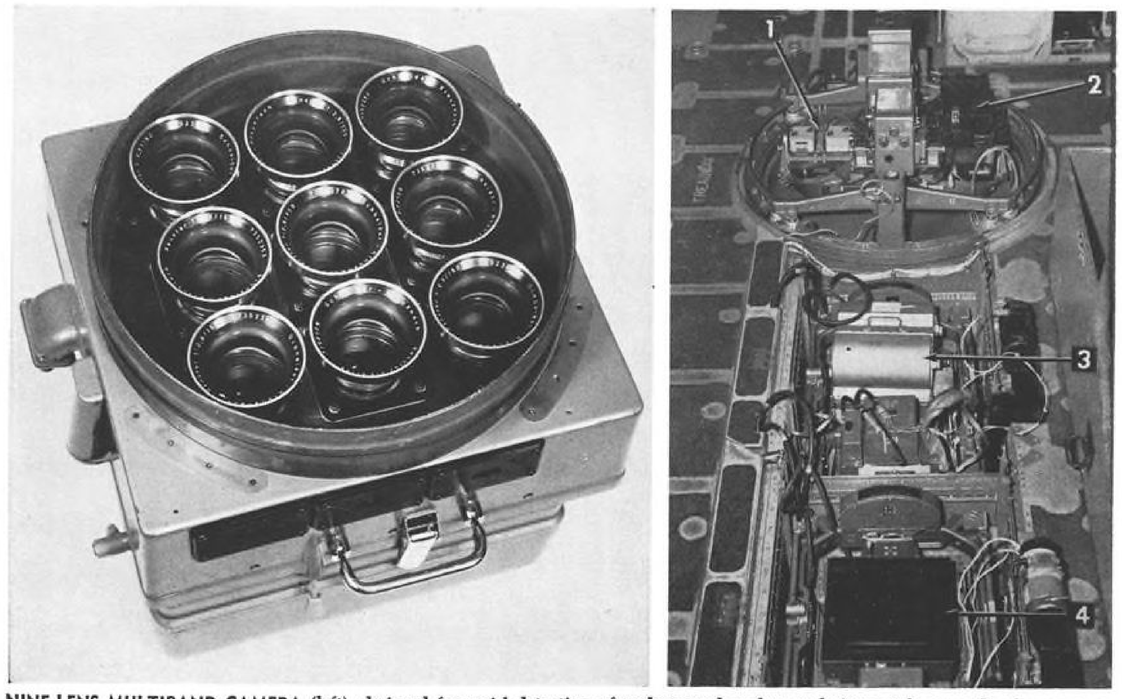
In the case of an underground nuclear weapons test, for example, the ground above the test site will undoubtedly change in one or more ways. Shock waves from the blast may compact the surface soil or somewhat later, perhaps, radioactivity may reach up to the roots of surface plants and cause chemical changes in the plant. These changes would lead to changes in the light reflected from the surface which, in turn, would be recorded by the Itek camera.

The pictures taken by the camera would then be processed through a computer and compared to pictures of the same area taken previously. Once a complete catalog of spectral photographs is established, the new Multiband camera and associated data collection and reduction system will make it possible to determine not only whether a nuclear explosion has taken place but when it took place.

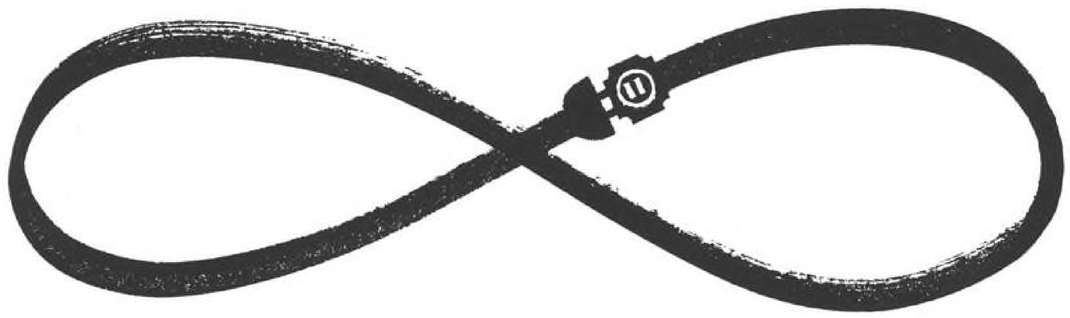
When no reference pictures are available (ARPA's Vela Uniform project makes provisions for "areas of limited access"), all that a series of multiband photographs may show is the fact that a change has occurred. This would then serve as the basis for a request for permission to enter the country where the change has occurred in order to make a detailed examination.

Aboard a satellite, the camera would work essentially the same way. In photographing the surface of the moon, for example, the camera would pick up and enhance spectral differences in different areas or in the same area at different times. There would not, of course, be reference photographs available to tell what these differences indicate.

Therefore, the next step will be to



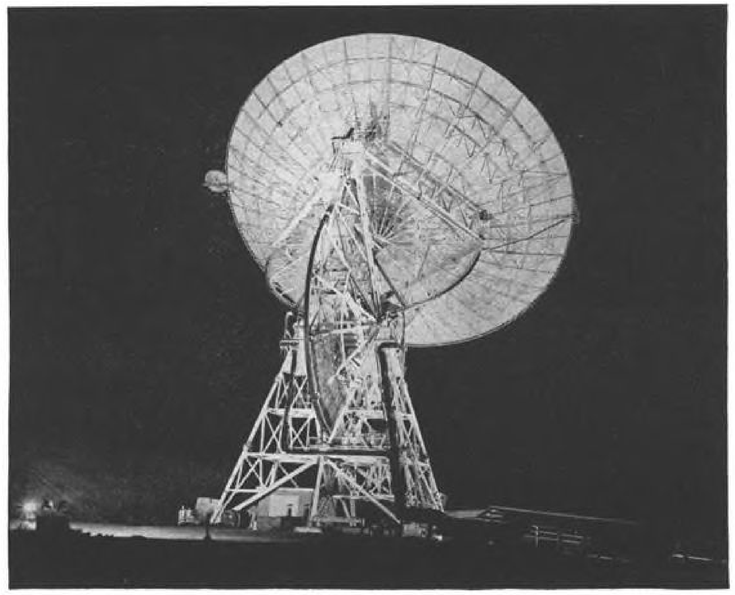

**NINE-LENS MULTIBAND CAMERA** (left), designed for aerial detection of underground nuclear explosions, picks up and enhances spectral differences in light reflected from ground surfaces. Detection system, installed aboard a surveillance aircraft (right), consists of (1) color and camouflage cameras, (2) spectrometers, (3) cartographic camera and (4) Multiband camera. Basic multiband photographic technique is also expected to prove useful in planetary terrain analysis from ground and satellite platforms.



# ELECTRIC POWER FOR SPACE

TRW Space Technology Laboratories is building electric power systems using electrochemical, photovoltaic and nuclear techniques. They are being used on America's major space programs, including OGO, Air Force 823 Program and Mariner. Engineers and scientists interested in energy conversion technology, transistor circuit design, electrochemistry and power system engineering should contact STL Professional Placement, One Space Park, Redondo Beach, Calif. Dept. A-11. TRW is an equal opportunity employer.

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## Rosman Satellite Data Site Operational

**Antenna at NASA's Rosman, N. C., satellite tracking and data acquisition facility weighs 300 tons and is 85 ft. wide by 120 ft. high. The facility, second of three built by the space agency to track and receive data from advanced satellites, became operational late last month. The facility is linked with Goddard Space Flight Center, Greenbelt, Md.**

carry out a detailed analysis of the color differences in the moon's spectral fingerprints in the hope of explaining their significance by, perhaps, finding a comparable multiband photograph taken on earth, according to Itek.

For example, the moon pictures may bear a striking spectral resemblance to pictures taken of a south seas volcano, thereby providing a pretty good indication that the particular moon landscape consists of volcanic ash. This could prove useful in evaluation and selection of suitable lunar landing sites.

The lunar multiband photographs taken by Itek through ground telescopes have been processed and show brightness differences between reflections in three discrete areas of the spectrum. These variations, the company says, could indicate different minerals or changes in surface consistency, as between solid rock and dust. They might also be the result of differences in elevation or due to the fact that sunlight strikes various areas of the moon at different angles.

Another potentially valuable application of the Itek Multiband camera is in earth terrain analysis. USAF's Cambridge Research Laboratories' Terrestrial Sciences Laboratory, which took part in the camera development program, believes the unit may prove useful in its investigation of properties of the earth's crust in inaccessible areas. The Air Force, of course, is interested in determining whether such surfaces are capable of supporting aircraft landings and takeoffs.

Basically, this is how the nine-lens Multiband camera developed by Itek works: When the shutter is released, the camera records on the same film nine pictures of the same scene which have been simultaneously photographed through nine different lenses and filters. The nine negatives record the scene at nine different wavelengths, because of the different filters.

The nine negatives are processed to make nine film positives. Then, the positive made from one of the negatives (say, negative number four taken with a blue filter) is superimposed on another negative (say, number eight taken with a red filter) and photographed through the same red filter used to make negative number eight.

This last photograph will show the difference in the spectral brightness that exists between the original negatives taken with the red and blue filters. The process is then repeated with the other negatives, superimposing as many positives and negatives as desired, or considered necessary.

At the present stage, a whole series of comparison photographs must be taken through different filters in various combinations in order to establish an adequate catalog of reference pictures and because the scientists don't yet know at what wavelengths the changes in an object's chemical, physical and biological characteristics will show up.




# STL
## NEW PROPULSION OPPORTUNITIES
### In Southern California

TRW Space Technology Laboratories is now developing the descent engine for the Apollo Lunar Excursion Module (LEM), and alternate vernier engines for the Surveyor spacecraft program. These programs, together with other research and development programs now under way at STL, combine to create many immediate openings in advanced propulsion technology.

Initial assignments will be at STL's new Space Technology Center in Redondo Beach, near Los Angeles International Airport, with opportunity for transfer to STL's multimillion dollar propulsion facility now under construction in the San Clemente/San Juan Capistrano, California area.

Requirements include a degree in engineering or science with appropriate experience.

**LIQUID ENGINE DESIGN, DEVELOPMENT AND TESTING**

Experience in the design, development or testing of liquid propellant propulsion systems, rocket engines, feed system components, thrust chambers, injectors and thrust vector controls.

**ROCKET ENGINE TEST STAND INSTRUMENTATION AND CONTROLS**

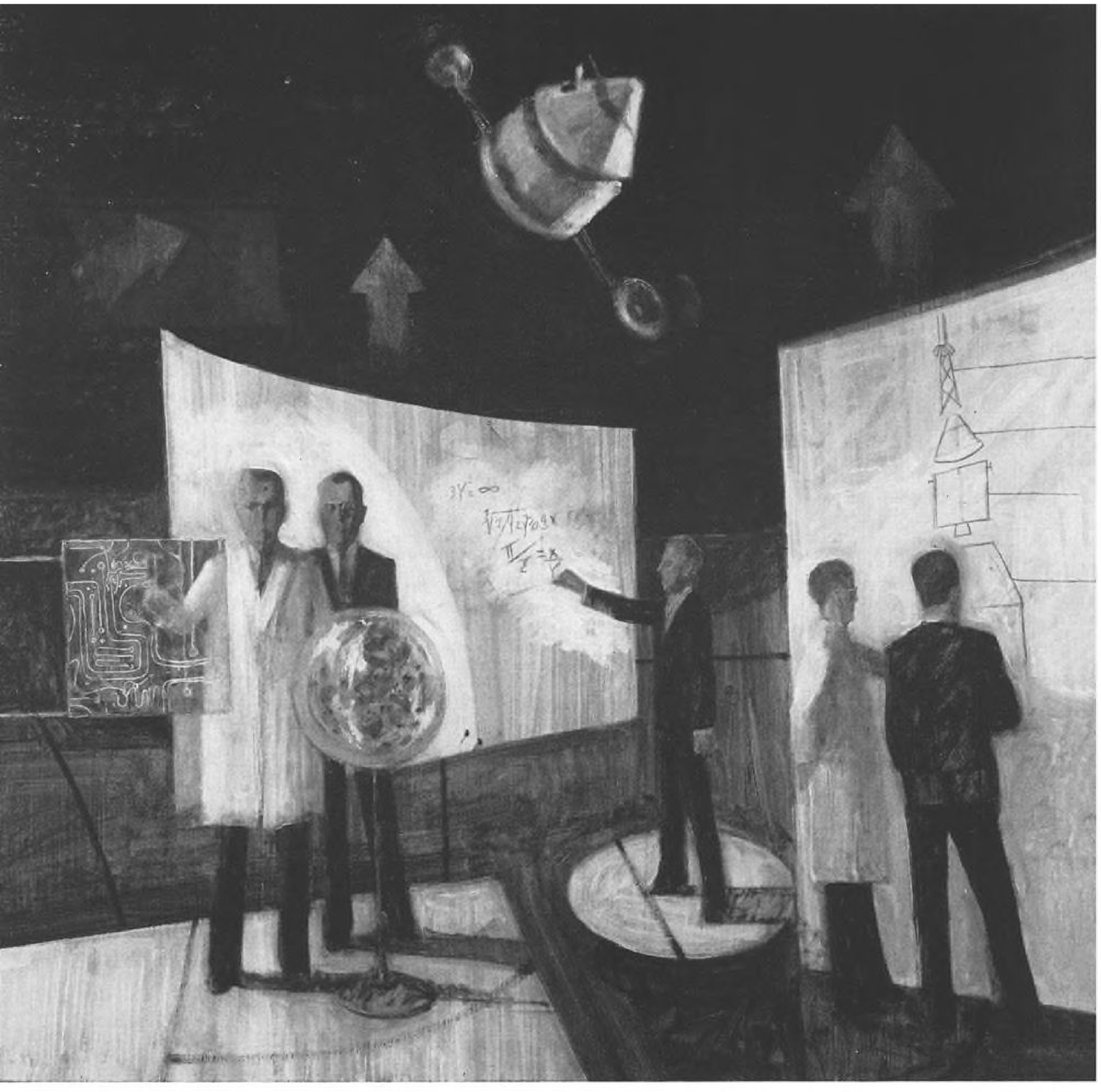
Experience in the design, installation, operation or maintenance of liquid rocket engine test stand data acquisition (analog and digital) and control systems.

**RESEARCH AND ANALYSIS**

Experience in heat transfer, hydraulics, gas dynamics, combustion, ablative materials, and data processing and analysis.

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**THE FLEXIBLE MEN AND THE APOLLO** In today's fast-moving aerospace industry, the constant interrelating of many scientific disciplines has led to a new age of versatility.

The single-minded specialist of yesterday has broadened his horizons to meet new challenges. He has become, in effect, a modern Renaissance man. A man well-versed in all fields of knowledge relating to his world of aerospace.

Thus today's chemist is also an electronics expert. Today's mathematician is at home in space flight technology. Today's design engineer can talk propulsion with rocket men, life sciences with biophysicists.

From the resulting intellectual ferment—the intermingling of ideas—are coming achievements such as the world has never seen. Among them: the three-man Apollo module—an aerospace project being built by NAA's Space & Information Systems Division to carry America's astronauts to the moon and return them to earth. Such advances are possible only because the men seeking them are not die-cast, their talents not hardened in a single mold.

For these are the flexible men.

**North American Aviation is at work in the fields of the future through these divisions: Science Center, Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Space & Information Systems.**


## NAA Studying Apollo As Orbital Laboratory

Earth orbiting laboratory version of the Apollo spacecraft aimed at determining man's requirements for protracted space missions has been studied by North American Aviation's Space and Information Systems Div. under a $100,000 fixed-price research and development contract from National Aeronautics and Space Administration's Manned Spacecraft Center at Houston, Tex.

MSC asked North American to consider both a single spacecraft on a 100-day mission and three or four spacecraft used consecutively on a one-year mission. The contractor was considering the possibility of rendezvous and docking methods using two modified Apollo spacecraft.

Use of both the service module and command module as crew quarters has been investigated with the concepts. This considered means of continuously evaluating the astronauts' physiological condition and their capabilities for performing space tasks under zero-g and under an artificial gravity force, if the latter can be provided.

The area that would normally be occupied by a Lunar Excursion Module would be utilized as a laboratory module to provide additional work space for the space sciences mission.

Boost vehicle considered was a Saturn 1B. North American was to complete its study by Nov. 1 and make a final report to MSC within 30 days of that date.

## Astronauts May Need Deeper Lunar Foxholes

**Greenbelt, Md.**—Estimates of the safe depth to which astronauts on the lunar surface would have to dig for protection from a lethal neutron dose resulting from major sunspot activity have been revised to 5 ft. from the original 1 ft. because of updated information derived from satellite instrumentation.

The probable neutron dose which the astronauts might expect to receive results from protons originating in sun spots striking the moon or the surface of a lunar exploration vehicle.

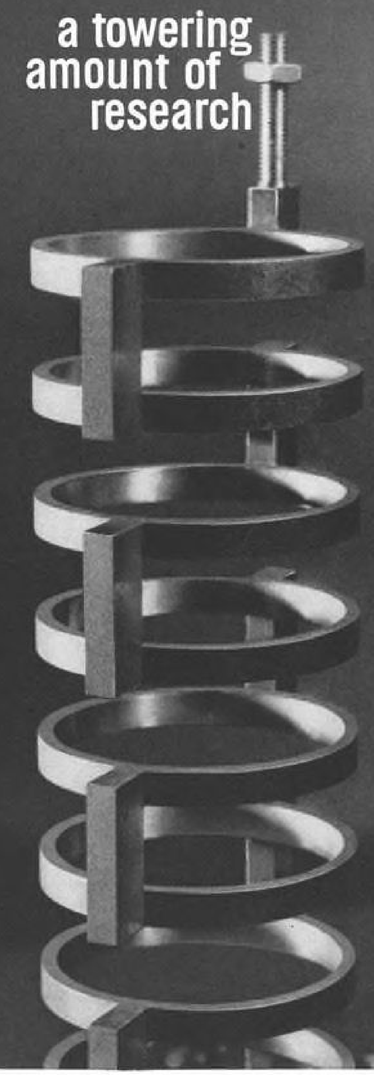
The dose rate is being calculated by National Aeronautics and Space Administration's Goddard Space Flight Center, with determination of the safe depth a major purpose of the calculations.

The interplanetary monitoring platform (IMP) scheduled to be launched this month will provide near lunar surface data on proton fluxes emanating from the sun and the earth/moon mag-




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netic field, which will enable physicists at Goddard to estimate more accurately the possible neutron hazard to astronauts.

At the present time, no way has been found to predict when the next maximum sunspot activity will occur and astrophysicists are skeptical that a way will be found soon. Even the much-discussed 11-year solar cycle is an idealization, since solar cycles as short as 9 years and as long as 14 years have been observed.

One unexplained phenomenon observed at periods of maximum sunspot activity has been that major solar flares, containing the largest flux of particles in the bev. energy range, have occurred only during the increasing and decreasing of sunspot activity rather than during the maximum activity period.

The largest solar flare ever recorded, in July, 1959, led many scientists to wonder whether the next maximum sunspot activity might not be even greater.

## PRODUCTION BRIEFING

**Kearfott Div.** of General Precision Aerospace, Little Falls, N. J., will continue to build hydraulic actuation systems for Army's Pershing missile under a $3.5 million letter contract. The systems position the Pershing's aerodynamic and jet vane control surfaces.

**North American Aviation's** Columbus Div., Ohio, has broken ground for a $1 million transonic-supersonic wind tunnel in support of its tactical missile activities. The tunnel will create wind velocities of 530 to 3,400 mph.

**Sylvania Electric Products, Inc.,** New York, has received a $2 million Air Force contract for the fabrication of a Minuteman ground electronics system. Work on the contract will be performed in Waltham, Mass.

**E. W. Bliss Co.'s Heavy Equipment Div.,** Canton, Ohio, has been awarded a $2,202,900 follow-on contract from General Motors Co.'s Allison Div. for production of forward domes, adapters and closures for Air Force's Minuteman missile.

**Atlantic Research Corp.,** Alexandria, Va., will build 140 ARCAS meteorological sounding rockets for the German government, which will use them for atmospheric research projects during the approaching International Quiet Sun Year. The $246,746 contract was received through the U.S. Bureau of Naval Weapons.

**Production schedule** for Swiss Air Force's Dassault Mirage 3S fighter-




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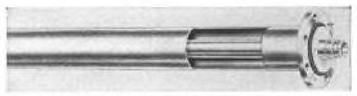
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interceptor has slipped one year, to first rollout in December, 1965, due to a change from French to U.S.-designed avionics package, Hughes TARAN system (AW Jan. 8, 1962, p. 33). French avionics package reportedly was too old and inadequate for coping with the rugged terrain of the Swiss Alps. The French also are reportedly too occupied with building their nuclear force to have time to give adequate technical advice to the Swiss.

**Aeronutronic Div.** of Philco Corp. will continue development work on the Shillelagh surface-to-surface combat vehicle missile system under a new $19-million Army contract. The contract is in addition to a $7-million letter contract awarded Aeronutronic Aug. 30 for Shillelagh work. Total Shillelagh funding to date stands at $88 million.

**P. R. Mallory & Co.,** Indianapolis, will study couples and electrolytes for high-capacity, non-aqueous secondary batteries under a National Aeronautics and Space Administration contract from Lewis Research Center, Cleveland, Ohio.

**Franchi Construction Co.** has received a $983,967 contract from the Canaveral District, Army Corps of Engineers, for modifications to the gantry, launch stand building, ready room, control building and liquid oxygen storage area of USAF's Atlas Pad 14 at Cape Canaveral, Fla. The pad, used for the now-completed Mercury program, will be used to launch Atlas-Agena target vehicles in the manned rendezvous Gemini program.

**Republic Aviation Corp.,** Farmingdale, N. Y., will design the fuselage midsection structure of the Grumman C-2A advanced carrier-based cargo aircraft. The $649,713 contract calls for structural redesign of the E-2A Hawkeye midsection, replacing the early warning electronics system with cargo- and personnel-carrying capability.

**General Tire & Rubber Co.** has Air Force contracts totaling $1.9 million to furnish tires for B-47, B-52 and B-58 bombers.

**International Business Machines Corp.,** Federal Systems Div., Rockville, Md., will negotiate with NASA for electronic equipment and support for the Saturn 1B and Saturn 5 launch vehicle programs. Negotiations will cover the integration and checkout of the launch vehicle's instrument units which house guidance, control, electrical, measuring, telemetry, radio frequency, and structural and environmental systems. In addition, the negotiations will cover the design and manufacture of data adapters for these units as well as development and production of digital guidance computers for them.

**United ElectroDynamics, Inc.,** Pasadena, Calif., will continue the company's deep-well seismic research program to develop and refine techniques for detection of underground nuclear explosions under a $448,000 Air Force follow-on contract.

**Aerojet-General Corp.,** Azusa, Calif., has been awarded an initial $528,500 on an Air Force contract to develop and operate an advanced research unit to study respiratory toxic hazards at USAF's 6570th Aerospace Medical Research Laboratories, Wright-Patterson AFB, Ohio. The contract, to run three years, will total about $3 million. Data from the study is planned to enable scientists to evaluate toxic hazards in closed atmospheres and to establish tolerance limits for long space flights.

**Boeing Co.** will supply improved wings for B-52G and H aircraft under a $5.1-million Air Force contract.

**Radio Corp. of America,** Moorestown, N. J., has been awarded a definitive $3.4-million, cost-plus-incentive-fee Air Force contract for electronic development work on the Ballistic Missile Early Warning System (BMEWS).

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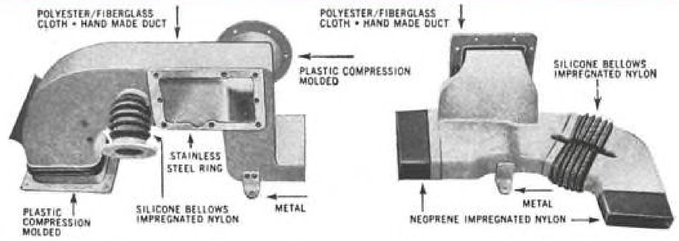
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3. Our 7-kw hydrazine-oxygen fuel cell powers an experimental, 2000 lb fork lift truck. Our 3-kw hydrazine-oxygen fuel cell powers an experimental golf cart. *Significance: Multiple kw fuel cell systems have been applied to vehicles like the experimental golf cart that have been demonstrated to thousands of people from coast to coast.*

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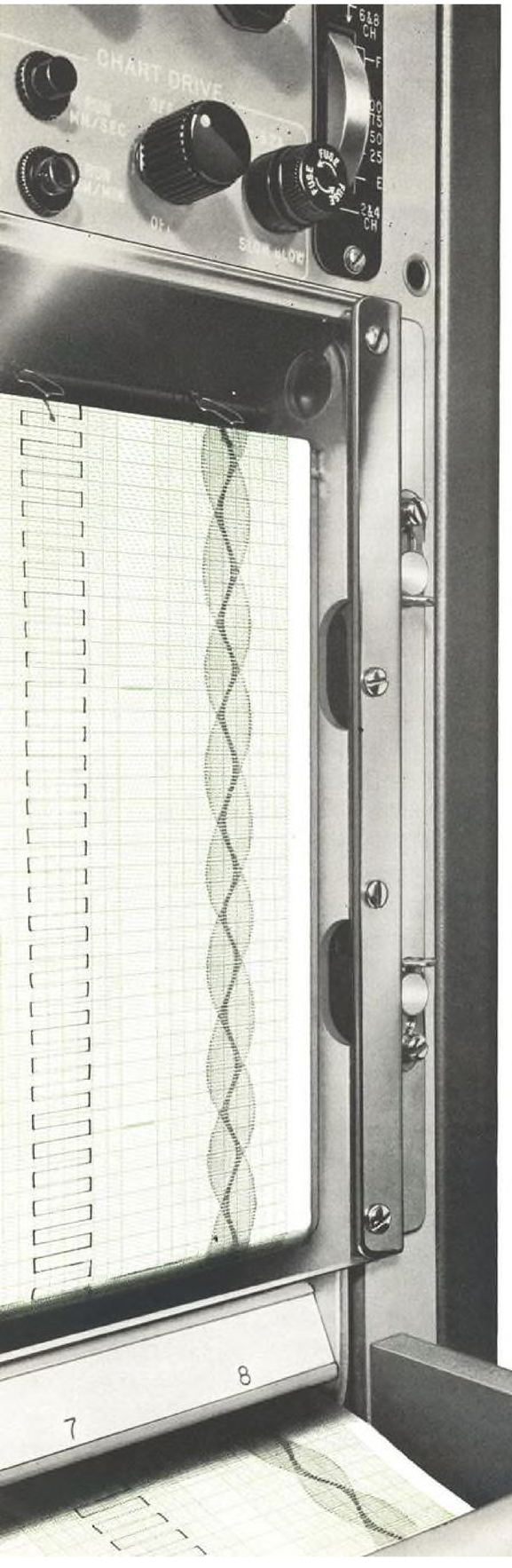
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# Most Rewarding Lunar Surveys Sought by MSC for Expeditions

By Irving Stone

Los Angeles—Study to determine most rewarding measurements, experiments and geologic investigations to be made on the lunar surface by Apollo astronauts is being performed for NASA's Manned Spacecraft Center under a 120 man-month effort by Texas Instruments, Inc. Funding for the task is $194,600.

Guidelines for the study include assumptions that there will be two Apollo missions in which there will be four manhours of working time on the lunar surface, followed by two more Apollo missions with one day of working time on the surface, minus whatever time is required for sleeping.

Assumption is that only one astronaut will be outside of the Lunar Excursion Module (LEM) and on the lunar surface at any given time, while the other astronaut will remain in the LEM.

Ultimately, missions probably will be extended to periods of one week during which both astronauts may be out on the lunar surface simultaneously.

### Missions Will Change

Because the plan for one-day and one-week missions probably will be heavily modified by the results obtained from the four-hour mission, emphasis will be placed on measurements and studies to be performed during this four-hour period on the surface.

Scientific payloads landed on the lunar surface will weigh at least 215 earth-pounds. The payload returned to earth will weigh approximately 80 earth-pounds.

A considerable portion of the equipment in the payloads to be landed on the moon is expected to be carried outside the spacecraft. They will be exposed to a high vacuum for as long as a week, and will have to withstand the temperature extremes to be encountered in space and on the lunar surface. They also will have to absorb launch and landing accelerations and shocks. Only equipment requiring special handling procedures, and that used to return payloads to earth, may be expected to be housed inside the LEM.

The study will include two general categories of measurements to be made on the lunar surface—those which will add directly to the probability of success of future missions to the moon, and those which will contribute significantly to fundamental knowledge of the moon.

Measurements which add directly to the probability of success of future lunar missions will include those intended to verify the engineering properties of the lunar surface and its hazards. Measurements will be made of the surface texture on a scale from several centimeters to several meters. They also will study the slope, bearing strength, shear strength, barriers to traffic, electrical and thermal properties, temperatures and associated factors.

Measurements for basic knowledge mostly will include those of a geological, geophysical and geochemical nature.

Geological measurements generally will be used to determine the chronological age and position of different formations on the moon. They will study rock types, variations of mineral content and sequence of mineral formations, absolute age and how various surface features were formed.

Other geologic problems include choosing the best methods to obtain and preserve samples, determining properties of sub-surface materials and recording the orientation of the samples. Advantages of analyzing samples on the lunar surface also will be considered, as well as a way to locate an astronaut doing field work.

Geophysical measurements may include those of seismic activity, magnetic field, temperature and its variations horizontally and in depth, and gravity and its variation with time and in position.

### Seek Water Sources

Geochemical measurements will be of elemental and mineralogical composition of surface and sub-surface material. Measurements relating to the search for compounds having possible significance to the problems of chemical evolution also will be studied. Methods to be used in the search for minerals suitable for the extraction of water and other resources also will be investigated.

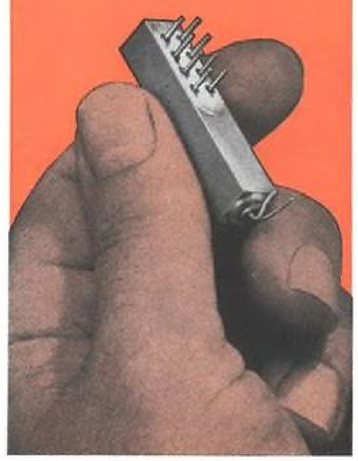
Specific measurements to be made on the lunar surface will include two general types:

- **Placement and activation,** by an astronaut, of instruments which will operate automatically for as long as six months, with provisions for telemetering data to earth.
- **Second type** will require the attendance of an astronaut during operation of the instruments.

Measurements which will require long periods of operation may use a single package containing power, telemetry and transmission equipment for the instruments. Continuous or command telemetry may be used.


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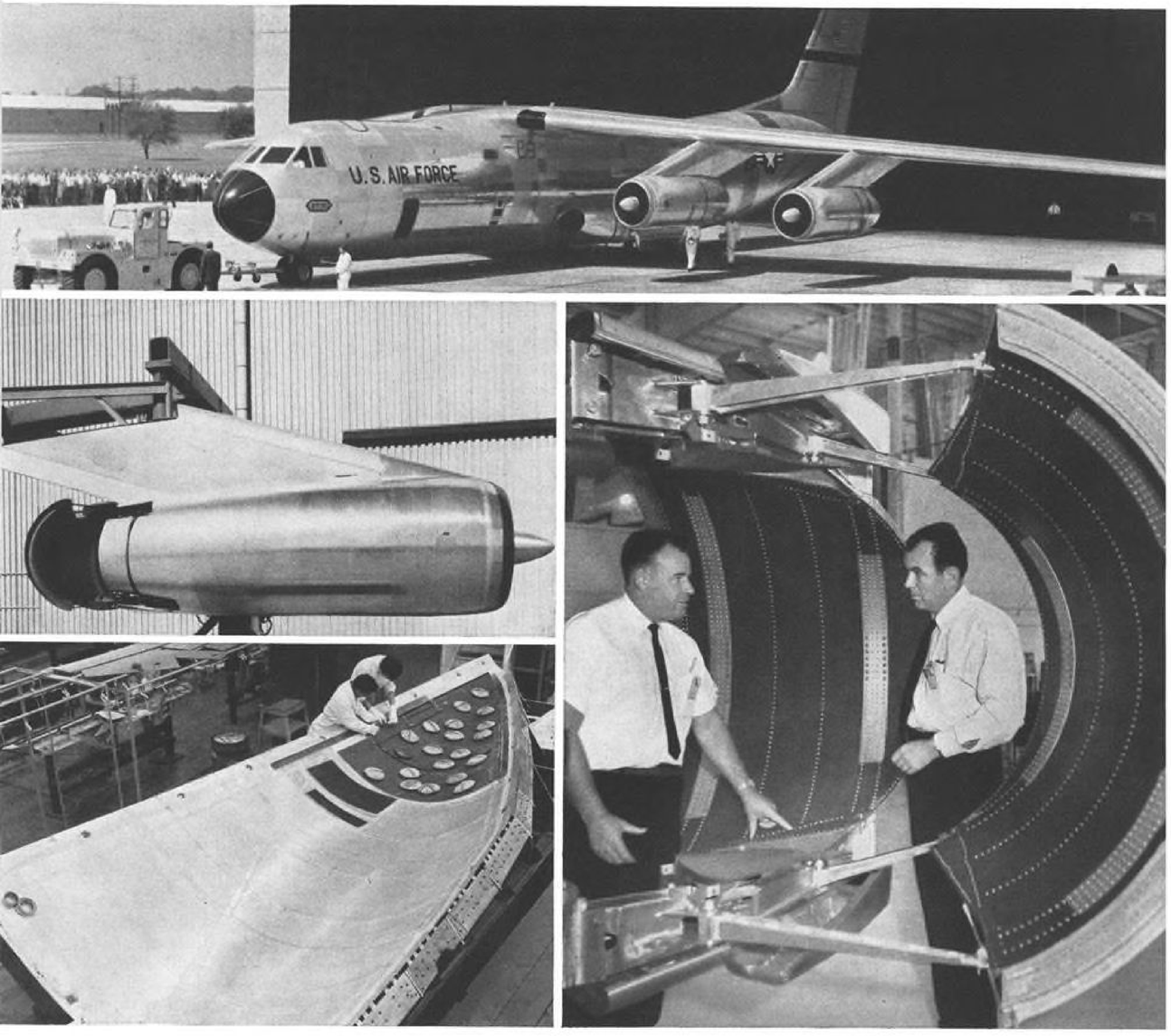


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# Hope of Increased DOD Space Funds Slim

**Baltimore**—Key Pentagon space official recently offered little hope for increased Defense Dept. funding of military space programs, but indicated that increased military capabilities could be obtained by more efficient use of the funds which the U. S. now is spending for space research and development.

Avionics manufacturers also were told that major procurements of guidance and control systems for strategic weapons are largely over, at least for the near future.

Dr. Albert C. Hall, deputy director of defense research and engineering for space, speaking here at the East Coast Conference on Aeronautical and Navigational Electronics said, "Space has yet to fulfill the expectations of those enthusiasts who have dubbed it the 'high ground' of future military power. Already it is clear that certain space systems cannot compete when they are weighed impartially against other feasible alternatives."

Hall pointed out that the $7 billion that Defense Dept. and the National Aeronautics and Space Administration now spend annually for space research and development is nearly half the total federal research and development expenditure, and 40% more than the entire defense research and development budget only five years ago. "We must look harder at both civilian and military space efforts . . . and seek greater efficiency there" before seeking more funds for additional programs, he said.

Hall suggested that more effective use might be made of the $1.7 billion now authorized for military space programs. "Ideas and plans that do not work out must be shelved to concentrate on things that do," he cautioned. While acknowledging that good progress had been made in navigation, meteorological and communication satellites, he said, "in several other areas, however, we have tested our theories with rather large-scale development efforts only to find the state of the art was not equal to the task, that the space system could not compete with contemporary systems on a cost-effectiveness basis, or that military necessity was no longer a predominant factor."

He also indicated that the Pentagon apparently is reluctant to increase the pace of the Midas early warning satellite program, cut back a year ago because of serious technical problems (AW Sept. 24, 1962, p. 54.), as recently requested by the Air Force. Hall said, "Space based detection of missile launches has turned out to be not so feasible as supposed . . ."

Referring to the now-defunct Project Saint satellite inspector program, Hall said that "despite considerable efforts, rendezvous with, and inspection of, unidentified satellites still appears technically difficult." In addition, the question of whether satellite inspection is sufficiently useful to justify the expense and trouble was raised by the Pentagon official.

He questioned whether it is possible to determine the mission of an unknown satellite "merely by examining it and/or intercepting its electromagnetic emissions." He asked, "Is it possible that we might be launching inspectors to look at decoys, spent booster stages or ordinary space junk?" It is necessary to consider how expensive it would be to develop, deploy and oper-




## First Production Wren Delivered for Sales Demonstration

First production version of the Wren 460 STOL conversion of the Cessna 182 (AW Apr. 15, p. 116) has been delivered by Wren Aircraft Corp. to Southwest Airmotive, national sales agent. Aircraft is converted 1963 Cessna Skylane. Full-width trim has been added to elevators, in addition to nose-mounted, low-speed controls, full-span flaps and vortex generators atop the wing.



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ate a system of satellite inspectors and to ask whether a comparable job can be done without going into space, he added.

Every proposal for a new military space system must undergo "searching questions about what specific military capabilities it will provide, how will space systems compare to other possible systems, and why go into space with a new experimental program if ground or aircraft experiments can provide the data needed, or if experiments can be piggy-backed with on-going orbital programs?" Hall asked. "In space, as elsewhere, research and development programs which affect our military posture must be reviewed objectively and dispassionately in the context of over-all needs."

### Manned Bomber

Hall indicated that the Pentagon's all-important criteria of cost-effectiveness also would affect a decision on a possible new manned bomber program. "If we are to build a new generation of manned bombers, they must measure up, not only against their own kind but with other systems competing for their mission and with the Soviet defensive posture."

Manufacturers of guidance and control systems were warned that "the past 10 years may soon be viewed in retrospect by the guidance industry as the 'good old days'. It is unlikely ever to be that good again." During the past decade, the Pentagon spent approximately $2.5 billion for the development of guidance systems for strategic missiles. Since 1957, approximately $500 million have been spent annually for inertial type guidance systems, $400 million of which was for systems used on strategic missiles, with possibly another $100 million per year for radio-command types of guidance for strategic missiles.

### No New Programs

With the exception of the new standardized space guidance system program (AW Sept. 16, p. 39), intended as a multi-purpose system for standard space boosters such as the Titan 3, there are no new major strategic guidance programs on the horizon. This explains why so many companies submitted bids on Oct. 15 for the program, Hall indicated, with "greater teaming-up of companies than ever before for such a program."

There will be funds available for product improvement on existing weapons, but not for "across-the-board innovation," Hall said. "We will fund many good ideas but few large [guidance system] developments."

Current Pentagon expenditures for research, development, test and evaluation in guidance and aircraft navigation technology, which includes systems for other than strategic weapons, run about $500 million, with an additional outlay of about $2 billion for production, spares, maintenance and retrofit. These and earlier figures cited by Hall are based on a recently completed analysis by the office of the director of defense research and engineering.

This drop-off in new strategic guidance system programs may be partially compensated for by the growing need for smaller aircraft guidance systems for use in limited warfare situations, Hall said (AW Oct. 7, p. 29).

In the field of defense electronics,




**New Battlefield Surveillance Drone**

Northrop Corp.'s Ventura Div. has proposed a new drone, NV-104, as an advanced version of MQM-57A radio-controlled pilotless drone now operational. NV-104, according to Ventura, could use 98% of existing group support equipment. Drone uses T-63 turboprop engine.



| U.S. Spacecraft | Launch Vehicle | Remarks |
|---|---|---|
| Mercury | Atlas D | Two 3-orbit and one 6-orbit manned missions successful; 18-22 orbit mission planned. |
| Gemini | Titan 2 ✓ | Rendezvous techniques development; 14-day mission with 2 men; continued development of spacecraft technology; USAF sharing cost. |
| Apollo A ✓ | Saturn 1 | 14-day earth orbit test of 3-man command module. |
| Apollo B ✓ | Saturn 1B | Earth-orbit test of rendezvous of command and service modules with lunar excursion module (LEM). |
| Apollo C ✓ | Saturn 5 | Circumlunar flight with command and service modules. |
| | Saturn 5 | Tentative lunar orbit mission to drop LEM loaded with supplies for landing mission to follow. |
| | Saturn 5 | Lunar orbit of composite spacecraft with 3 men, followed by descent to surface in two-man LEM and exploration. |
| Lunar Excursion Module (LEM) ✓ | Saturn 5 | Vehicle to land two men on lunar surface from lunar orbit. |
| X-20 (Dyna-Soar) | Titan 3C ✓ | Hypersonic glide re-entry research in one-man vehicle. |
| Manned Orbital Development Station (MODS) | ..... | Under study. |
| Manned Orbital Space Station (MOSS) | Saturn 5 | Possible 12-man long-life station under study. |
| Tiros | Delta ✓ | IR studies and photography of clouds for meteorological satellite development. |
| Nimbus | Thor-Agena B ✓ | First operational meteorological satellite. |
| Synchronous Meteorological Satellite (SMS) | ..... | Formerly called Aeros. |
| Echo 2 | Thor-Agena B ✓ | Passive communications satellite with 135-ft. diameter rigidized sphere. |
| Telstar | Delta ✓ | AT&T funded project to develop wide-band commercial communications satellite. |
| Relay | Delta ✓ | Feasibility tests of low-altitude, one-way active repeater satellite. |
| Syncom | Delta ✓ | Lightweight two-way active repeater satellite in synchronous orbit. |
| Advanced Syncom | Atlas-Agena B ✓ | Larger, more sophisticated follow-on to Syncom 1. Hughes has study contract. |
| Medium-Altitude Random-Orbit Comsat | Atlas-Agena B ✓ | Air Force planned system of random-orbit comsats to be launched in groups of up to 8 satellites. |
| Oscar | Thor-Agena B ✓ | Non-governmental comsat for amateur radio operators; piggy-back launches with Discoverer satellites. |
| Transit | Thor-Ablestar ✓ | Orbiting navigation beacon development. |
| Agena D Gemini Target ✓ | Atlas D | Rendezvous target for 2-man Gemini spacecraft. |
| Ranger | Atlas-Agena B ✓ | Lunar impact; high-resolution photography; landing of survivable instrument capsules on the moon. |
| Surveyor Landor | Centaur | Unmanned lunar lander with payload for examination of lunar crust and environment. |
| Surveyor Orbiter | Centaur | Selenodetic satellite for lunar reconnaissance and photographic mapping; to monitor lunar radiation. |
| Mariner 1, 2 | Atlas-Agena B ✓ | Sealed-down Mariner A spacecraft which successfully completed Venus fly-by on Dec. 14, 1962, taking magnetometer and radiometer data. |
| Mariner B | Centaur | Advanced, heavier version of Mariners 1 and 2 which will drop survivable instrument capsules to the surface of Mars and Venus. |
| Mariner C | Atlas-Agena D ✓ | Mars fly-by vehicle. |
| Voyager | Saturn 1B | Mars/Venus orbiter. |
| Solar Probe | Atlas-Agena B ✓ | Designed to come within 0.2 A.U. of the sun's surface for close-up observations. |
| Pioneer | Delta ✓ | Solar-orbiting spacecraft (perihelion 0.8 A.U., aphelion 1.2 A.U.) for measurements during the International Quiet Sun Year. Formerly known as PIQSY. |
| Outer Planets Spacecraft | ..... | Fly-bys and orbitings of the Jovian planets. |
| Out-of-Ecliptic Plane Spacecraft | ..... | Investigations of phenomena out of the ecliptic plane. |
| Interstellar Probe | ..... | Solar system escape spacecraft. |
| Discoverer Series | Thor-Agena A, B ✓ | Development of Agena vehicle and test of designs, techniques and components for military and scientific satellites. |
| Explorer Series | Juno 2/Scout; Delta ✓ | General name for NASA scientific earth satellites. Explorer 1 was first U.S. satellite. |
| Orbiting Astronomical Observatory (OAO) | Atlas-Agena B ✓ | Orbiting telescope for mapping of heavens in UV spectrum. |
| Orbiting Geophysical Observatories: | ..... | Study of radiation belts, magnetic fields and ionosperic phenomena. |
| EGO S-49 | Atlas-Agena B ✓ | Eccentric-orbiting geophysical observatory. |
| POGO S-50 | Thor-Agena B ✓ | Polar-orbiting geophysical observatory. |
| Orbiting Solar Observatory (OSO) | Delta ✓ | Study of solar UV and X-radiation. |
| Helios | Thor-Agena B ✓ | Advanced orbiting solar observatory; to study particle radiation as well as electromagnetic radiation. |
| ANNA 1-B | Thor-Ablestar ✓ | Joint Army-Navy-NASA-Air Force geodetic satellite. |
| Injun | Thor-Ablestar ✓ | Investigation of earth's radiation belts. |
| Greb (SR Series) | Thor-Ablestar ✓ | Study of solar and cosmic radiation. |
| Traac | Thor-Ablestar ✓ | Test of gravity-gradient stabilization system for Transit satellites. |
| Arents | Atlas-Agena B ✓ | Advanced research environment test satellite to study environmental conditions and radiation in synchronous orbit. |
| TRS-1 | ..... | Radiation belt mapping. |
| Bios 2 | Atlas-Agena B ✓ | Long-term exposure of primates and other biological specimens; recovery by ejected capsule. |
| Lofti | Thor-Ablestar ✓ | Test of propagation of very low frequency radio signals in ionosphere. |
| Energetic Particles Satellites: | ..... | Measurement of artificial radiation created by high-altitude nuclear blasts. |
| S-3a (Explorer 14) | Delta ✓ | |
| S-3b (Explorer 15) | Delta ✓ | |
| Atmospheric Structures Satellite S-6 | Delta ✓ | Study of composition, density, pressure and temperature of upper atmosphere. |
| Fixed-Frequency Topside Ionosphere Sounder S-48 | Scout | Study of ionosphere from above by measuring electron distribution, electron density and cosmic noise level. |
| Micrometeoroid Detector Satellite S-55 (Explorer 16) | Scout | Study of spatial-temporal distribution of micrometeoroids as hazard to spaceflight. |
| Polar Ionosphere Beacon S-66 | Delta ✓ | Study of ionospheric behavior and electron content, as well as conditions which disrupt communications. |
| Interplanetary Monitoring Platform (IMP) S-74 | Delta ✓ | Ascertain Project Apollo radiation hazards; increase solar flare prediction capability; study solar-terrestrial relationships. |
| Large Micrometeoroid Detector Satellite | Saturn 1 | Obtain better statistical information of meteoroid distribution with larger area. To be flown in boilerplate command module during a test of Saturn 1 booster. |

Excerpts from AVIATION WEEK & SPACE TECHNOLOGY 1963 International Aerospace Spec Tables


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|---|---|---|---|---|---|---|
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| Explorer VII | Midas II | Courier | Transit IV-A | TRAAC | Tiros VI | Transit V-A |
| Pioneer V | Transit II-A | Tiros II | Greb II | Tiros IV | Alouette | Tiros VII |
| Tiros I | Greb I | Transit III-B | Tiros III | OSO-1 | Anna I-B | Next? |

(Can you pick out the 16 illustrated above?)

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Hall said that industry can expect "less proliferation of systems, more emphasis on reliability, maintainability and long service usefulness plus applicability to a wide variety of different systems instead of optimizing for a particular system."

The Pentagon plans to "push microcircuitry to the full limit of its potential," Hall said. Digital computers will play an increasing role in weapon systems, but they must have the capacity to perform check-out and "housekeeping" functions as well as the basic guidance and control functions, he noted.

Hall said that industry must filter its projects to ensure that only those which are technically sound are proposed to the military services. "You should prove to yourself that the ideas and concepts are technically feasible. Let us, the customer, decide whether or not we need the particular idea or concept." Hall, who was vice president and general manager of the Martin Co.'s Space Systems Div. prior to taking his present post, said that many of the ideas expressed were derived from his experience in industry prior to coming to the Pentagon.

He concluded by saying, "we must emphasize what we have the capability for doing as opposed to what we would like to do."

## FINANCIAL BRIEFS

**Douglas Aircraft Co.** reports a profit of $9.6 million for the first nine months of 1963 on sales of $545.5 million. Comparable figures last year showed a profit of $6.4 million on sales of $552.8 million. Per-share earnings for the period were $2.32 this year and $1.54 last year.

**Northrop Corp.** had a net income of $9.056 million on sales of nearly $347 million for the fiscal year ended July 28. Last year Northrop had a net income of $9.051 million on sales of $347.5 million. The company's order backlog stood at $392.5 million on July 28 compared with $325 million the year before. Per-share earnings were $2.16 for both years. Northrop's present level of sales and earnings was attained despite the cancellation of Skybolt missile work, 25% of its sales.

**National Aeronautical Corp.** showed earnings of $790,000 on sales of $9.3 million for the first nine months of the year, ending Aug. 31. Same period last year showed earnings of $694,000 on sales of $7.9 million.

**Aerojet-General Corp.** had sales of $506 million with earnings of $12.6 million, equal to $2.70 a share, for the nine months ending Aug. 31. Same period last year showed sales of $431.6 million with earnings of $8.9 million, equal to $1.89 per share.

**Radio Corp. of America's** sales for the first nine months of the year totaled $1.31 billion with a net profit of $44.2 million, or $2.40 a share. Comparable figures for last year show sales of $1.27 billion with net profits of $34.3 million, equal to $1.88 a share. RCA's chairman, David Sarnoff, reported that government space and defense business totaled $420 million for the period—a 9% decrease from a comparable period last year. However, Sarnoff said, commercial and industrial sales have more than offset the drop in government work.

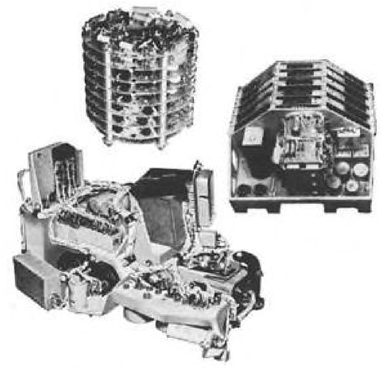
**E. W. Bliss Co.** had sales of $93 million and earnings of $2.7 million, equal to 98 cents a share after preferred dividend requirements, for the nine months ending Sept. 30. A comparable period last year showed sales of $88.9 million with a net income of $1.9 million.

**Sanders Assocs., Inc.,** reports sales of $55 million and profits of $2.6 million for the year ended July 31—32% and 28% increases above last year's totals, respectively. Earnings for this year were $1.72 per share compared with $1.37 per share last year (AW Aug. 12, p. 87).


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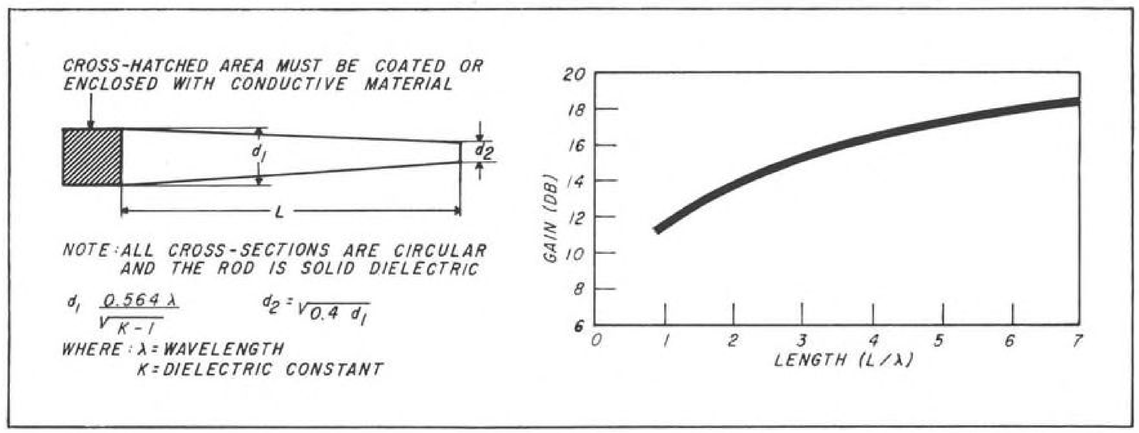
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**MAJOR AND MINOR** diameters of the tapered dielectric rod are determined by the operating wavelength and dielectric constant of the material used, as shown in equation, above left. Gain of the device is a function of its length, as shown above right.

# Dielectric Rod Produces Radar Echo Gain

By Philip J. Klass

**Washington** — Simple, low-cost method for enhancing the radar echo produced by target drones and small aircraft, using one or more small tapered dielectric rods, has been developed by Naval Research Laboratory.

Application to small general aviation aircraft could enable them to make increased use of ground radar facilities and might eliminate the need for a more costly radar transponder.

### First Public Report

First public report on the technique was made last week at the National Electronics Conference in Chicago by NRL's Dean D. Howard in a paper coauthored by N. A. Thomas. The technique, an outgrowth of dielectric rod antenna work, was developed by NRL for use on small target drones to replace more complex and costly radar enhancement devices. It has been tested on a Navy jet fighter at subsonic speeds following extensive laboratory measurements.

A single tapered polystyrene rod a few inches long mounted, for example, along the leading edge of a wing or in a tip tank, produces a radar echo equivalent to that of a flat metal plate which has 25 times greater cross-sectional area exposed to the windstream. By using material with a greater dielectric constant than polystyrene, the effective radar cross-section can be increased to 100 times the actual diameter of the tapered rod, according to Howard. If a group of tapered rods are used in a suitably spaced array the beamwidth can be increased so that echo enhancement can be obtained when the ground-based radar is located as much as 40 deg. on either side of the aircraft flight path.

A similar array installed on the horizontal stabilizer could provide signal enhancement to ground radars to the rear of the aircraft up to 40 deg. off its flight path. The new type reflector could be used for broadside viewing but probably is not needed because from this aspect angle a small metal aircraft usually provides a fairly strong radar echo.

The tapered rod is the ultimate in simplicity, consisting of a suitable dielectric material either molded or machined to the required taper and dimensions (see sketch). The large-diameter end of the rod is electrically terminated in a short circuit by coating it with a thin layer of copper or by inserting it into a threaded copper receptacle.

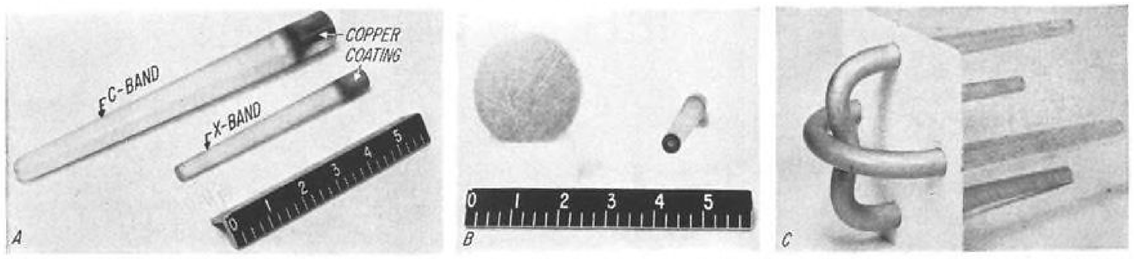
### Diameter Requirement

The diameter required at each end of the rod is determined by the frequency (wavelength) of the radar with which it operates and the dielectric constant of the material used. The diameter increases with increasing wavelength and decreases approximately as the square-root of the dielectric constant (see sketch, above). For example, using polystyrene, which has a dielectric constant of 2.55, results in major/minor diameters of approximately 0.44 in./0.38 in. for X-band operation and 1.03 in./0.63 in. for C-band use.

The signal enhancement (gain) achieved with a single rod increases with length while the beamwidth decreases. By beamwidth is meant the angle on either side of its longitudinal centerline through which it is responsive to ground radar signals. Both are independent of the dielectric material used, according to Howard. Using a rod whose tapered length is equal to one wavelength of the radar gives a gain of about 11 db. while a length of five wavelengths provides about 16-db. gain.

This means that for X-band operation, the wavelength of precision approach radars, a rod with a tapered length of 6 in. would provide 16-db. gain. For operation at S-band, the wavelength of civil surveillance radars, a length of 19 in. would be needed to achieve 16-db. gain. However, an array of several shorter rods could provide equivalent gain with more desirable broad beamwidth.

The length of the electrically shorted portion of the rod is not important and need be only long enough to provide a secure anchor.




**SIMPLE, LOW-COST RADAR** reflector which greatly enhances radar echo from small drones and aircraft consists of tapered polystyrene rod coated with conductor at one end. Fig. A shows size of units designed to give a 16-db gain at C-band (left) and at X-band (right). Fig. B shows comparison of frontal area of plastic rod which produces as strong a radar echo as a flat metal plate shown alongside. Fig. C shows Van Atta array, consisting of two U-shaped tapered rods, which provides greater echo enhancement.

### Frequency Band

The frequency band over which a particular dielectric rod will provide the desired gain has not yet been measured at NRL. However, based on dielectric rod antenna measurements reported by others, Howard estimates that the dielectric rod radar reflector response should be flat to within 3 db. over a 15% bandwidth.

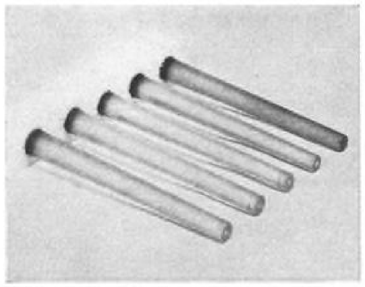
Measurements made by NRL on an X-band single rod reflector showed that it provided 16-db. gain. This is equivalent to a 2¼-in.-dia. flat metal disc, having 25 times the area of the rod's maximum diameter. However, the rod's beamwidth was twice as wide as that produced by the disc, being 12 deg. vs. 6 deg. at the 3-db. down point, Howard reported.

Where greater signal enhancement and/or beamwidth is required, it can be obtained by going to a suitable array of multiple dielectric rods. The simplest is an elementary Van Atta type of two-element array which can be formed by bending a long rod tapered at each end into a U-shape. The curved portion of the U-shape is electrically shorted by a copper coating or similar means.

### U-shaped Rod

NRL fabricated and tested a U-shaped rod with a separation of 2½ wavelengths between its two tapered legs. Theory predicted that it should exhibit 6-db. additional gain above that obtained with a single rod, while actual measurements showed a 5-db. increase. Using two such U-shaped elements, oriented at right angles to one another, should in theory provide a 12-db. gain over a single element or a total of 28 db. and in NRL measurements it came close to that figure (see photo, p. 88).

When the separation between adjoining elements of a dielectric rod array is reduced, mutual coupling between the elements results in broadening of the beam, or acceptance angle. For example, using a single U-shaped element whose tapered legs were separated by only one wavelength provided a gain which was 3 db. higher than that obtained from a single tapered rod and some 2 db. less than that obtained from the element with 2½-wavelength separation between its legs. However, in exchange, the narrow-spaced U-shaped element provided nearly twice the beamwidth of the wider-spaced element of a single rod.



**LINEAR ARRAY** of five dielectric rods, with suitable phasing, provides 7-db gain more than single rod without reduction in beamwidth. For airborne use, rods can be made with rounded or streamlined tips without adverse results. Length of electrically shorted portion of the rod is not important.

### Linear Array

Another way to achieve higher gain or broader beamwidth is to use a linear array of several individual rods. Antenna theory indicates that if all elements of such an array are in phase, the effective cross-section area should increase as the square of the number of elements while the beamwidth is reduced in proportion to the number of elements.

For example, if a single rod has an effective cross-section area of a 2½-in. disc (6.25 sq. in.), and a beamwidth of approximately 25 deg. (total), then a linear in-phase array of five such elements should exhibit an effective area of 156.25 sq. in. (6.25 x 5²) while its beamwidth should be 5 deg. (25/5).

For some applications this performance might be desirable, but for radar enhancement of a lightplane, a broad beam is desirable. By mounting the individual dielectric rods so their tips are not in line with one another, it is possible to alter the phasing between them and trade off gain for beamwidth, according to Howard. NRL constructed such an array using five suitably phased rods. It exhibited a gain which was 7 db. higher than that of a single rod and a beamwidth that was slightly broader than that of a single rod, or about 30 deg. across at the 3-db. down point. Additional beamwidth could be obtained by using shorter rods, sacrificing gain.

### Semi-active Device

Howard suggests the possibility of obtaining still higher gain by making the dielectric rod reflector into a semi-active device. This could be accomplished by terminating the rod with a tunnel diode or parametric amplifier instead of an electrical short circuit. Power levels might be too high for presently available tunnel diodes, but this is not a permanent obstacle, he believes.

An extension of this technique could be used to enable the aircraft to superimpose modulation on the signal reflected back to the radar. This modulation could be imposed by a pilot-actuated switch at the request of ground traffic controller to enable him to identify the aircraft from the image on his radar scope.

To accomplish this, the rod would be terminated at its end with a varactor diode which could be driven from a 50-mc. oscillator-modulator, generating 50-mc. sidebands on the reflected signal. By retuning the ground radar slightly, returns from other aircraft would be rejected and only the one in question would be displayed. It might even be possible to vary the aircraft modulation frequency as a function of altitude to provide the controller with at least a rough indication of the aircraft's altitude.

### Polarized Signals

The single electrically shorted dielectric rod is essentially insensitive to the polarization used on the ground radar signal. Circularly polarized signals are reflected with a reversed-sense (rotation) as with more conventional single-bounce radar reflectors.

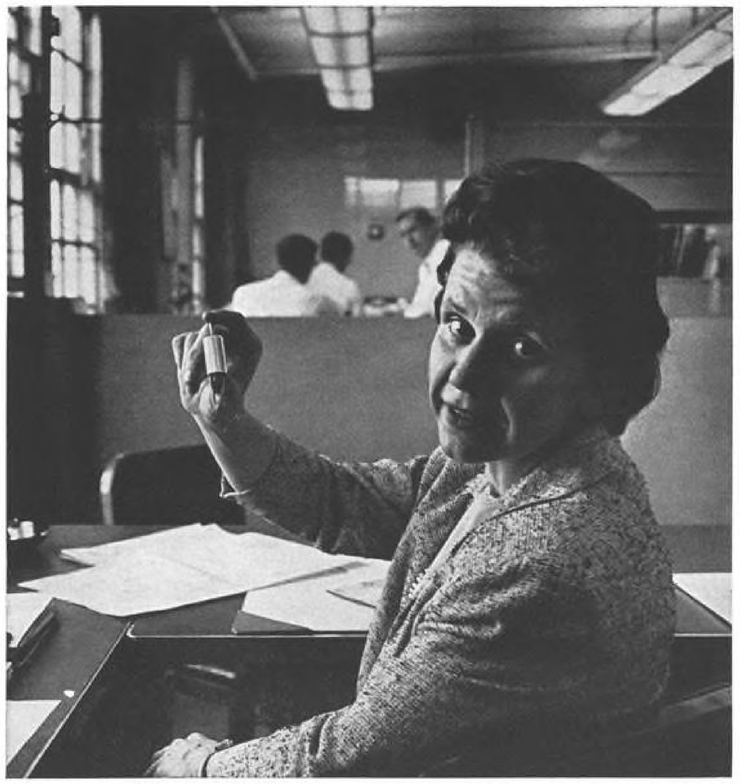
The U-shaped reflectors are somewhat more sensitive to signal polarization, providing a maximum return when the linear polarization is normal to the plane of the two legs. At right angles to this plane, a linear polarized signal experiences an attenuation of about 0.5 db. when the legs are separated by 2½ wavelengths, NRL measurements indicate.

### Laser Preamplifier

**Use of a laser as a radar preamplifier is under investigation at Hughes Aircraft Co.'s Research Laboratories in Malibu, Calif.**

**The company is looking at the possibility of using the laser preamplifier with a combination photo-traveling wave tube detector/amplifier in an effort to extract from a single transmitted pulse range and velocity data.**

**The Hughes program is sponsored by the Air Force.**



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## FILTER CENTER

▶ **Servomechanisms Closes Santa Barbara Labs**—The Santa Barbara Research Laboratories of Servomechanisms, Inc., have been closed and the company's research consolidated at its Los Angeles facilities. A pioneer in thin-film avionics devices, Servomechanisms will deemphasize its work in this field, discontinuing its activity on magnetic thin film computer memory components.

▶ **New Semiconductor Material Study**—USAF's Aeronautical Systems Div. is seeking qualified sources to investigate boron phosphide for use in diodes, transistors and injection lasers. Program will include development of techniques for preparation of single crystals of boron phosphide and fabrication of active devices.

▶ **Laser Data Link Has Wide Bandwidth**—A gallium-arsenide laser communication system which has a bandwidth of 12 mc., the largest bandwidth reported to date, has been developed by General Electric for transmission of data at missile test ranges. The transmitter, which measures 7 x 7 x 12 in., uses a 6-in. parabolic reflector to collimate laser energy into a 1-deg.-wide beam. The gallium arsenide diode, operating at room temperature, has output of 70 microwatts which is sufficient to give minimum of 35 db. signal-to-noise ratio at the receiver. The receiver, measuring 8 x 8 x 24 in. uses an 8-in.-dia. collector lens to focus incoming beam on a vacuum phototube. The system, which weighs only 10 lb., is expected to have usable range of more than 10 mi., GE says.

▶ **NBS, Navy Turn Back Their Clocks**—Time signals transmitted by National Bureau of Standards and Navy radio stations were set back 0.1 sec. on Nov. 1 to correct for slow-down in earth's rotation since last signal adjustment on Aug. 1, 1961.

▶ **Signed-on-the-Dotted Line**—Among recent contracts awarded to avionics companies are the following:

• **Astrophysics Research Co.**, Los Angeles, will conduct studies of ionospheric phenomena induced by missiles during their launch phases for the Army Missile Command.

• **Block Engineering, Inc.**, Cambridge, Mass., will provide engineering services to USAF's Electronic Systems Div. to assist in determining launch, midcourse and re-entry radiation measurements on missile phenomenology.



# Microwave Amplifier Advances Described

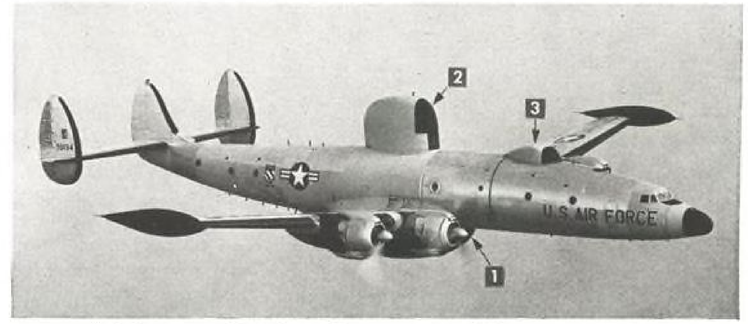
**Washington**—New advances and developments of particular interest in the field of avionics, reported here last week at the Electron Devices Meeting, include the following:

• **Cyclotron wave amplifier,** an electron-beam device exhibiting an excess-noise temperature of about 100K which does not require an RF pump source was reported by Robert Adler and George Hrbek of Zenith Radio Corp. An experimental model of the new type tube, operating at 400 mc., has shown a terminal-noise figure of 2 db. with 5 db. of signal gain. The cyclotron wave amplifier opens the way to the design of slow-wave amplifiers such as transverse field traveling wave tubes or to devices which use d.c. pumping to actively couple fast and slow waves, permitting very low-noise performance without need for a radio frequency pump.

• **High-power 25 gc. (kmc.)** traveling wave tube amplifier which delivers more than 1 kw. continuous wave (cw) power, called "a significant advancement in the state-of-the-art in millimeter wave power generation," was reported by J. W. Sedin and Kenneth Slocum of Watkins-Johnson Co.

• **Semiconductor microwave generator,** which contains no P-N junctions, is simple and inexpensive to manufacture and which operates at room temperature without a magnetic field, appears feasible using technique of direct generation of microwaves in bulk semiconductors, J. B. Gunn, of International Business Machines Corp., reported. Technique, which uses pulsed electric field applied to 3-5 type compound semiconductor by means of ohmic contacts, first reported using gallium-arsenide, has been demonstrated in other materials including N-type indium-phosphide.

• **Three - terminal high - current a.c.** switch, which can be made to conduct in either direction by applying a low-voltage, low-current pulse between the trigger terminal and one of the load-




## Airborne Radar Processes Target Data

**Airborne long-range input (ALRI), which enables Air Defense Command's EC-121H to process target data on board the aircraft and transmit it directly by data link to SAGE direction center via shore-based communications relay station, has increased the usefulness of the aircraft, if further "marring" its appearance with another large external antenna. In addition to large belly surveillance radar (1), and height-finder antenna (2), aircraft now carries the smaller ALRI antenna (3). Burroughs Corp. is ALRI systems manager.**


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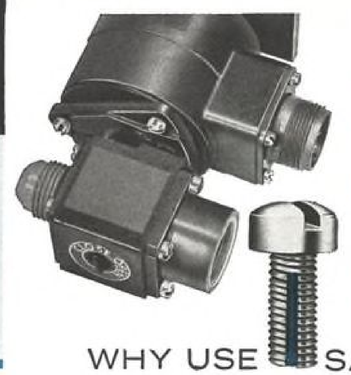
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WHY USE SAFETY WIRE?



## Monopulse Laser Tracks Azimuth, Elevation

**Monopulse laser tracker, right, is able to determine target azimuth and elevation from a single pulse bounced off the target by laser transmitter, left. Experimental system, developed by Westinghouse Air Arm Div., uses neodymium-doped calcium-tungstate laser, emitting at 1.06 micron, with output level of 0.1 joule per pulse and a repetition rate of up to 40 pulses per sec., using air as the only coolant.**

current terminals, was reported in paper by F. E. Gentry, R. I. Scace and J. Flowers of General Electric, Auburn, N. Y. The device is ideally suited for a.c. switching and phase control. Previously available silicon controlled rectifier, a three-terminal device, could conduct current only in one direction and two-terminal devices that could handle two-way conduction had to be triggered by either a very rapidly rising anode voltage or a voltage pulse high enough to exceed the avalanche breakdown voltage of the blocking junction.

• **Cathode-ray-tube moving target indicator,** which measures only 1 in. in diameter and 6 in. long and offers several modes of operation, was described by Leon S. Yaggy of Hughes Aircraft Co.'s Vacuum Tube Products Div. The device can accommodate wide range of repetition rates, provide frame-to-frame, line-to-line or area type cancellation. Interval between sweeps need not be limited to single value, as with delay line type MTI. Cancellation ratios greater than 40 db. have been obtained at TV scanning rates and typical radar repetition rates, Yaggy reported.

• **New type low-level camera tube,** which offers higher resolution, wider dynamic lighting range, is more rugged and potentially less expensive than conventional image orthicons, was reported by G. W. Goetze and A. H. Boerio of the Westinghouse Research Laboratories. Tube uses new type of image storage target backed by a thin layer of potassium chloride which is scanned by an electron beam.

• **High-resolution meshless storage tube** is possible application of the discovery that conductivity of cadmium-sulfide thin-films can be increased by factor of 100 to 10,000 if excited on a pulsed basis by an electron beam, light or electric field, N. H. Lehrer and R. D. Ketchpel of Hughes Research Laboratories reported. The increased conductivity, roughly proportional to the excitation energy, continues for many minutes so long as the applied electric field remains, but its removal or momentary reversal of the field restores the cadmium-sulfide film to its original low conductivity.

• **High-power 100 gc. (kmc.)** backward-wave oscillator, designed to produce 100 kw. peak power and 1 kw. average, has achieved power levels of 107 kw. peak and 324 w. average in tests to date, according to paper by J. W. Sedin, K. W. Slocum and M. V. Purnell of Watkins-Johnson Co.

• **Low-noise wideband millimeter** traveling wave tube, for operation in the 70-115 gc. (kmc.) band, with a noise figure of 12 db. and a gain of 25 db., was described by E. W. Kinaman and S. B. Leaf of Watkins-Johnson Co. Stable emission has been obtained on experimental tubes and one subjected to life tests showed an improved emission throughout the 1,500-hr. test, it was reported.

• **Hybrid microcircuit,** a differential amplifier using combination of epitaxial, diffused and thin-film techniques, provides performance comparable to that obtained using discrete components, Helmut Wolf and H. Jekat of Fairchild Semiconductor reported. The complete circuit, occupying an area of 60 x 120 mils, contains eight transistors and nine resistors. Use of thin-film and diffused resistors gives circuit a very low temperature coefficient and provides an input impedance of 0.5 megohm.

• **Field-effect silicon triode** which exhibits pentode characteristics, consisting of a P-N junction with a gate electrode insulated by means of an oxide layer, was reported by H. C. Nathanson, J. R. Szedon and N. A. Jordan of Westinghouse Research Laboratories. Small devices with 2 picofarad input capacitance and two megohm output resistance, have yielded transconductance values of 20 micromhos and open circuit voltage gains of more than 40, while larger devices have exhibited transconductances of 5,000 micromhos and gains of more than 300, the authors reported.

• **New injection laser junction** geometrical configuration, which provides more than six-fold increase in emission per ampere of excitation over previous designs, was reported in paper by R. B. Liebert, B. V. Keshavan, M. F. Lamorte and L. J. West of Radio Corp. of America's Electronic Components and Devices Div., Somerville, N. J. New configuration has achieved output as high as 170 milliwatts per ampere, permitting average output levels above 10 w. and pulse power levels above 1 kw., the RCA scientists indicated.

• **Rotary tuned magnetron,** which permits variation of frequency at rates 10-50 times faster than previously possible, offering attractive potentialities

## PROBLEMATICAL RECREATIONS 195



Three times Dick's age plus Tom's age equals twice Harry's age. Double the cube of Harry's age is equal to three times the cube of Dick's age added to the cube of Tom's age. Their respective ages are relatively prime to each other. How old are they?

*—Contributed*

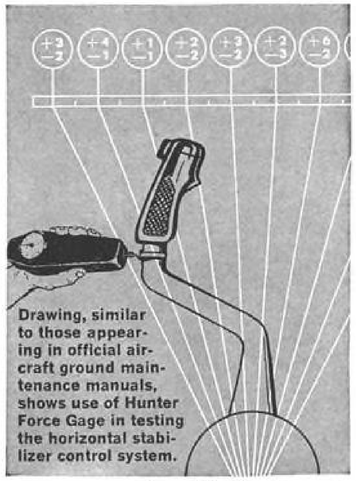
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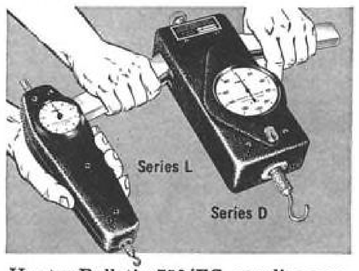
ANSWER TO LAST WEEK'S PROBLEM: The equation must have been either $x^2 - 11x + 24 = 0$ (which was copied as $x^2 + 11x - 42 = 0$) or $x^2 - 22x + 57 = 0$ (which was copied as $x^2 + 22x - 75 = 0$). In either case the common root is 3.


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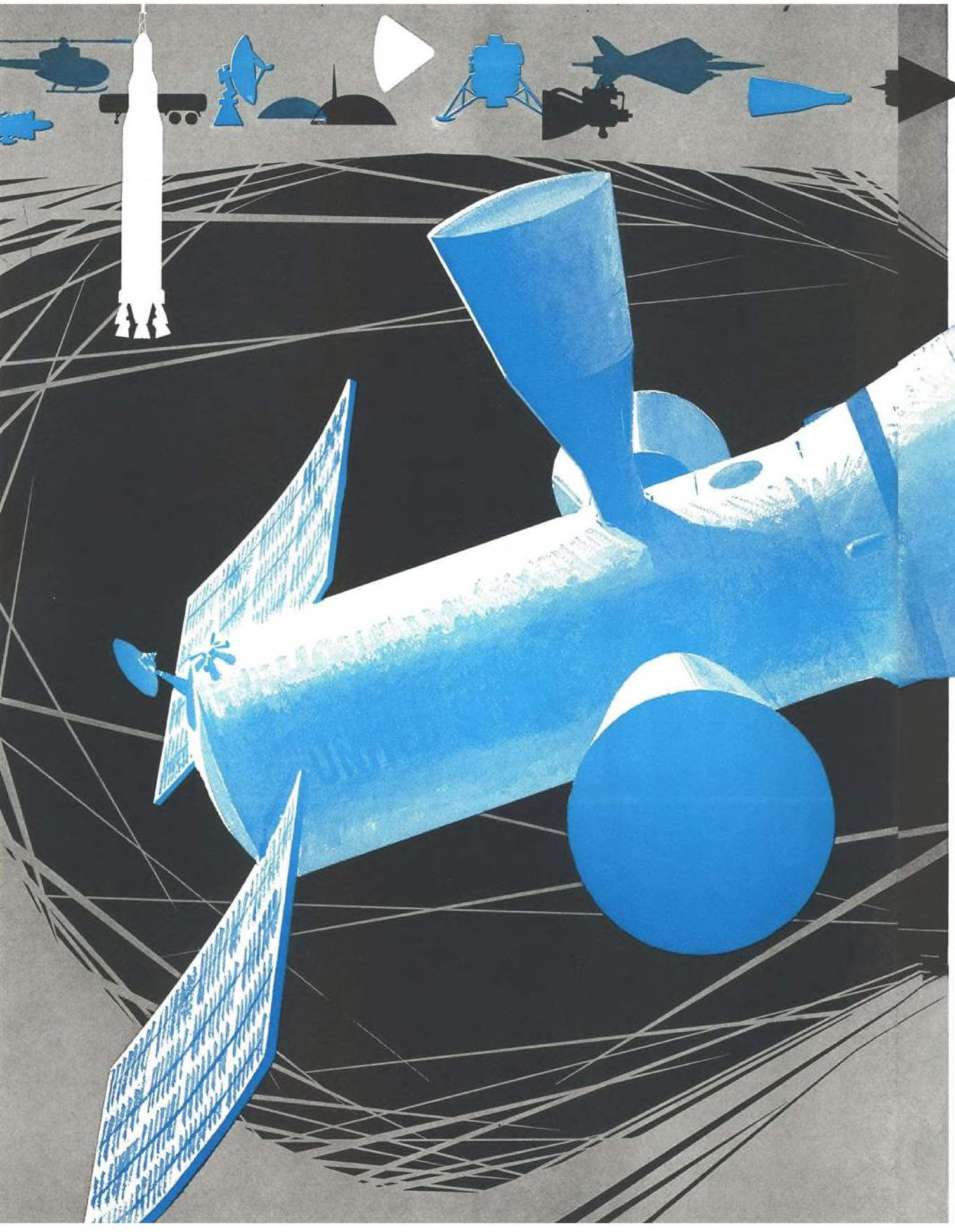
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**Staff Engineer**—BS in Engineering or Physics mandatory. Basic grounding in engineering design and test at the working and supervisory level. Quality Control engineering and supervisory experience in weapon systems or major electronic assemblies.

☐ **SYSTEMS**

**Senior Research Engineer**—MS with 3 years experience. Analytical studies of complex lunar spacecraft missions from point of view of relating the celestial mechanics problems to the expected "value" obtained by alternate actions. Development of analytical techniques to handle such problems.

**Research Engineer**—MS with at least 2 years in research or engineering problems related to space flight. Define and analyze mathematical models of guidance for lunar spacecraft with particular emphasis on control theory and statistical estimation. Study of the interacting problems of orbit determination and trajectory correction to develop optimal techniques for specific objectives.

**Senior Engineer**—BS plus 5 years experience required. Will have the system responsibility of integrating the various scientific experiments (e. g. radiometer, plasma detectors, magnetometer, etc.) with the remaining subsystems on the spacecraft. Specific duties include: 1) Accept inputs and schedule necessary test time for his area of responsibility. 2) Write procedures covering the interfaces between his area and the remainder of the spacecraft. 3) Evaluate and write related reports from test data.

**Research Engineer**—MS plus 2 years experience. To develop mathematical models of complex man-machine system operations leading to computer simulation and empirical evaluation of system performance.

☐ **SPACE SCIENCES**

**Senior Research Specialist**—BS with MS desirable. Advanced courses in geometrical and physical optics, with 15 or more years experience. Responsible for detailed technical monitoring and progress on all the optical instrumentation elements related to the specific space program connected with the television spacecraft systems. To review in technical detail, the approach and performance of the vertical contractors and subcontractors to assure conformance with specifications and mission success.

**Senior Scientist**—PhD with emphasis in space-oriented subjects. Three or more years experience. Must have conceived, designed and carried out some original research in experimental physics.

**Design Engineer**—BS plus 5 years minimum design experience in instrument or small mechanism design or equivalent. Design of physical science experiments and instruments and breadboard models of flight scientific instruments.

☐ **TELECOMMUNICATIONS**

**Senior Research Engineer**—MS plus 5 years experience in RF systems and/or circuitry. Development work in RF subsystems. Work concerned with wide band RF frequency multipliers and with frequency synthesizers characterized by low phase jitter and high spectral purity.

**Operations Project Engineer**—BS plus 8 to 10 years experience. Experience in operation of tracking station and networks, also with the technical systems and subsystems in tracking stations. Involves planning and scheduling of tracking operations. Will act as liaison between the DSIF and other JPL organizations in establishing the equipment and procedures to meet requirements.

**Senior Research Engineer**—BS with MS desirable. Two to 4 years experience in design and analysis of microwave antennas and microwave components desirable. General familiarity with antenna measurement techniques. Design and analysis of feed systems and wave guide components for large ground antennas.

**Research Engineer**—MS plus 2 years experience in communication, telemetry or radar system design and analysis. Analyze and solve telecommunication system problems in direct support of design, development and use of spacecraft telecommunications systems.

**Senior Development Engineer**—BSEE necessary and MSEE preferred. Five to 10 years experience in microwave system development. Radio communications techniques; UHF and microwave systems development of receiving and transmitting ground equipment.

☐ **GUIDANCE AND CONTROL**

**Research Engineer**—BSEE or MSEE with background in probability and statistics desirable. Develop advanced, reliable automatic test equipment for use with space vehicle guidance and control systems in laboratory, system and field checkout operations. Includes determination of functional requirements, design of circuits and logic, breadboarding, supervise prototype fabrication and participation as flight/GSE cognizant engineer in testing operations at JPL and Cape Canaveral.

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**Senior Engineers (Structures)**—Requiring active participation in the structural design and development of spacecraft; working familiarity with problems ranging from "nuts and bolts" to matrix methods of structural analysis; sufficient interest in academic pursuits to promote state-of-art advancements. Requires MS with 7-10 years experience in project support of aircraft, missile or spacecraft programs.

**Structural Dynamics Engineers**—Responsible for initiation and performance of model vibration analysis, dynamic loads analysis and testing in support of spacecraft design and development. Must have working familiarity with launch vehicle dynamics, including aeroservoclastic coupling. MS with 7-10 years experience applicable to position requirements.

☐ **ENVIRONMENTAL**

**Senior Research Engineer**—BS with some course work in heat transfer. MS desirable with 5-10 years direct experience in testing. Environmental testing experience is preferred but other types of testing are acceptable such as wind tunnel or flight testing.

**Senior Research Engineer**—BS with MS preferred. Five to 10 years direct experience in hardware testing. Environmental testing experience preferred particularly in the acoustic, vibration and shock areas. Other types of testing such as flight testing, flutter and vibration may be considered.

**Senior Design Engineer**—BS required, MS preferred. Six to 8 years minimum experience of a broad nature, analysis and project areas. Prefer some experience outside aircraft industry. Perform technical and economic feasibility studies of advanced facilities in vacuum technology, cryogenics, electricity, magnetism, optical and thermal systems, structures, aerothermodynamics, etc.

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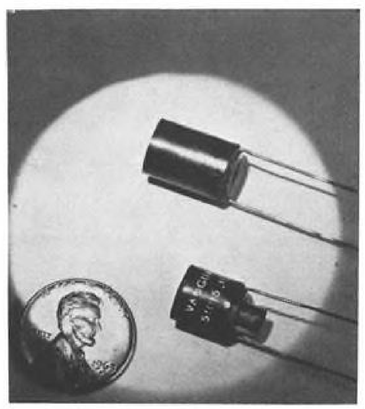
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• **Normalized freqmeter,** an all solid-state device for converting frequency or repetition rate into a d.c. voltage which is proportional to frequency/repetition rate. Four standard models cover range from zero to an upper limit


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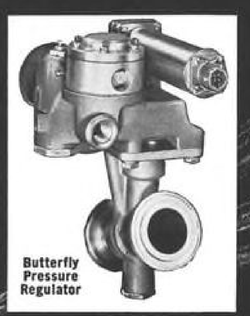
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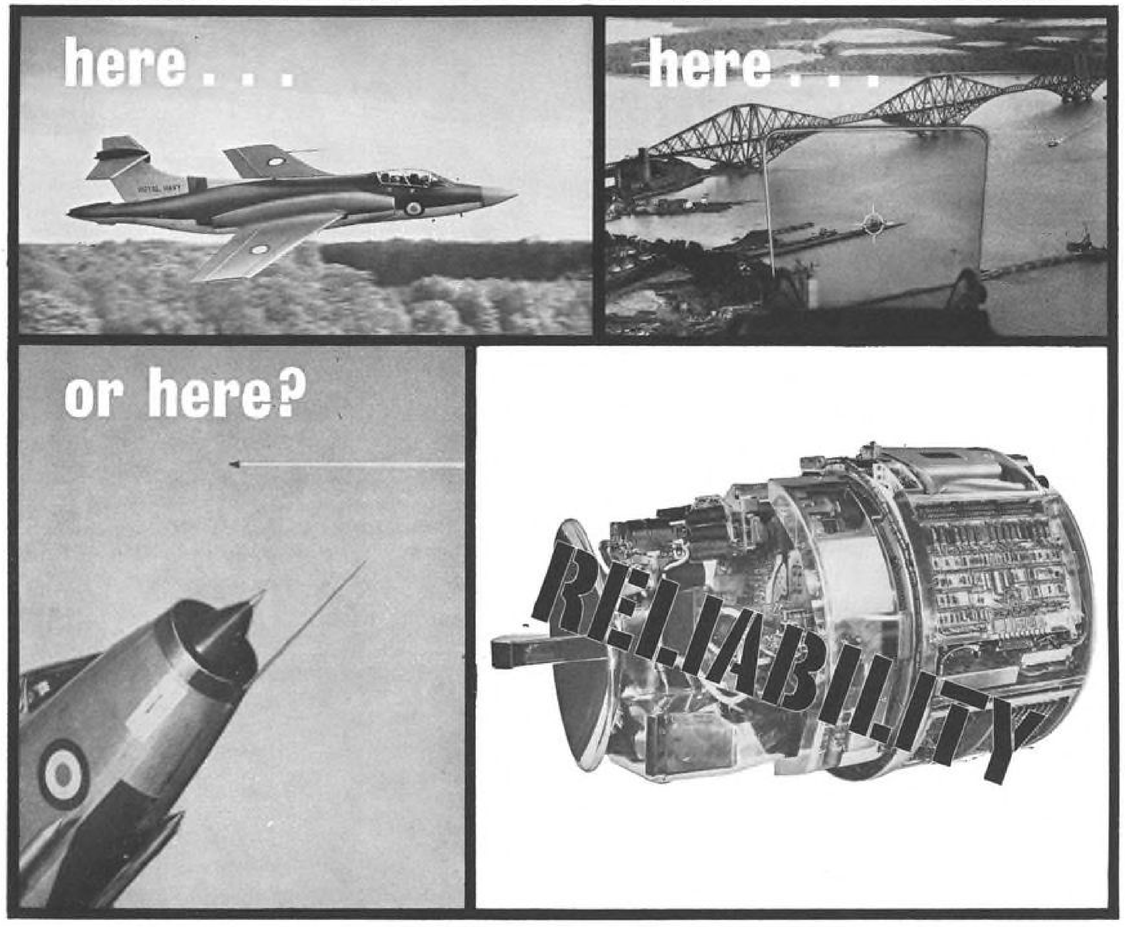
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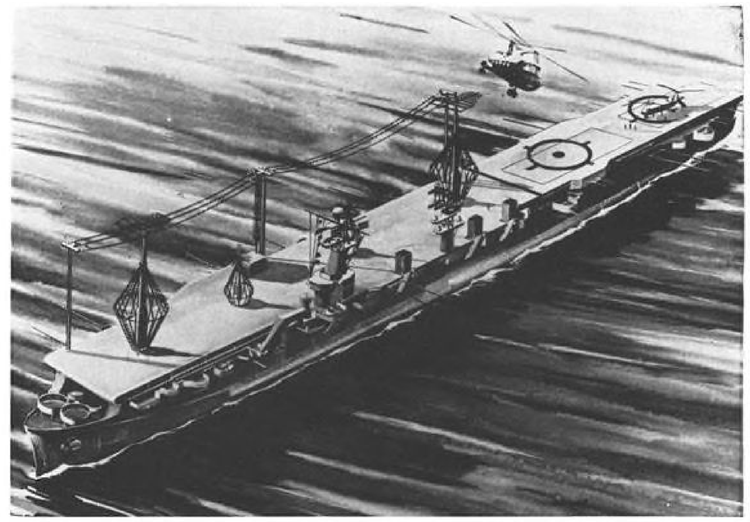
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• **Airborne tape transport,** Model DX-01, rapid start-stop type designed for airborne and vehicular applications, provides tape speed of 15 ips., adjustable over ±30% range, with fast forward and rewind time of 1½ min. for 2,400 ft. of tape. Magnetic head provides total of 7 tracks. Transport is designed for operating temperature range of 0C to 40C at altitudes to 15,000 ft. Device has servo-controlled reel drives and capstan motor system and self-contained transistor amplifiers. Manufacturer: S-I Electronics, Inc., 103 Park Ave., Nutley 10, N. J.

• **Data logging system,** with data sampler that can be located remote from central data-recording unit permitting latter to be fed from several data samplers, will accept signal inputs from 0-5 millivolts with full scale continuously adjustable to maximum range of 0-2 volts. Data sampler unit can accept up to 144 three-wire differential input



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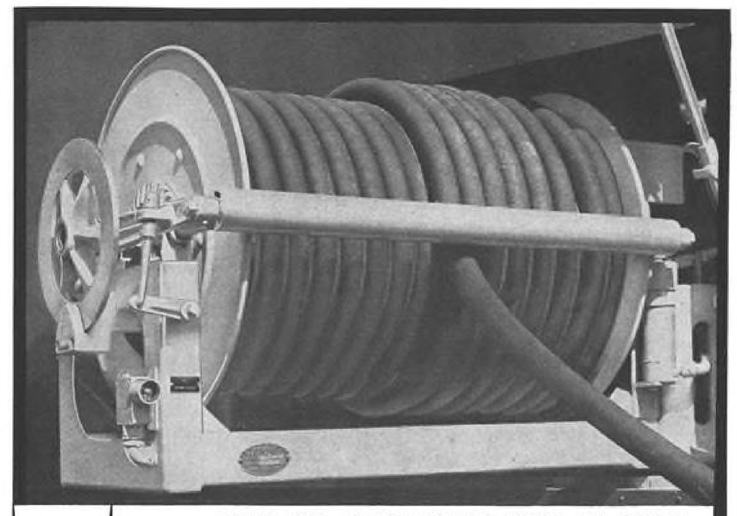
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*Creating a new world with electronics*

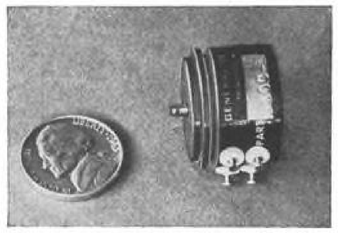
**HUGHES**

HUGHES AIRCRAFT COMPANY
AEROSPACE DIVISIONS



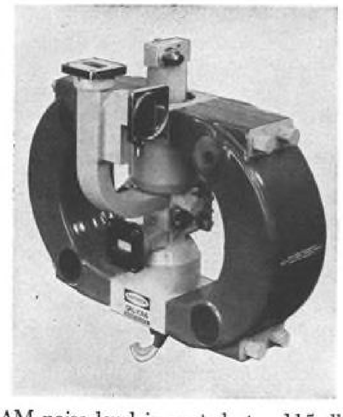

signals from millivolt-level transducers. Central control unit generates all timing and control functions and converts measured data into IBM-compatible code, punches data plus time and identification information into paper tape for direct computer use. Recording accuracy is quoted at better than 0.2% of full scale value selected. Manufacturer: Thompson Ramo Wooldridge, Inc., 7209 Platt Ave., Cleveland 4, Ohio.

• **Subminiature programming switch,** offering variety of accurately related switching functions with shaft rotation, is available in many standard or special



configurations. Photograph shows three-pole commutating switch providing up to 50 on-off functions per pole per revolution in unit measuring ⅛ in. dia. x ⅛ in. long. Manufacturer: General Devices, Inc., P. O. Box 253, Princeton, N. J.

• **Low-noise klystron amplifier,** Model QKL1066, for operation in the 10.2-10.6 gc. (kmc.) band, has rated output power of 2 kw. maximum, is tunable, liquid cooled and weighs 38 lb. The



AM noise level is quoted at −115 db. below carrier measured in a 1 kc. bandwidth from 2-20 kc. Beyond 20 kc., noise level drops to −125 db., according to manufacturer: Raytheon Co., Microwave & Power Tube Div., Waltham 54, Mass.

• **Miniature torque-limiting slip clutch,** designed to take over load for continuous or intermittent periods of slip and to maintain torque setting at variable


## Aeronautical Engineers:

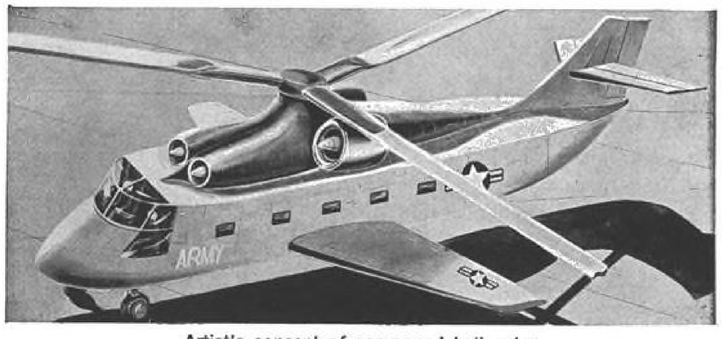
***If you want to do research work on advanced aircraft concepts***

# Join the TRECOM team

Yes, we stressed AIRCRAFT because we—the Army's Transportation Research Command (TRECOM)—want to hear from only those engineers who are truly interested in researching the future of subsonic airborne vehicles. No satellites, solar probes or moon rockets for us—just high performance helicopters, VTOL and STOL aircraft, and exotic individually-controlled airlift vehicles.

**"Just" the sort of subsonic aircraft that will be extensively needed for troop transport, surveillance, logistics, and special missions—many of which will have a bright future on the commercial marketplace as well. Here are some of the projects in the works at TRECOM today:**

• **A flexible wing vehicle** capable of being packed into a parachute-sized space will be used by airborne combat troops for speedy, directed attack. • The **XV-4A VTOL** aircraft uses the jet ejector principle for carrying two men at high subsonic speeds. • A new **Hot Cycle** Pressure Jet Rotor System represents a revolutionary technique for increasing helicopter speed and payload. • **Small rocket lift devices** (Rocket Belts) have been tested by propelling a man through a series of low-level maneuvers.




Artist's concept of compound helicopter

We are a small, but expanding group of aviation specialists who live and work right in the heart of Virginia's beautiful and historic Tidewater Virginia—within a 15-mile radius of Williamsburg, Jamestown and Yorktown. Already we have more demands on our research time than we can meet, and have immediate need for engineers experienced in:

- Aerodynamics*
- Propulsion
- Structures & Materials
- Dynamics*
- Stability & Control*
- Aircraft Subsystems
- Advanced Configuration Design*
- Flight Performance

**especially in the field of rotary wing aircraft*

**If you are interested in basic and applied aeronautical research please submit a resume of your education and experience, or a Federal Employment application (available at any Post Office) to Mr. L. B. Epps, Civilian Personnel Officer. Starting salaries up to $12,845 ($13,615 after January 1st) plus all the benefits of Career Civil Service.**

**U.S. ARMY** TRANSPORTATION RESEARCH COMMAND

# TRECOM

**Fort Eustis, Virginia**

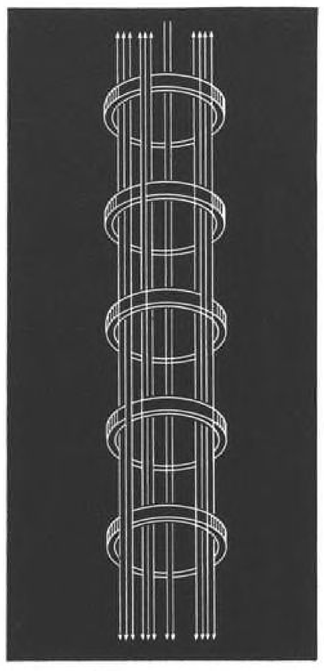
# Engineers/Scientists...like to share in the Genesis of significant new computer techniques?

## ...like Magnetic Logic for an Astronaut

Conceiving and developing novel and advanced computer techniques and systems is standard procedure at Burroughs Laboratories.

The midget computer—D210—(briefly described to the right)—is one recent example. Another is Burroughs' new, large scale command/control multi-module processing system—D825. This carries on parallel computation, controlled by automatic programming and is, in fact, the first totally modular processor.

Engineers at the Laboratories find our friendly, informal atmosphere conducive to creative work of this calibre. Here a man is associated with cooperating groups but, at the same time, finds management doors always open for the discussion of original ideas.



*Logic in this computer is physically implemented with a device resembling the core-rope fixed memory but distinguished from it by certain novel characteristics. Designed for an astronaut's cabin, this magnetic computer fits into a breadbox, weighs only 19 lbs., but can solve guidance and control equations at lift-off, in orbit and at re-entry at minimum 1-kc rate.*

THERE ARE OPPORTUNITIES TODAY ACROSS THE SPECTRUM OF COMPUTER TECHNOLOGY

**SOME IMMEDIATE OPENINGS:**

*Assignments Requiring Deep Experience (7-10 Years) and BS or Advanced Degree.*

**Command & Control Systems**—Create and apply state-of-the-art data processing techniques to c/c systems using nuclear instrumentation. Also opportunities to apply to c/c systems latest techniques in radar, intelligence gathering, missile & space vehicles, communications.

**Analysis-Advanced Computer Systems**—Preliminary design of computing equipment for use with advanced systems concepts.

**Systems Integration**—Develop new concepts in this area for application to broadbase c/c system. Minimum 5 years' experience as supervisor or staff consultant.

*Assignments Requiring BS and Minimum of 3 Years' Applicable Experience.*

**Control Systems Analysis**—Emphasis on applications in guidance, navigation, etc. (Senior & Intermediate positions)

**Logic Design**—Specification & detailed logic design of special purpose digital data processing systems. (Several levels)

**Digital Circuitry**—Design and development of solid state circuitry; circuitry for peripheral equipment; ferrite memories.

**Analysts**—AE, EE, ME, Math, Physics. Specialized experience in one or more of the following: (1) radar data processing; (2) powered flight simulations; (3) guidance equations utilizing know-how in guidance systems, missile dynamics, trajectories; (4) statistical data on performance & tracking of satellites and missiles.

*Also a Number of Senior and Intermediate Level Openings in the Following Critical Areas:*

**Electronic Circuit Design; Value Engineering; Evaluation Engineering; Performance Analysis; Environmental Testing; Equipment Test Coordination; Failure Analysis; Electronic Packaging; Specifications; Maintainability & Reliability Engineering (planning & implementation); Quality Assurance; Equipment Integration (resolving interface problems).**

Why not find out more about these unusual positions—and the attractive locations of Burroughs' facilities in the famous Philadelphia Main Line suburbs?

**Please write in confidence to Burroughs Laboratories, Dept. 593-R, P.O. Box 782, Paoli, Penna.**
**—on Philadelphia's Main Line.**

Burroughs

**Burroughs Corporation**

"NEW DIMENSIONS / IN COMPUTATION FOR MILITARY SYSTEMS"

An Equal Opportunity Employer





# ELECTRICAL ENGINEERS

Melpar's Engineering Division has immediate need for engineers in the areas noted below. These openings include positions of major responsibility for Senior Engineers as well as unusual opportunities for advancement for recent graduates.

### MICROWAVE RECEIVER DESIGN

Specific problems include parametric amplifiers, varactor techniques, microwave filters, ultrastable programmable oscillators and dual and triple channel balanced receivers for monopulse and guard antenna gating.

### SYSTEMS DESIGN

For the logic design of digital equipment, specifying necessary digital/analog interface equipment, the analysis of real-time flight simulation systems and the design of analog computer systems for flight simulators.

### ANTENNA DESIGN

Working with modern techniques of achieving narrow beam, low side-lobe, d/f antennas in the microwave region. Must have a strong theoretical background.

### PROGRAMMING

To write and debug programs for fixed-point real-time computers to be used with special purpose digital and analog equipment for the real time simulation of aircraft.

For further details, write in strictest confidence to:

**John A. Haverfield**

*Manager, Professional Placement*

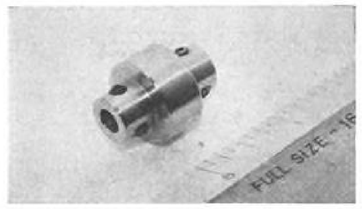
**MELPAR INC.**

*(A Subsidiary of Westinghouse Air Brake Company)*

**3427 Arlington Boulevard**
**Falls Church, Virginia**
*(a suburb of Washington, D. C.)*

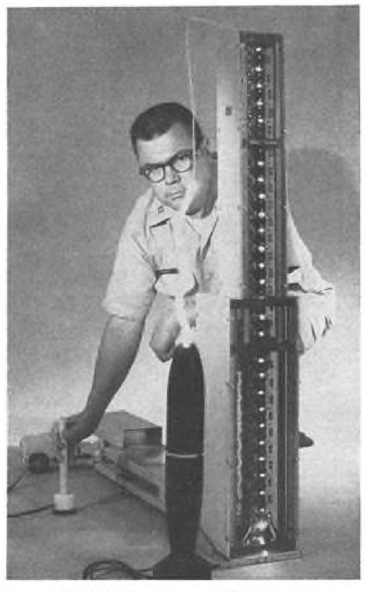
*an equal opportunity employer*


rpm. is available with torque settings ranging from ½ in.-oz. to 1,500 lb., with



outer diameters ranging from $\frac{7}{16}$ in. to 3 in. Device uses self-lubricating friction discs. Manufacturer: Sentinel Standard, 426 East 102nd St., Brooklyn 36, N. Y.

• **Refractosyn sun sensor,** Model S-4, contains two silicon photocells and a prism cut at critical angle of 41.5 deg. When sensor is aimed directly at the sun, no light reaches either photocell. Movement of sun to either side causes abrupt refraction of light onto one or the other of the two photocells, generating a positive or negative output signal. Device has a null sensitivity of 15 microamps per arc-min., an acquisition range of ± 90 deg., a spectral response



## Lightning Tester

Lightning tests on ICBM sites will be conducted by AF Special Weapons Center using portable machine being built by Lightning and Transients Research Institute, Minneapolis, under a $416,000 contract. Machine will produce bolts as long as 50 ft. with currents up to 300,000 amps, roughly 60% of the current maximums achieved by natural lightning, USAF says. Machine, mounted on a five-ton trailer truck, initially will be tested early next year at Kirtland AFB, N.M., using Jupiter IRBM.


**Management**

attitudes and philosophies can make a world of difference in YOUR personal and professional success. Martin Denver **knows** this...and has a continuing management program aimed toward creating an excellent working atmosphere, encouraging employee advancement and providing rewarding benefits.

Martin's current TITAN III contract and many other research and development programs provide exciting challenges in aerospace assignments, with immediate openings in...

- **INERTIAL GUIDANCE**
- **PROPELLANT PERFORMANCE**
- **ENVIRONMENTAL CONTROL**
- **ELECTRO-HYDRAULIC SUB-SYSTEMS**

**Send resume to F. A. McGregor**
**Manager of Personnel Staffing**
**Mail #A-251, P.O. Box 179-A-13**

**MARTIN** MARTIN MARIETTA

Denver Division, Denver, Colorado 80201

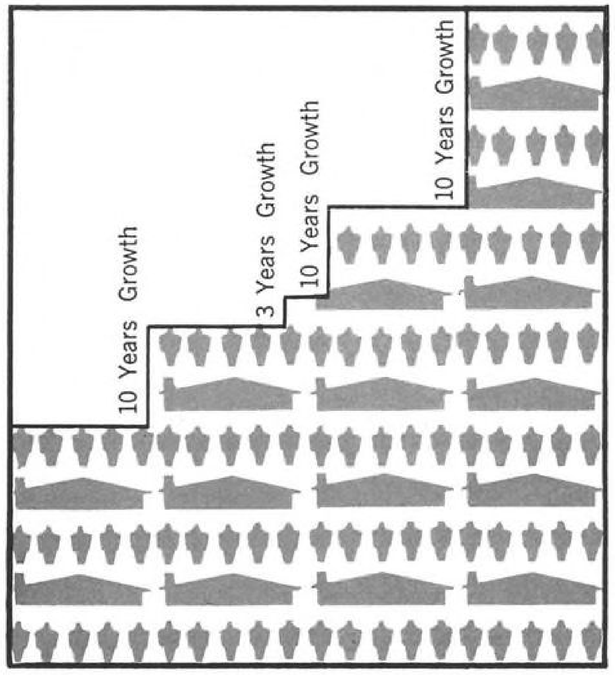
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Engineers and Scientists

You can Invest Your Future In

the PLACE with SPACE

*for everything*




Thirteen years ago — 726,984 people in the Atlanta Metropolitan Area, with plenty of living space around. Today — 1,117,325 people and still plenty of living space here. Twenty years from now, the estimation is for a 2,120,000 population and even then the thousands of wooded acres stretching away in every direction will provide plenty of wide open living space. BUT — as population increases, the value of real estate tends to increase, as there gets to be less of it. With population estimated to practically double within the next twenty years, the real estate bought today should make a most attractive investment.

You are invited to invest your Career Future with us now, for enhancement in our growing Research Center. At the same time, your home or other real estate investments stand to enhance, too.

*Openings in the fields of:* Aircraft Structures (Basic Loads, Strength Analysis, Fatigue Analysis, Ground Dynamics, Weights) . . . Flutter and Vibration . . . Sound and Vibration . . . Aircraft Research Engineering . . . Flight Test Engineering . . . Aerodynamics . . . Operations Research . . . Preliminary Design . . . Reliability and Systems . . . Thermodynamics . . . Propulsion

*Send complete resumé, in confidence, to:* Thomas I. Thrasher, Professional Employment Manager, Lockheed-Georgia Company, 834 West Peachtree Street, Atlanta 8, Georgia, Dept QQ-75

R.S.V.P.

Lockheed-Georgia Company

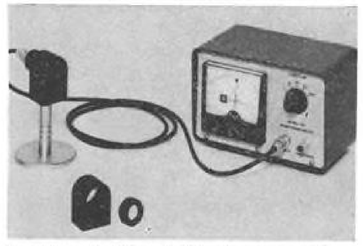
A Division of Lockheed Aircraft Corporation

*An equal opportunity employer*

*Don't forget to write*

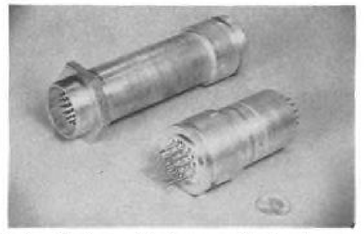

of 0.4 to 1.1 microns, and weighs only 1 gram. Manufacturer: HH Controls Co., Inc., 69 Pearl St., Cambridge 39, Mass.

• **Laser power meter,** Model 401, measures radiation of 6,328 angstroms directly and is supplied with calibration curve for use between 4,000 and 12,000 angstroms. Instrument is calibrated to within 2½% at 6,328-angstrom wave-



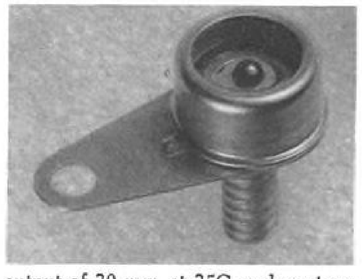
length and offers full-scale ranges from 1-100 mw. Output is provided for use by recorder. Sensing cell has a 25-mm.-dia. lens aperture and a ±10-deg. acceptance angle. Manufacturer: Spectra-Physics, Inc., 1255 Terra Bella Ave., Mountain View, Calif.

• **Deep penetration hermetic connectors,** designed to provide multiple electric connections through high vacuum or other chambers where high structural



integrity is required, can withstand pressures greater than 1,000 psi. Variety of connectors are available in different lengths with internal conductors isolated by dielectric oil. Air leakage is quoted at 0.2 micron cu. ft./hr. at 30 psi. differential pressure. Manufacturer: The Deutsch Co., Municipal Airport, Benning, Calif.

• **Gallium-arsenide infrared source,** Model SNX-110, provides continuous



output of 20 mw. at 25C package temperature at forward bias of 2 amps with


Space Navigation Systems Engineers:

# THINKING INTERPLANETARY?



## so are we!

Engineers and Scientists at Honeywell in Florida are actively engaged in the design and development of airborne and spaceborne navigation systems for such programs as X-20A, Centaur, Gemini and many others of great complexity. Are you qualified to make a significant contribution to our systems capabilities? We offer the inquisitive, imaginative engineer the growth and responsibility which comes only from working with an aggressive, engineering-oriented firm.

**INERTIAL SYSTEMS DESIGN ENGINEERS**

Will examine the state of the art for the broad application of inertial, electro-optical, and manually operated optical sensors for navigation and control of manned and unmanned spacecraft. Will conduct preliminary design studies of guidance techniques for such craft. Experience desirable in Guidance and Control Systems Design, configuration and error analysis, system test or evaluation, circuit theory, optical and inertial sensors or servo theory.

**SYSTEMS ANALYSIS ENGINEERS**

Will analyze systems performance, conduct servo analysis and solve trajectory problems using analog/digital computers and construct mathematical models. Knowledge of advanced calculus, vector analysis, classical mechanics, Bode diagrams, root locus plots and LaPlace transforms highly desirable.

**SYSTEMS INTEGRATION ENGINEERS**

Will integrate components into the inertial guidance system and the system into the vehicle and solve problems of interface, such as grounding, signal isolation, and hardware and digital computer interface. Knowledge of inertial navigation, gyros and accelerometers is required.

Qualified Applicants are invited to visit our facilities, meet our people and discover for themselves the many added advantages of working and living here on Florida's Suncoast. A brief note, describing your education, experience and specific area of work interest, addressed to **L. M. Keese, Honeywell 13350 U. S. Highway 19, St. Petersburg, Florida,** will bring a prompt, confidential reply.

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"A Good Place to Live . . . A Good Place to Work"

To investigate professional openings in other Honeywell facilities, send resume to F. F. Laing, Honeywell, Minneapolis 8, Minnesota.



# AEROSYSTEMS

## CLOSE TO THE HEART OF AN ENGINEER

Seeing finished hardware creates a special kind of satisfaction for an engineer and Temco Aerosystems knows it. As a matter of fact, we believe an engineer needs to be close to his project throughout systems design, systems evaluation, development, installation and testing. At Aerosystems, this emphasis on engineering also means that administrative services, marketing, new business proposals, and engineering laboratories are complementary functions in support of our objective to develop the nation's most advanced airborne electronics systems. Our engineers have found this approach to total electronics engineering involvement provides opportunity for engineering inventiveness and professional recognition. We believe that you will, too.

If you are being lost in the maze of routine humdrum, investigate these and other positions at Temco Aerosystems.

**ELECTRONICS DESIGN ENGINEERS** Strong background in design of communication systems with experience in receiver and digital circuitry design. Ability to analyze and establish design criteria to provide maximum control of electromagnetic interference. Experience in RF and IF design is of particular interest.

**LEAD ELECTRICAL DESIGN ENGINEERS** Strong background in aircraft electrical systems, power generating, distribution and control systems. Installation and checkout experience preferred.

**ELECTRONIC SYSTEMS ENGINEERS** Heavy experience in analysis and design development of advanced airborne receiving systems. Must be capable of directing the efforts of other engineers. Knowledge in RF and microwave theory.

**COMMUNICATIONS SYSTEM DESIGNERS** Heavy experience in transistorized receiver design and other related components of communications systems. Knowledge of advanced systems and applicable techniques in communications field desirable.

**ELECTRONIC SYSTEMS ENGINEERS** Design engineers with heavy background in electronic systems design, specifications and installation. Must be capable of assuming complete responsibility for a major electronic system requiring integration of a number of black box units into a compatible system.

For complete information on Temco Aerosystems and career opportunities, write B. G. Hickey, Dept. C-113, P. O. Box 6118, Dallas 22, Texas. An equal opportunity employer.

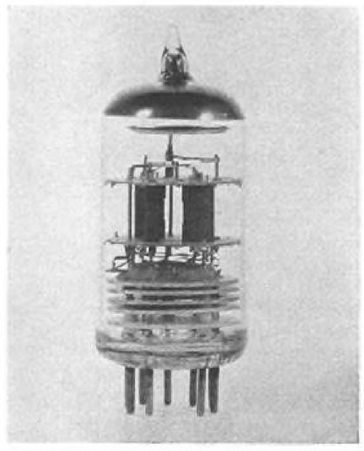
LTV TEMCO AEROSYSTEMS

A DIVISION OF LING-TEMCO-VOUGHT, INC.


peak emission at a wavelength of 0.92 micron. Device has achieved peak optical outputs above 250 mw. at 0.85 micron when cooled to −195C. Device has a sub-microsecond response time which permits amplitude modulation at high frequencies. It is housed in stud-mounting package with flat glass window. Manufacturer: Texas Instruments Inc., 13500 North Central Expressway, Dallas, Tex.

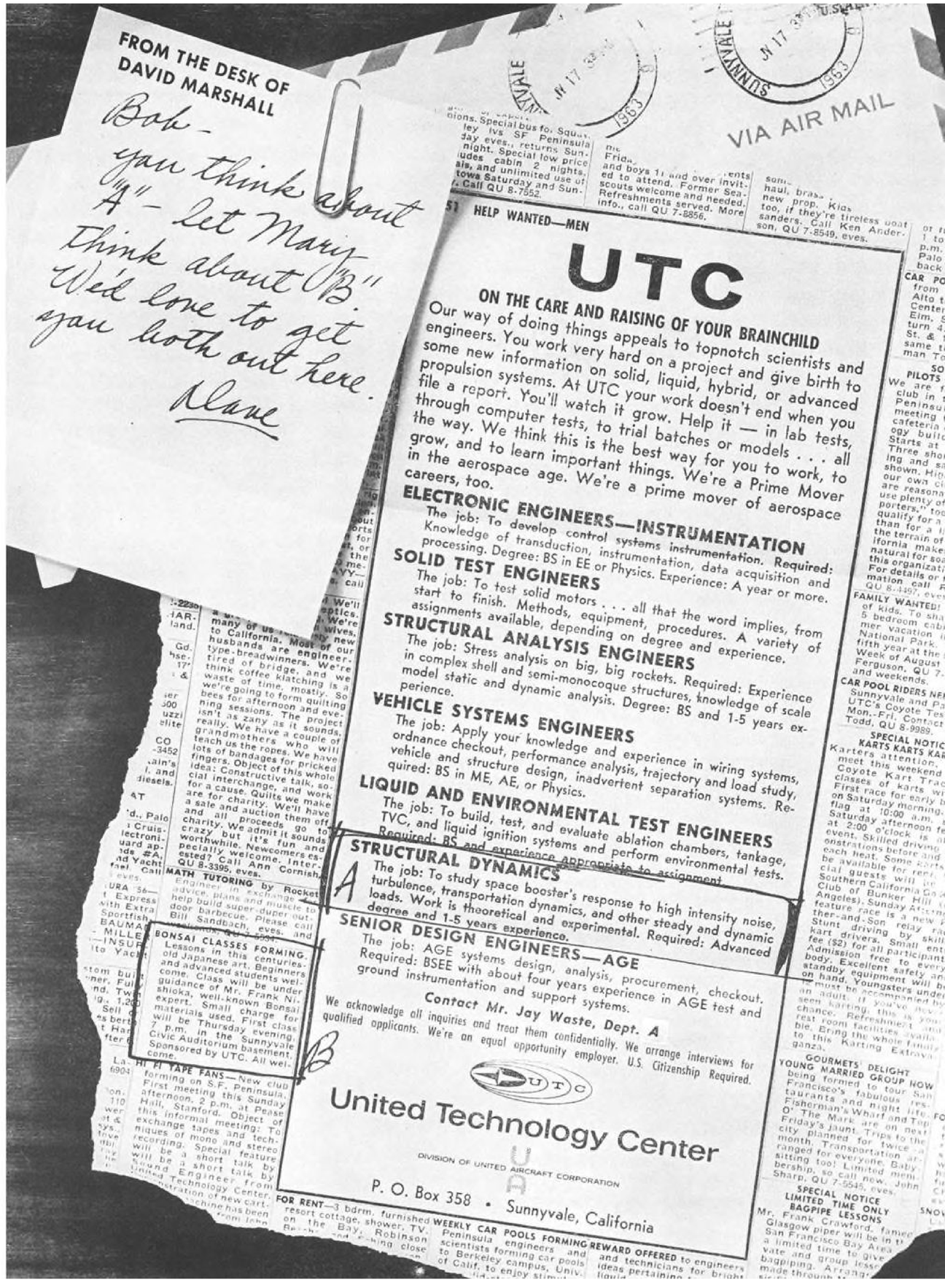
• **Four-year timer-encoder,** an electromechanical device, provides 321,400,000 distinct code pattern outputs, one for every second during a four-year period, taking account of Feb. 29 on leap year. Device can be set to any selected code within 1 min., the manufacturer says. Newsletter No. 118 provides application data. Manufacturer: The A. W. Haydon Co., Waterbury, Conn.

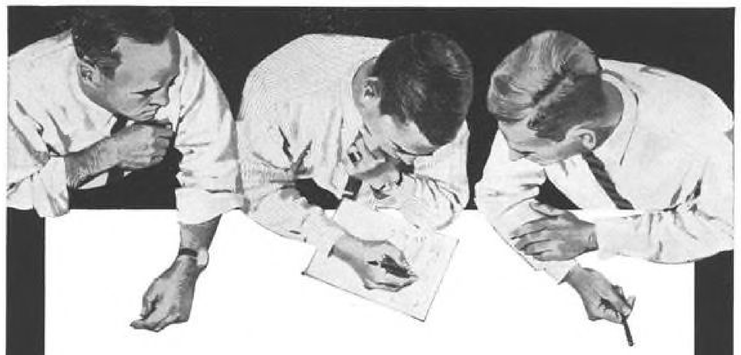
• **Longitudinal instrumentation recorder,** Model AR-200R, for airborne and mobile reconnaissance applications, has frequency response up to 750 kc. The tape recorder is designed to operate at altitudes to 50,000 ft. and at temperatures from −10C to 55C. Recorder weighs 109 lb., provides 7 channels with ½-in. wide tape or 14 channels when 1-in. tape is used. Tape speeds are 30 and 60 ips. Manufacturer: Ampex Corp., 401 Broadway, Redwood City, Calif.



## Vacuum Tube

Radiation-resistant vacuum tube with built-in passive components on ceramic wafers in the base, called Circuitron, is available in sample quantities to perform bistable multivibrator, OR gate and AND gate functions. Circuitrons can function after integrated nuclear exposure of $10^{16}$ (n, v, t) epithermal neutrons and 4.5 x $10^{7}$ Roentgens of gamma radiation, and operate at ambient temperatures of 200C as well as withstand 160 db. noise and 500G impact acceleration, according to manufacturer: Sylvania Electric Products, Inc., Emporium, Pa.



# ENGINEERING RESEARCH

The division for missiles and aircraft at NAA-Columbus offers engineers the opportunity to do research and development work in the areas of:

## PHYSICAL METALLURGY

Plan and conduct research studies in physical metallurgy of metallic structural materials with emphasis on high temperature alloys and refractory metals. High degree of technical skill and experimental aptitude required.

## CERAMICS

Plan and conduct research studies of piezoelectric materials and ceramic materials for radome application.

## AERO-THERMO INSTRUMENTATION

Plan and conduct research and development of instrumentation to meet new requirements in the aero-thermodynamics field. Wide instrumentation experience required with basic understanding of compressible fluid flow as applied to requirements of test equipment.

## ELECTRICAL & MECHANICAL STANDARDS

Prepare design standards to control standardization of electrical or mechanical parts and components. Determine new areas for standardization and advise design engineers on use of standard parts.

**To arrange an interview, please write to: Mr. J. A. Hitchcock, North American Aviation, Inc., 4300 East Fifth Avenue—Box AW-654, Columbus 16, Ohio.**

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

COLUMBUS DIVISION
NORTH AMERICAN AVIATION




# WHO'S WHERE

(*Continued from page 23*)

## Changes

**Robert J. O'Brien,** chief project engineer, Lockheed Propulsion Co., Redlands, Calif., a division of Lockheed Aircraft Corp.

**Henry G. Beaird, Jr.,** chief of flight test engineering, Lear Jet Corp., Wichita, Kan.

**Nelson C. Smith,** contracts manager, Aerospace Div. of Walter Kidde & Co., Inc., Belleville, N. J., succeeding Leslie J. **Dikovics,** now assistant controller.

**Joseph W. Coddou,** head of the fluorine-oxygen (flox) oxidizer test program at General Dynamics/Astronautics, San Diego, Calif.

**Eric Stanley Greenwood,** sales manager-military, Hawker Siddeley Aviation's Avro Whitworth Div., London, England.

**Don Fairchilds,** director of public relations, The Singer Co.'s Metrics Div., Bridgeport, Conn.

**Seymour Colman,** manager-Apollo program, Beech Aircraft Corp., with offices at the company's missile and space vehicle research and development center, Boulder, Colo.

**Dr. James E. Boyle,** sales manager-laser products, Hughes Aircraft Co.'s Electronic Products Div., Newport Beach, Calif.

**Robert S. Kraemer,** chief engineer-space systems, and **John G. Hammond,** chief engineer-electronics systems, Aeronutronic Div. of Philco Corp., Newport Beach, Calif. Also: **Marvin W. Sweeney,** chief engineer of re-entry systems, succeeding **Carl E. Grigsby,** now manager of the newly created re-entry technology programs within the re-entry systems programs organization.

**Clarence Eliason, Jr.,** corporate director of industrial relations, Giannini Controls Corp., Duarte, Calif.

**Lee Hachey,** manager-quality assurance and reliability, Packard Bell Computer, Santa Ana, Calif., a division of Packard Bell Electronics.

**Lt. Col. Victor E. Redding,** chief, Scientific and Technical Liaison Office (STLO), Research and Technology Div. (Cleveland, Ohio), Air Force Systems Command.

**Charles E. Cripps,** senior engineer, Houston Fearless Corp., Los Angeles, Calif.

**Robert S. Tucker,** director of facilities, Northrop Corp., Beverly Hills, Calif., and **J. W. Hinchliffe, Jr.,** corporate director of materiel. Also: **Dr. William B. Fallis** has joined Northrop Corp.'s Norair Div. as a member of technical management in charge of development activities-hypersonic and lifting entry vehicles.

**Frederick W. Garry,** manager-CF700 jet engine project, General Electric Co.'s Small Aircraft Engine Dept., Lynn, Mass.

**Fred D. Kochendorfer,** manager, Advanced Systems and Programs, Philco's WDL Div., Palo Alto, Calif.

**Dr. Marvin Cohn,** manager, Microwaves and Applied Physics Section, Research Div. of Electronic Communications, Inc., Timonium, Md.

**Dr. Domenic Bitondo,** technical director, Bendix Systems Div., Aerospace Systems of The Bendix Corp., Ann Arbor, Mich.




# Goal:
# Perfected aerospace systems...in operation as needed

The mission is well defined. The complexity of its accomplishment fringes comprehension. The urgency of its success need not be dwelt upon.

The Air Force Logistics Command civilian-military team has responsibility for supervising procurement, supply, maintenance engineering and transportation in support of aerospace and weapons systems of every kind for the Air Force. The engineers, the scientists, the theoreticians and the practitioners, the people of dozens of different disciplines who accept their share of this responsibility have qualifications of the highest order.

In ten different installations across the country, AFLC hastens the progress of the technology of aerospace support, puts it to immediate use. Maintenance of operational aerospace and weapons systems, inventory control, communications developments, all of the vastly varied projects that probe every direction of aerospace activity are the province of AFLC. The problems are legion, their nature the most advanced and sophisticated. Their solution demands outstanding ability.

AFLC benefits include patent protection for inventions, opportunity for advanced study, honorary, academic and cash awards, promotion based on merit, health and retirement benefit programs, low cost life insurance, paid vacations and sick leave plus full career Civil Service benefits.

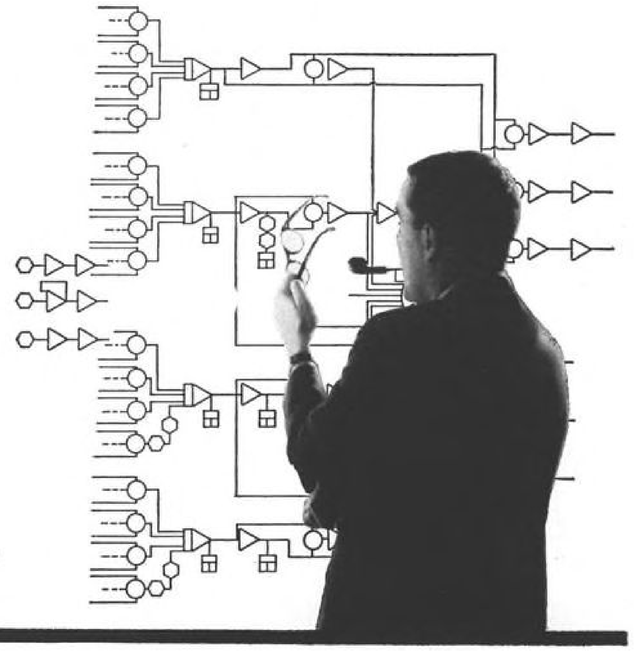
AFLC is now staffing the specific positions named below. If your qualifications are appropriate, we would be interested in discussing with you the unique career opportunities with AFLC.

**AIR FORCE LOGISTICS COMMAND**
has immediate openings for engineers and scientists in these areas.

**CIVIL ENGINEER (GENERAL)**—Previous experience will include the design, quantitative and cost estimates on buildings, roads, utilities and distribution systems.
**INSTRUMENTATION ENGINEER**—Will work in the investigation and application of new electronic measurement and calibration techniques.
**ELECTRONIC ENGINEER**—Responsibility will involve the maintainability and reliability of electronic missile guidance and support systems.
**COMMUNICATIONS ENGINEER**—Work will involve integration of wire, SSB/HF and UHF communications.
**INDUSTRIAL ENGINEER**—Will plan, design and implement complex systems in material handling, storage, transportation, document handling, manufacturing, production control and equipment utilization.
**MECHANICAL ENGINEER**—Duties will involve studies on technical integrity and functional operation of all airborne and ground mechanical systems, subsystems and equipment of advanced missile systems.

To arrange an early interview, direct your resume or Application for Federal Employment (SF57) with geographical preference and salary requirement in strict professional confidence to:

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Some really important parts of this picture don't show. They are the technical papers inside the brief cases of these Cornell Aeronautical Laboratory staff members — papers ready for presentation at last January's IAS meeting in New York.

CAL men were selected to present five papers* at this national aerospace conference, an indication of the caliber of the Laboratory's research programs and the staff's active participation in technical societies.

The vigorous climate of applied research at Cornell Aeronautical Laboratory — coupled with ample opportunities for internally sponsored research, a unique educational advancement program, and active participation in professional societies — has produced the wide range of competence in applied mechanics and hypersonic aerodynamic research reported in the IAS papers. The Laboratory also has similar far-reaching programs in computer science, flight research, vehicle dynamics, life sciences and systems research. If your capabilities qualify you to be a part of this picture, send the coupon. You'll receive an interesting briefing on this community of science.

**Some positions are available at our Washington Projects Office as well as in Buffalo.**

**Boarding the plane, left to right: Orren Tufts, who wrote "Dynamic Derivative Measurements in a Wind Tunnel"; Gary Ludwig and Gordon Brady, co-authors of "Theoretical and Experimental Studies of Impinging Uniform Jets"; Dr. Walter Gibson, who wrote "Nonequilibrium Shock Layers with Radiation Transfer and Species Diffusion"; and Charles Gates, who co-authored "Comparison of Theoretical and Experimental Flutter Characteristics for a Model Rotor in Translation Flight" with Raymond Piziali and Frank DuWaldt (both not included in this photo). Also not appearing in the photo was Dr. Hsien Cheng, author of "Recent Developments in the Theory of Viscous Hypersonic Flow around Blunt Bodies."*

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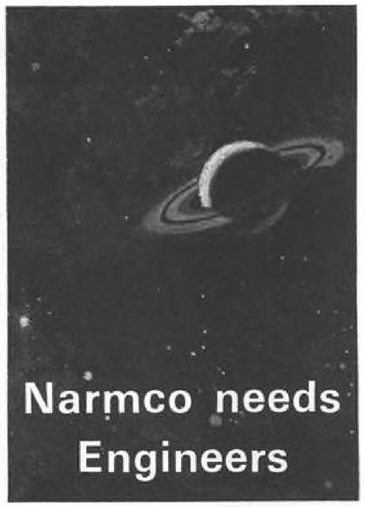
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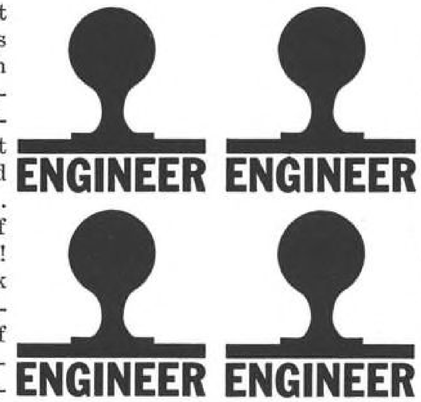
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LIFE IN GEORGIA

## Lockheed Wife Becomes Instant Atlanta Booster

**By Doris Lockerman**
*Atlanta Constitution Columnist*

Jane Damiano nuzzled the red fuzz of Little Joe's head, color-matched to her own. Joe is one of two unexpected, but not undesired, adopted babies who have expanded the Damiano household since they joined the Lockheed Aircraft group 2 years ago.

"Instant everything! That's Atlanta for you!"

Mrs. Damiano, 31, moves like a college girl, speaks in exclamation points. Until the arrival of Little Joe she drove a red M. G. to the shopping center a few blocks up the street from her brick-and-glass, three-bedroom, two-bath house in the Vernon Woods section of suburban Sandy Springs, 7 miles from the Lockheed plant. Daughter Judy just fit the bucket seat. They walked to the community swimming pool three blocks away and to the Baptist church, three blocks in the other direction.



*Doris Lockerman*

**"Now the M. G. must go". Like this city, the Damianos are growing mighty fast. You know, this is the first city in my life I have owned. Very possessive about Atlanta. A real emotional involvement... I love Rich's, for example. Insist on Coca-Colas exclusively. You see what I have become? A one-woman chamber of commerce.**

Until Joseph Damiano, 34, joined Lockheed-Georgia Corporation in the Production Design department he had been associated with an aircraft factory in St. Louis. With a degree in journalism, his wife had worked her way up to Assistant Creative Director of Brown Shoe Company, had reached the top for women workers.

But now, happily situated in a handsome household, young Mrs. Damiano admits she was probably ready for domesticity. "I had had freedom for ten years of marriage. Bought all the special things I'd wanted. Now I'll be satisfied with this the rest of my life. Someday, I'm going to get a law degree, but that's another story."

For example, Mrs. Damiano answered her husband's plaintive request for a cherry pie by baking him five pies, including an apple, two pumpkins and a mincemeat tart.

**"By Monday morning they were gone. Everybody in the world seemed to drop in after the Georgia Tech game Saturday night. That's what I mean. We're in everything!"**

*If yours is an engineering or scientific family, join the swing in Atlanta. Write Lockheed-Georgia Company, 834 West Peachtree, Atlanta 8, Georgia, an equal opportunity employer.*

# LETTERS

## NASA Critic

Congratulations on your editorial on NASA in the Aug. 26 issue (p. 21). It aroused both my sensibilities as a believer in free enterprise and my sensitivities as a taxpayer. There can be little doubt that the earliest fears of the skeptics are being realized; for NASA is fast becoming a vast WPA project. The situation is particularly deplorable because the manned space program is vital to our country.

I am confident that a poll of industry would confirm my belief that not only is NASA duplicating facilities and capabilities currently existent in industry and other government agencies, but there has been a strong tendency for each center to have its own complete facilities, particularly in the electronics area. This felony is further compounded by the vast number of small projects taking place in parallel at each center.

There appear to be far too many of these self-education programs. Their strong insistence on the retention of systems and equipment design responsibility may well be a result of an inability to specify requirements or even realize that these problems have been previously solved. The "Not Invented Here" complex is rampant and will undoubtedly be the theme song of the proposed Electronic Center.

It is encouraging that a responsible organization such as the U.S. Chamber of Commerce has looked into this situation. Even their gross assessment has shown that people cannot be added or money spent at the proposed rate without tremendous waste. Although Messrs. Webb, Dryden and Seamans evaluate and select contractors on all programs with a value in excess of $5 million, it is apparent that very little control is exercised over the hundreds of smaller programs being conducted in-house.

I submit that this wholesale proliferation has brought NASA to the point where responsibilities are broken down to the very brink of irresponsibility—where individuals are engaged in their own private projects having only vague connection with the overall program and none with each other. In geometry these were called tangents. As a result, each has more money than it can intelligently spend even if it is only a dollar.

It is time that our citizenry recognized this socialistic monster for what it really is because we can ill-afford to be second best in the space race.

(Name Withheld by Request)
New Hartford, N. Y.

## 'Argosy Error'

Regarding "Argosy Error" (AW Oct. 21, p. 106): For the record, Hawker Siddeley make the Argosy, irrespective of the payload carried, not Avro Siddeley.

ALEXANDER F. JOHNSTON
Public Relations Manager
Hawker Siddeley Group, Ltd.
Publicity Dept.
London, England

***Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.***

## Dulles Lounge

As the Customer Services Supervisor for Eastern Air Lines, stationed at the new Dulles International Airport, I would like to take issue with the article written by Mr. Robert H. Cook (AW Aug. 26, p. 40) on Major U.S. Airports (Part 8) entitled "Dulles Faces Struggle to Prove Design."

I agree with Mr. Cook in that Dulles will prove its superiority in time. However, I do not agree with the last paragraph in the article where Mr. Cook singles out Eastern's lounge operation by name as the airline creating the impression that the lounge operation does not function properly.

If Mr. Cook had extended an Eastern representative the privilege of discussing its lounge operation with him on his visit to Dulles, he would have learned the following facts:

If you have not ridden Eastern during the past year you would not know that Eastern has something new. Eastern has made every effort to improve its service to the public. Two of these improvements have a great effect on the lounge operation and, as you will see, could not delay the lounge in its operation.

One is that passengers cannot get to their destination setting on the ground so all flights have been scheduled to a minimum of ground time. Two, all stations have been given a minimum time of one minute to have the passengers step in place at the plane. Too long, this was a passenger complaint.

All of Eastern flights at Dulles are through flights with 30 min. or less ground time, thus a planned operation is necessary.

Upon the arrival of a DC-8 on the ramp the lounge is waiting across the taxi way for the plane to stop. Stopped, the two outboard engines are shut down, the third engine is then shut down. Now the fourth engine is left running to supply power to the plane until the external power unit is attached and the nose wheel has been chocked.

By the time this operation has been accomplished the passage steps have been put into place. The lounge cannot approach the plane until all engines have been shut down and the nose wheel chocked. Thus, the lounge was not forced to wait before mating.

With the steps in place the ramp agent has gone up and opened the plane door and turned back against the side of the plane. The mobile lounge driver is now free to walk out of his cab half way of the lounge loading ramp and put it into place at the plane's door and the passengers walk off without any delay. The carrier not using the steps has to wait until the lounge driver walks the full length of the lounge loading ramp and opens the door and turns it back against the plane and then returns to his controls on the lounge loading ramp to make final adjustment, causing the passenger to wait.

On through flights with minimum ground time our fueling operation, due to high volume, must be started as soon as possible after arrival. At about the same time the mobile lounge arrives at the plane the gas trucks are pulled into place. There is a Civil Air Regulation as well as an airport rule that no flight will be refueled when passengers are on board without steps in place.

Our refueling operation starts as soon as possible after the plane has been parked and while passengers are deplaning, and as the lounge moves away, we still have through passengers on board. The steps must be in place in order for Eastern to comply with these rules.

At no time is the mobile lounge driver free to move on his own nor does he act on the progress of our ground handling. He is controlled by a mobile lounge dispatcher and does not move until he receives clearance. If the dispatcher should be busy talking to another lounge driver, our driver would have to wait until he gets the okay to move into place. This could create the impression he was waiting on our actions.

There are nine carriers operating into Dulles at present; only four of these carriers are not mating over the standard stairs. All four of these carriers have flights that terminate or originate. With an operation of this type they have sufficient ground time to allow for holding off on refueling and the relocation of ground equipment.

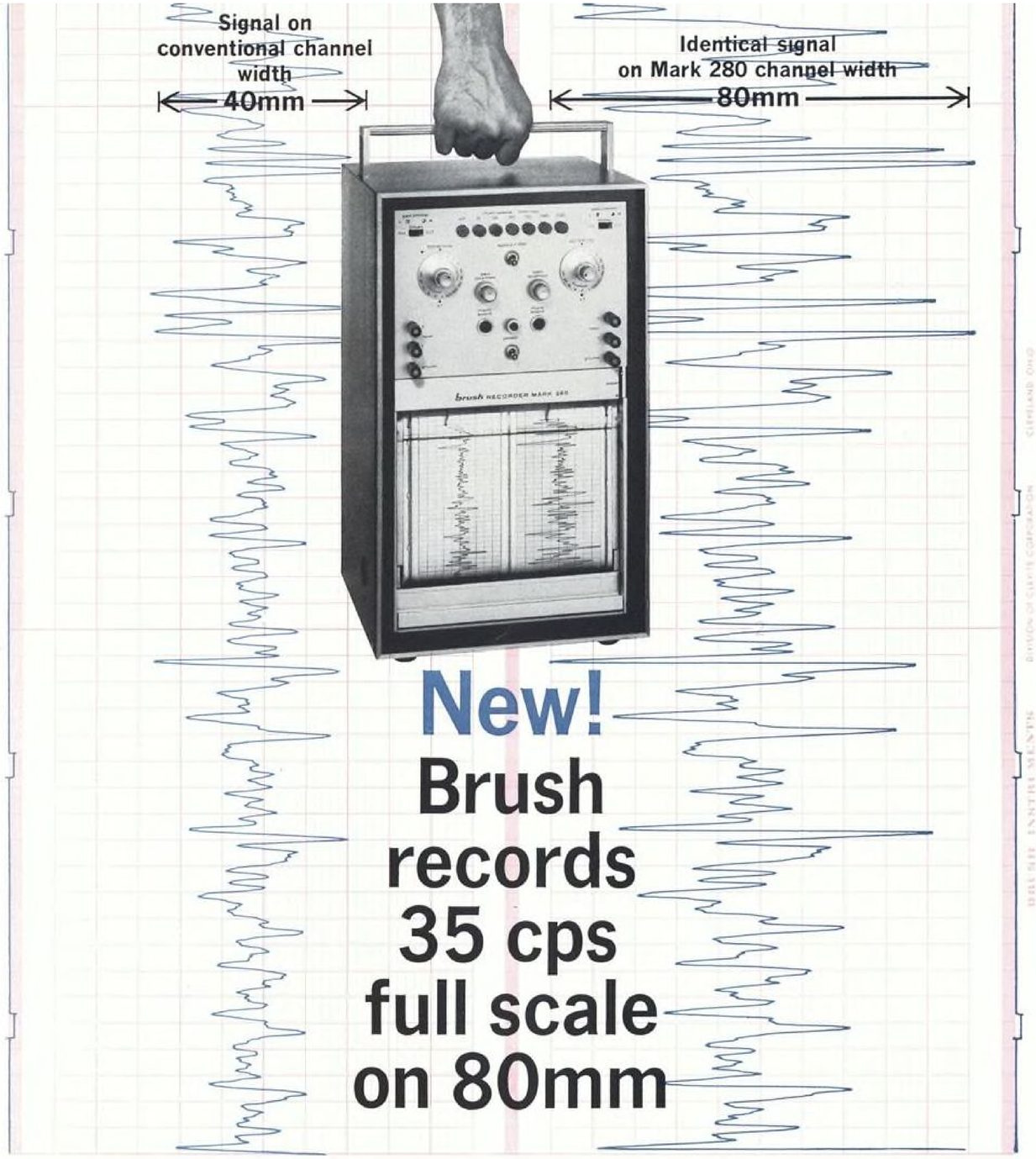
Through Eastern's efforts to make the mobile lounge a success, to date we have not had a view of public opinion expressed on a complaint that we could not explain or satisfy.

We at Eastern feel very strongly in regard to the reflection cast on Eastern in this article, and request that the record should be set straight.

R. L. KENDRICK, Supervisor
Customer Services
Eastern Air Lines
Dulles International Airport

*(The primary purpose of the entire airport series was to evaluate airport facilities from the viewpoint of passenger convenience. Since the mobile lounge concept at Dulles has been criticized by the industry in the past, it would have been unfair to ignore passenger reactions to the method of ground handling employed by Eastern. While Mr. Kendrick's letter explains the necessity for this method, passengers are nonetheless left with the impression that something is wrong with the lounge operation, or else it would not be required to mate with the aircraft after standard ramp stairs are first positioned. Federal Aviation Agency admits that four trunk carriers now use the same system, but maintains that this casts an unfair reflection on the lounge operation and is employed by the airlines to cut ground handling time.—Ed.)*




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(Illustrated: The Fairchild Series 500)

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