Aviation Week & Space Technology

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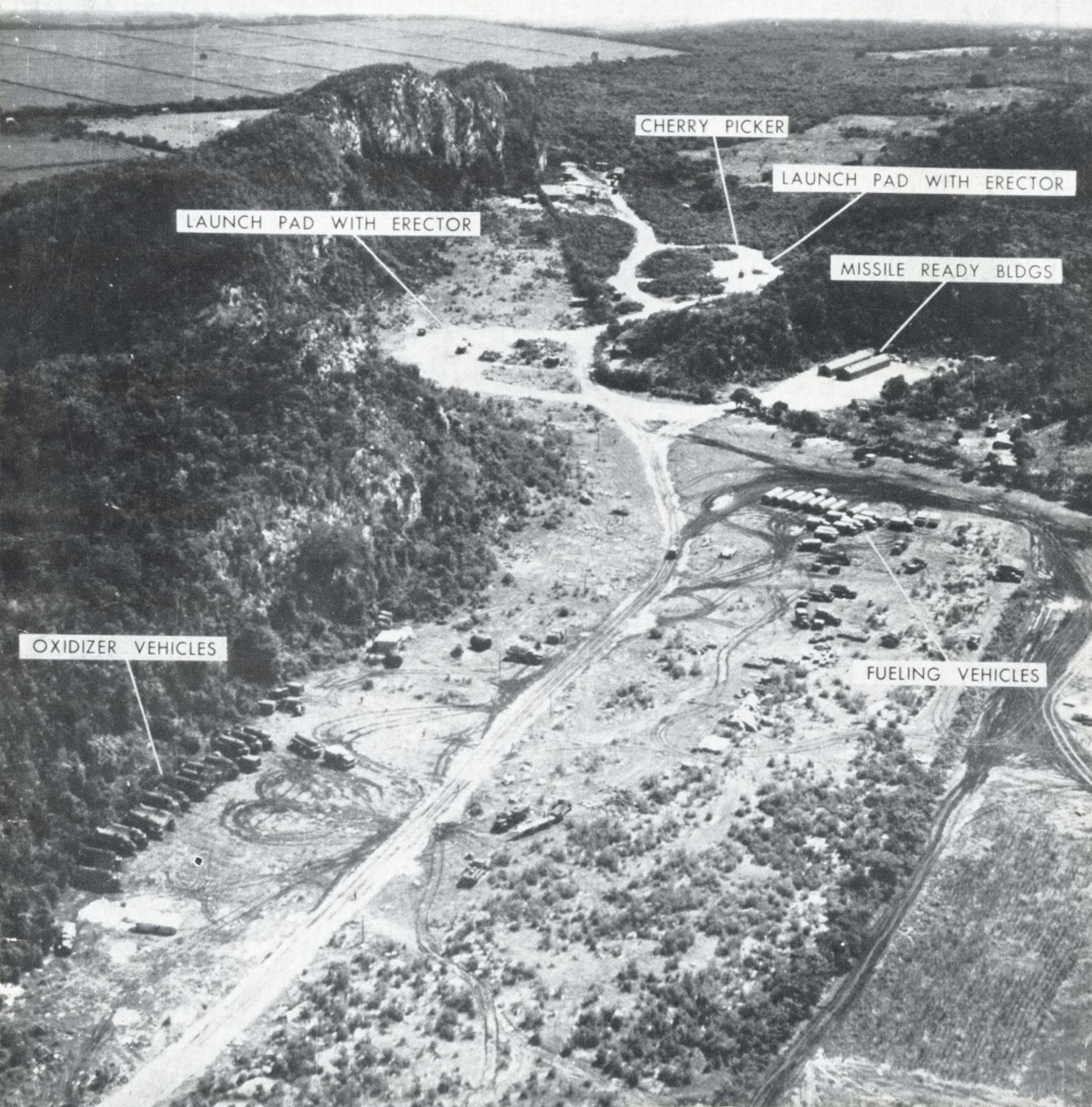
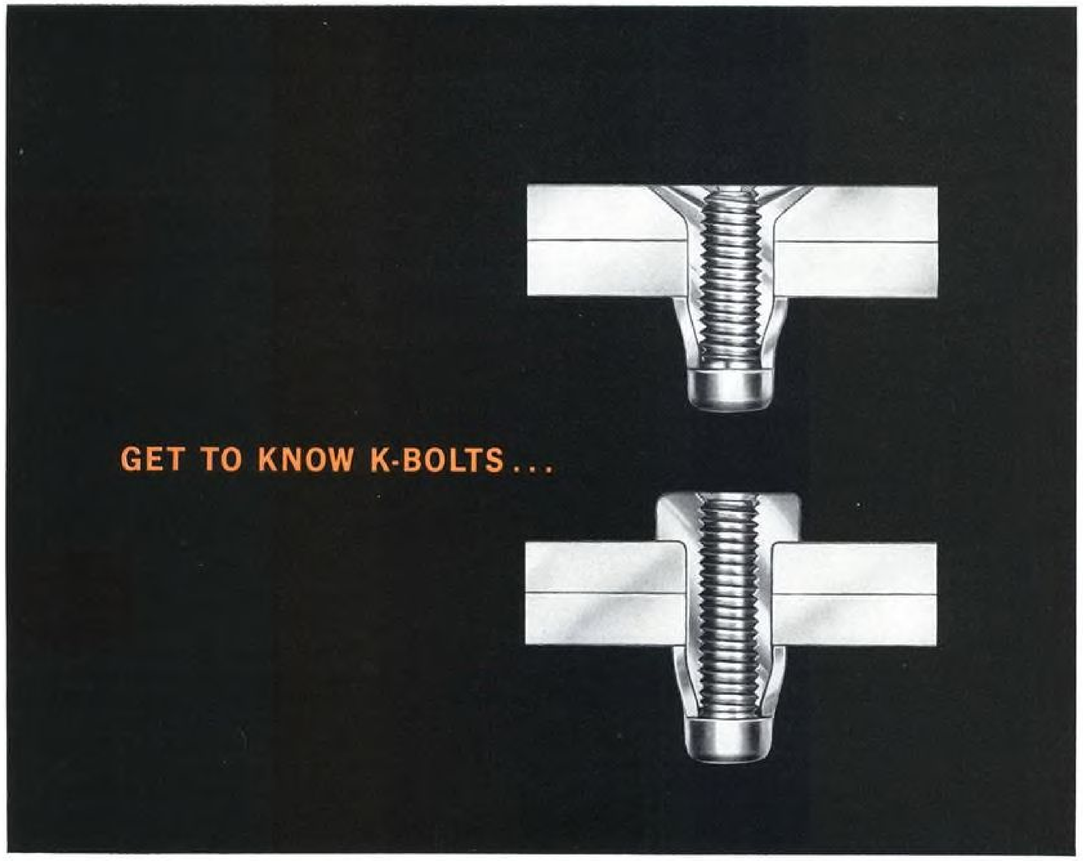
A McGraw-Hill Publication

November 5, 1962

Avionic System Integrated For A2F Mission

Cuban MRBM Site





K-BOLT the blind fastener with Kaylock® reliability

Get to know K-Bolts—the bright new addition to Kaylock's already broad line of quality fasteners for the aerospace industries. Designed for structural applications, K-Bolt single-unit assemblies are easily installed from one side of the work surface, using existing crib stock tools. They reduce assembly time and costs, overcome limited-access problems. With traditional Kaylock reliability, K-Bolt clamp-up characteristics provide high resistance to vibration and fatigue—exceed existing specifications for tensile and shear strength. K-Bolts conform to proposed NAS specifications and are available with hex or flush heads, in nominal shank diameters of 5/32 to 3/8 inch. Write today for Bulletin 2622.

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first in all-metal self-locking fasteners

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This new titanium wheel will outlast ordinary aircraft wheels at least 5 to 1

This revolutionary titanium wheel by Goodyear is the most durable ever built. To date, it has rolled up a service life of over 14,000 miles in tortuous dynamometer tests—and it's still going strong. This compares with 2000 to 3000 miles of roll-life for ordinary aircraft wheels. • And the new wheel has other advantages: **1.** High strength-to-weight ratio cuts many pounds off high-performance military aircraft. **2.** Permits thinner wheel sections — allows more space for brake assemblies. Can be made 15-20% lighter than today's air-transport wheels. **3.** Increases safety factors. **4.** Low thermal conductivity helps tires run cooler. **5.** Exceptional anticorrosion properties eliminate the need for painting, make inspections easier and cut maintenance costs. • If you'd like to know more about this aircraft wheel—or other new products for the aerospace age from the largest, most experienced engineering staff in the business—write Goodyear, Aviation Products, Dept. W-1715, Akron 16, Ohio.

GOODYEAR
AVIATION PRODUCTS

JIM LING KNOWS GROWTH FIRST HAND

Guiding corporate growth is a way of life for Jim Ling, Chairman of the Ling-Temco-Vought Executive Committee. His wide experience has been brought to bear in financial matters, policy-making that led to streamlining a complex company, and long-range planning that is keyed to increasing the importance of Ling-Temco-Vought as a partner in our country's space and defense efforts. Rapid progress at LTV stems from the company's ability to utilize the talents of a unique management team. Already the LTV depth management team has proved its ability to guide such important programs as Scout, V/STOL, Crusader and others. Under the guidance of these men, the company has made significant investments in research, development and production facilities, and in company-funded studies that have earned LTV the reputation of having the answers when the questions are asked. This kind of management . . . and this kind of investment in the future, coupled with proved technical competence in aerospace, electronics, communications and consumer products, are the reasons why Ling-Temco-Vought will continue to grow as it keeps pace with our country's needs.

LING-TEMCO-VOUGHT, INC. LTV DALLAS, TEXAS

AEROSPACE CALENDAR

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

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

Nov. 12-15—Eighth Annual Conference on Magnetism and Magnetic Materials, Institute of Radio Engineers, Penn-Sheraton Hotel, Pittsburgh, Pa.

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

Nov. 13-14—U. S. Army, NSIA Training Conference, Fort Bliss, Tex.

Nov. 13-15—National Symposium: Materials Compatibility and Contamination Control Processes, Society of Aerospace Material and Process Engineers, Hollywood-Roosevelt Hotel, Hollywood, Calif.

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

Nov. 14-16—17th Annual Meeting Armed Forces Chemical Assn., Statler-Hilton Hotel, Washington, D. C. Host: U. S. Navy.

Nov. 15-16—Seventh Symposium, Welded Electronic Packaging Assn., Thunderbird Motel, Los Angeles, Calif.

Nov. 16-17—Second Canadian Institute of Radio Engineers Symposium on Communications, Queen Elizabeth Hotel, Montreal, Canada.

(Continued on page 7)

AVIATION WEEK and Space Technology

November 5, 1962

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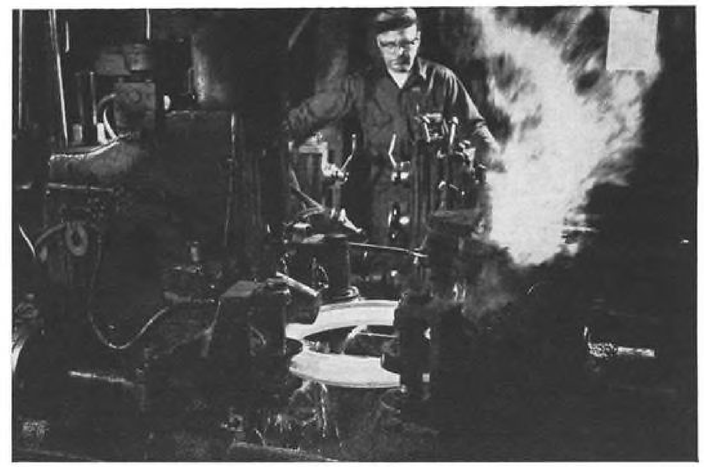

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Edgewater rolls each ring from one solid block of carefully selected steel. Rolling creates dense grain structure, develops flow lines in the metal that strengthen the ring for high unit loading, for exceptional resistance to stress.

Diameters: 5″–145″. Wide variety of shapes including ribs, flanges, grooves, conical and tapered surfaces, and others.

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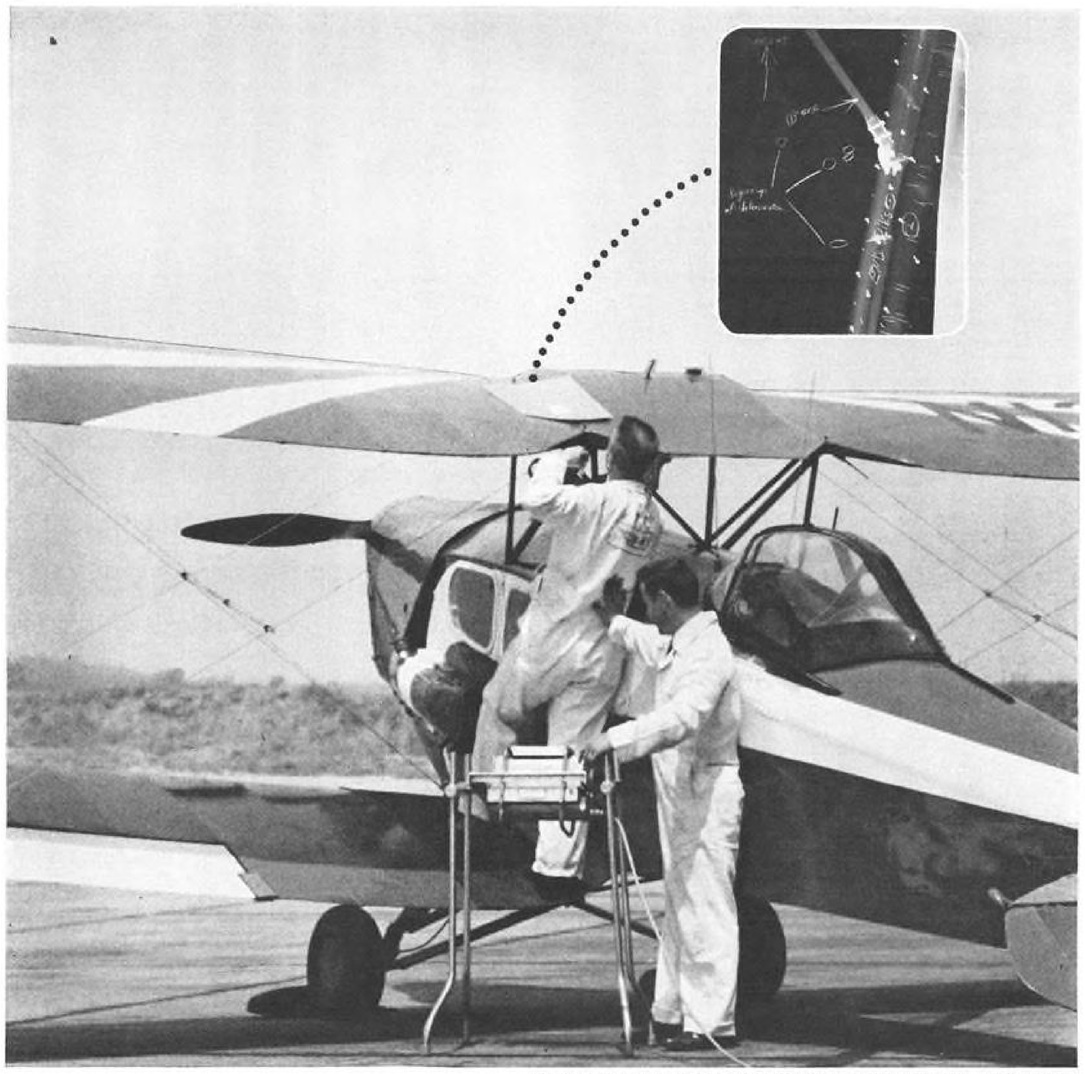

1932 DeHavilland 83 Fox Moth owned by Kenneth Horton was recently X-rayed by Lockheed Air Service team at Westchester, N.Y.

Can your present X-ray film detect fabric deterioration?

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X-RAY FILM
CHEMICALS
SERVICE

AEROSPACE CALENDAR

(*Continued from page 5*)

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

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

Nov. 26-29—Annual Coordinated Meetings: American Nuclear Society, Atomic Industrial Forum, and joint AtomFair, Sheraton-Park and Shoreham Hotels, Washington, D. C.

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

Nov. 27-29—Fall Meeting, Radio Technical Commission for Aeronautics, Marriott Motor Hotel, Washington, D. C.

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

Dec. 4-6—Fall Joint Computer Conference, Sheraton Hotel, Philadelphia, Pa. Sponsors: American Federation of Information Processing Societies; IRE.

Dec. 4-6—1962 Convention, National Aviation Trades Assn., Fabulous Flamingo, Las Vegas, Nev.

Dec. 6-7—Vehicular Communications Conference, IRE, Disneyland Motel, Los Angeles.

Dec. 10-11—First Annual Symposium on Unconventional Inertial Sensors (classified), Republic's Paul Moore Research & Development Center, Farmingdale, N. Y. Co-sponsors: Bureau of Naval Weapons; Republic Aviation Corp.

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

Dec. 26-31—Space Physics Meeting, American Rocket Society and American Assn. for Advancement of Science, Philadelphia, Pa.

Dec. 27—American Astronautical Society Symposium on Scientific Satellites-Mission and Design, Franklin Hall, Philadelphia, Pa.

Jan. 7-10—Millimeter and Submillimeter Conference, Institute of Radio Engineers, Cherry Plaza Hotel, Orlando, Fla.

Jan. 13-16—15th Annual Convention, Helicopter Assn. of America, Cabana Motor Hotel, Palo Alto, Calif.

Jan. 14-18—Automotive Engineering Congress and Exposition, Society of Automotive Engineers, Cobo Hall, Detroit, Mich.

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

Jan. 21-24—43rd Annual Meeting, American Meteorological Society, New York, N. Y.

Jan. 22-24—Ninth National Symposium on Reliability and Quality Control, Sheraton-Palace Hotel, San Francisco, Calif.

Jan. 30-Feb. 1—Fourth Annual Solid Propellant Rocket Conference, American Rocket Society, Bellevue Stratford Hotel and also The Franklin Institute, Philadelphia.

Jan. 30-Feb. 1—National Winter Convention on Military Electronics, Institute of Radio Engineers, Ambassador Hotel, Los Angeles, Calif.

(*Continued on page 9*)

CARE AND FEEDING OF MISFIT BITS

(Or: Down to bedrock with EDP)

"Data," quoth one of our intrepid R&D Engineers in a moment of bemused relaxation, "are too often treated like a woman's foot!"

"The object," he elaborated, "seems to be to squeeze it into the smallest shoe available. It's axiomatic, of course, that *feet don't fit shoes. Vice versa. And data . . .*"—well, you know the rest.

Which is another way of saying that trying to solve a specialized data processing problem with a "standard" system will usually get you bunions . . . and a lot of wasted time and money. We frankly prefer to start with the data itself . . . and an unfettered mind. We've been doing it for something over 20 years, and you would find the results most interesting.*

Take, for instance, the Radar Data Processor we developed and produced for the 433-L Weather Observing and Forecasting Program. One big objective of this program is to generate composite radar displays of large storm systems. The idea is to get cloud intensity and height data from a hundred or so weather radar sets across the nation, and combine all this information at a single processing center.

Foregoing a treatise on the problems, let it suffice to say that a size 9 brown oxford data processor out of a box was "no fit" for the job. The unit as we produced it accepts the quantized grey levels of radar echoes from clouds . . . eliminates interference effects from practical consideration . . . and encodes the data in 7 intensity and 6 height levels. For each 5 by 5 nautical square mile area, maximum cloud intensity and the height of the highest cloud are stored in a magnetic core memory.

The radar unfortunately supplies its information in a spherical coordinate system, so we had to convert it for storage in rectangular coordinates, for ease of display. Conversion is accomplished with some interesting (see previous footnote) analog computation techniques. On command, stored data are transmitted either to a local display printer, or over phone lines to the central control station, or both.

There are also facilities for inserting code into outgoing messages, alarms to signal certain weather conditions, and internal test equipment for checking system performance. And there's a Telecoder with some unique capabilities that can be adapted for use wherever information on printed or punched tape has to be converted for serial transmission or readout. (If this is up your alley, write for Data Sheet 6-106.)

We'll gladly tell you more about what we've done, but we'd much rather talk about your current problem in converting data into "hard copy," telephone line signals or visual displays . . . or in developing specialized data handling systems or computer control centers. When can we get together? Data Processing and Display Systems Dept., Budd Electronics, 43-22 Queens St., Long Island City 1, New York.

*Term commonly used by R&D men in referring to their own accomplishments. Meaning: "Remarkably ingenious; nothing else quite like it."

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RF Systems • Earth Sciences
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EEMCo

MAKES MUSCLES FOR F-104G

The leading and trailing edge slats for the Lockheed F-104G, actuated by Eemco systems, were originally used for landing and takeoff only. When they were used for maneuvering as well, stresses increased sharply. To protect the structure from overstresses, Eemco designed a mechanical disconnect that automatically disengages the motor from the driving actuator above preset loads; protects over heating of the motor clutch. An additional feature: if one motor of a leading or trailing edge set fails, the other automatically takes over and drives both actuators. For the F-104G, Eemco delivers optimum muscle, instantly, precisely as required.

At Eemco, more than 4,000 different custom actuators, motors, and starter generators have been manufactured in the last 20 years. If you would like custom muscles for your aircraft, missile or space system, please write to Dept. CCC.

D-1227 Actuating System—Leading Edge Slat

Type: Limited travel electromechanical linear actuator, mechanically synchronized.
Operating Loads:
Normal operating: 6000 lbs. tension
6000 lbs. compression
In-flight maneuvering: 8000 lbs. tension
8000 lbs. compression
Max. Operating: 12,000 lbs. tension
12,000 lbs. compression
Operating Stroke: 3.15 inches
Operating Speed: 11 seconds max. at 200 volts 480 C.P.S. AC. with normal load applied.
Static Non-Operating: 16,000 lbs. tension
16,000 lbs. compression
(Safety factor on above 1.5)
Operating life: 10,000 cycles at maneuvering load
200 cycles at max. operating load
1000 mechanical disconnect loads
Voltage requirements: 190-210 volts, 320-480 CPS, 3 phase AC.
Current Requirements: 4.6 amp/phase max. at max. operating load.
Limit Switches: Retract limit, mid-position indicator and extend limit—must repeat within .001 inch, 24 to 31 volts DC.
Mechanical Stops: Positive, non-jamming.
Brake: Operates on 24 to 31 volts DC.
Mechanical disconnect: Must mechanically disconnect motor from driving actuator at a pre-set load and withstand 1/2 min. of continued motor operation while disengaged.
One Motor operation: With only one motor operative, the system must function by driving both actuators thru a mechanical interlock with the normal load applied to both actuators.

D-1228 Actuating System—Trailing Edge Flap

Type: Limited travel electromechanical rotary actuator
Operating Loads:
Normal Operating: 0 to 26,000 pound-inches—torque increasing linearly from 0 to 45° travel.
Landing load: 0 to 38,000 pound-inches—torque increasing linearly from 0 to 45° travel.
In-flight maneuvering: 0 to 33,000 pound-inches torque increasing linearly from 0 to 15°.
Max. Operating: 0 to 46,000 pound-inches torque increasing linearly from 0 to 45°.
Operating Stroke: 45° between limit switches
52° between mechanical stops
Operating speed: 13.5 sec. max. at 200 volts—480 CPS with normal operating load applied.
Static, non-operating load: 50,000 pound-inches torque
(Safety factor on above 1.5)
Operating Life: 5000 cycles at landing load.
5000 cycles at maneuvering load.
50 cycles at max. load.
1000 mechanical disconnect loads
Voltage Requirements: 190-210 volts, 320-480 CPS, 3 phase A.C.
Current Requirements: 4.6 amp/phase max. at max. operating load.
Limit Switches: Retract limit, 15° position indicator, and extend limit—must repeat within .001—24 to 31 volts D.C.
Brake: Operates on 24 to 31 volts D.C.

ELECTRONIC SPECIALTY CO., Eemco Division • 4612 West Jefferson Boulevard, Los Angeles 16, California • REpublic 3-0151

AEROSPACE CALENDAR

(Continued from page 7)

Feb. 5-6—Symposium on Engineering for Major Scientific Programs, Georgia Institute of Technology, Atlanta, Ga.

Feb. 11-15—Third International Symposium on Quantum Electronics, UNESCO Building, Paris, France. Sponsors: International Scientific Radio Union; Office of Naval Research; La Federation Nationale Des Industries Electroniques.

Feb. 20-22—1963 International Solid-State Circuits Conference, Philadelphia, Pa. Sponsors: Institute of Radio Engineers; American Institute of Electrical Engineers; University of Pennsylvania.

Mar. 7-8—Propulsion Meeting, Institute of the Aerospace Sciences, Cleveland, Ohio.

Mar. 11-13—Electric Propulsion Conference, American Rocket Society, Colorado Springs, Colo.

Mar. 18-20—Space Flight Testing Conference, American Rocket Society and Institute of the Aerospace Sciences, Cocoa Beach, Fla.

Mar. 19-21—Second Air Force-sponsored Symposium on Bionics, Biltmore Hotel, Dayton, Ohio.

Mar. 25-28—International Convention, Institute of Radio Engineers, Waldorf-Astoria and Coliseum, New York, N. Y.

Apr. 1-3—Fourth Annual Structures and Materials Conference, American Rocket Society and Institute of the Aerospace Sciences, El Mirador Hotel, Palm Springs, Calif.

Apr. 2-5—Spring Conference, Airport Operators Council, Shoreham Hotel, Washington, D. C.

Apr. 10-11—Fourth Symposium on Engineering Aspects of Magnetohydrodynamics, University of California, Berkeley, Calif.

Apr. 17-19—International Nonlinear Magnetics Conference, Shoreham Hotel, Washington, D. C. Sponsors: American Institute of Electrical Engineers; IRE.

Apr. 17-19—Southwestern Conference and Electronic Show, Institute of Radio Engineers, Dallas Memorial Auditorium, Dallas, Tex.

Apr. 17-19—Technical Meeting: Nuclear Materials for Space Applications, American Nuclear Society, Netherland Hilton Hotel, Cincinnati, Ohio.

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

May 7-9—Electronic Components Conference, Institute of Radio Engineers, Marriott Twin Bridges Motel, Washington, D. C.

May 13-15—National Aerospace Electronics Conference, Institute of Radio Engineers, Dayton, Ohio.

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

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

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

June 6-16—25th French International Air Show, Le Bourget, Paris, France.

WESTON AEROSPACE INSTRUMENTS . . .
PROVED RELIABLE IN ORBIT

Flying by wire imposes rigid reliability demands on aerospace instruments. Weston Aerospace Instruments for the Mercury Capsule have lived up to this requirement. These lightweight, low-current indicators are backed by unique engineering and manufacturing experience dating from the original ILS instrumentation, and by a traditional reputation for accuracy and reliability.

Weston has applied this unusual design and production experience in a number of advanced space projects:

Mercury — More than a third of the Spacecraft's analog indicators were supplied by Weston for measurement of 14 variables: fuel, coolant and oxygen supply, cabin and suit environment, A-C and D-C functions.

Gemini — As a result of the proven reliability of Weston instrumentation in Mercury, Weston dual indicators have been selected to monitor similar variables for Gemini.

Other projects — Weston instruments . . . proved in orbital flight, will accompany astronauts in future manned space probes. Experienced Weston engineers can design and supply instrumentation to meet your most rigid requirements. Write for our aerospace capabilities brochure. Dept 88.

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BENDIX

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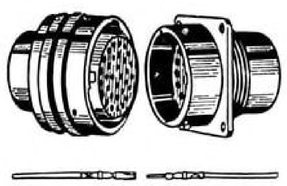

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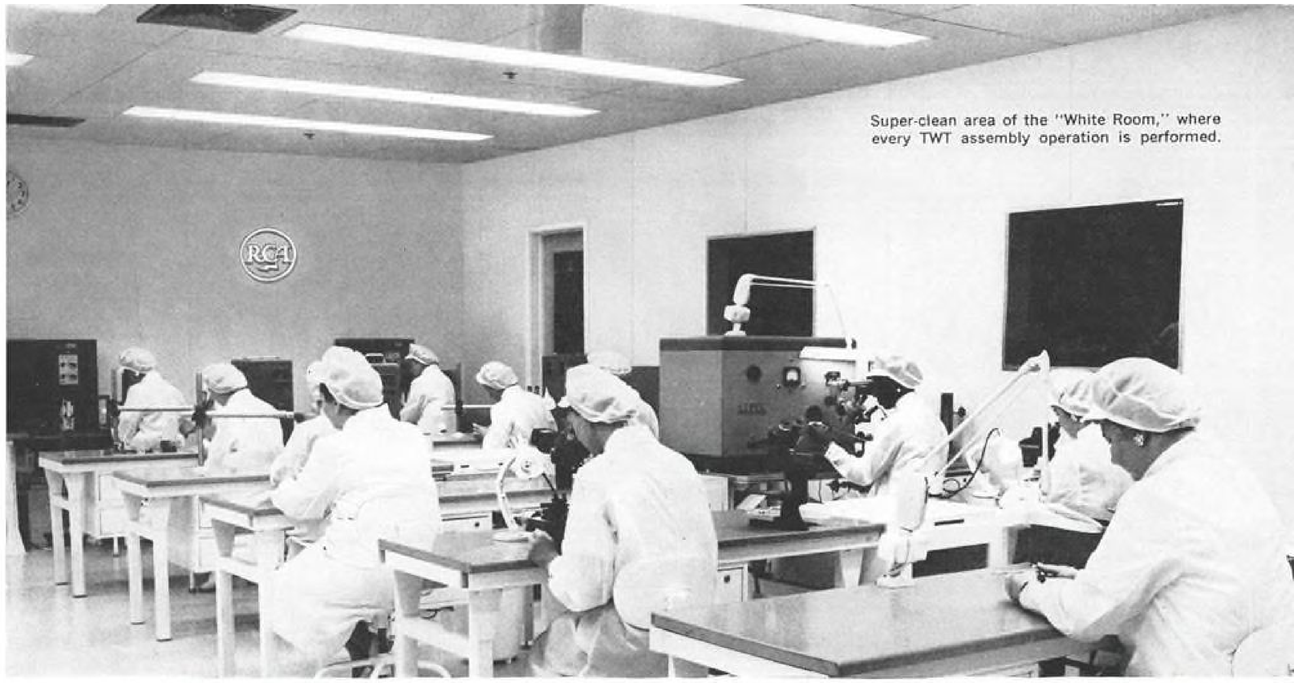
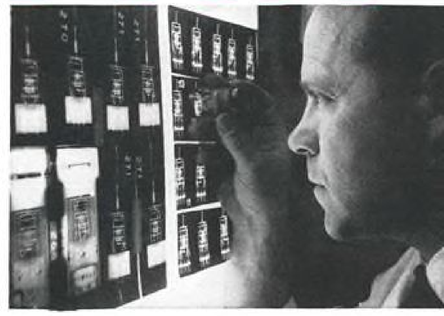


Super-clean area of the "White Room," where every TWT assembly operation is performed.

OPERATION TWT

Automatic magnetization and stabilization eliminate operator variability, ensuring required field characteristics.

All helices are inspected to a tolerance of ± 2 microns on a Helix Pitch Error Resolver.



X-ray techniques are used for control of critical sub-assembly spacing and tolerance.

RCA'S MODERN PRODUCTION CAPABILITY SUPPORTS THE ADVANCE OF TRAVELING-WAVE TUBE TECHNOLOGY

Reliability and tube-to-tube uniformity in Traveling-Wave Tubes depend on skillful engineering design and modern production techniques. RCA has both. Backed by development at the David Sarnoff Research Center, RCA produces a variety of Traveling Wave Tube types for a wide range of frequencies. Assembly work is done in a "white room", under controlled conditions of temperature and humidity. Even air is filtered to limit dust particle size to .3 micron!

Many RCA Traveling-Wave Tubes produced in the "white room" were developed on contract for important industrial and defense projects. Tubes are subject to four levels of quality control. No wonder that there are reports of many tubes with 20,000 hours of service. It is no wonder, too, that RCA is the largest producer of TWTs for ECM applications.

If you have a problem in TWT research or development requiring the most recent concepts in TWT state-of-the-art; or require high production resources and capabilities, consult the leader in both areas—RCA.

For information, write: Manager, Microwave Marketing, RCA Electron Tube Division, Harrison, N.J.

A typical example of an RCA ruggedized TWT for ECM applications.

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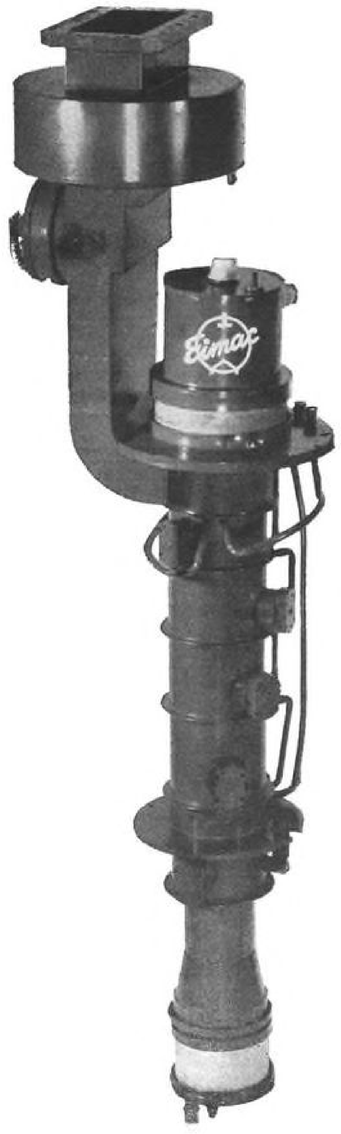
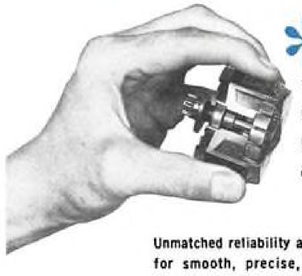


This one covers 165 mc in L-Band.

We just finished making this power klystron. (We're Eimac, of course.) It's our X832. And here's the objective data: **165 megacycles bandwidth (to 1 db) / 1217 to 1382 megacycles with no tuning / 10 megawatts peak / 10 kilowatts average power output / microperveance 7 results in full power operation at 114 kilovolts with 272 amperes peak / hollow beam, magnetron-injection gun.** The X832 L-Band Broad-Band Power Klystron is another example of the way Eimac meets tomorrow's tube needs today. Another reason to keep your eye on Eimac for high-power klystrons, advanced microwave tubes, power grid tubes, accessories. Eitel-McCullough, Incorporated, San Carlos, California. Subsidiaries: Eitel-McCullough, S.A., Geneva, Switzerland; and National Electronics, Geneva, Illinois. **KEEP YOUR EYE ON**

Eimac



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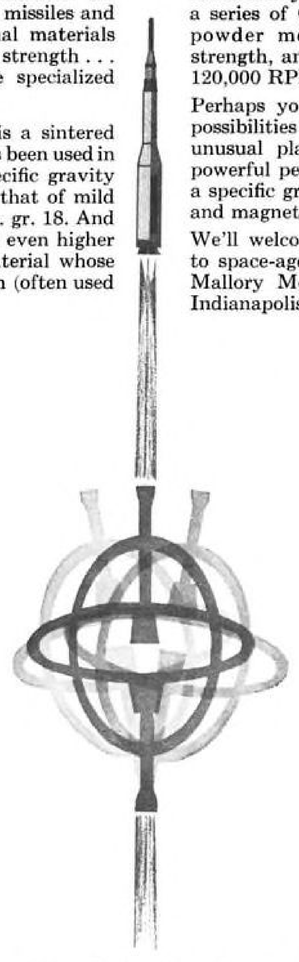

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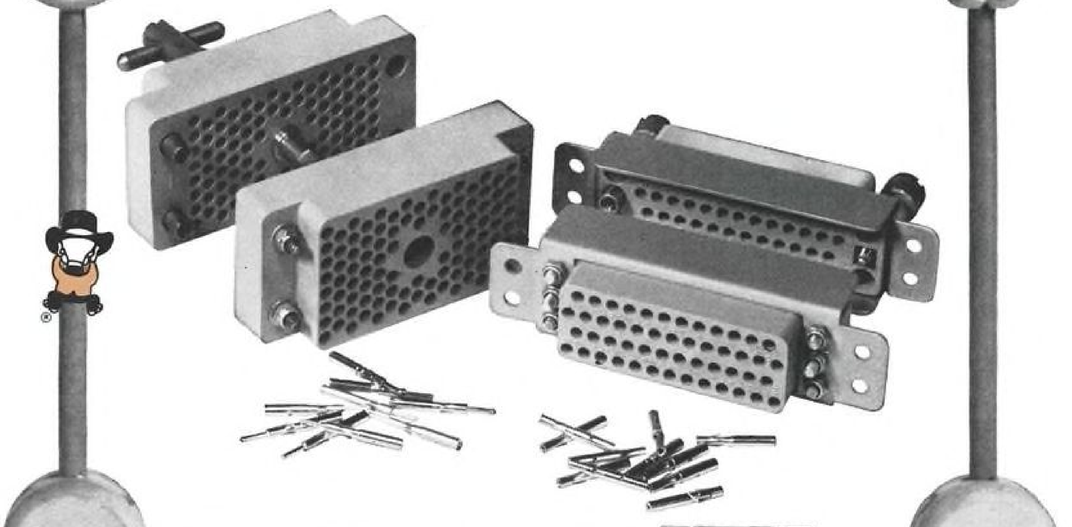

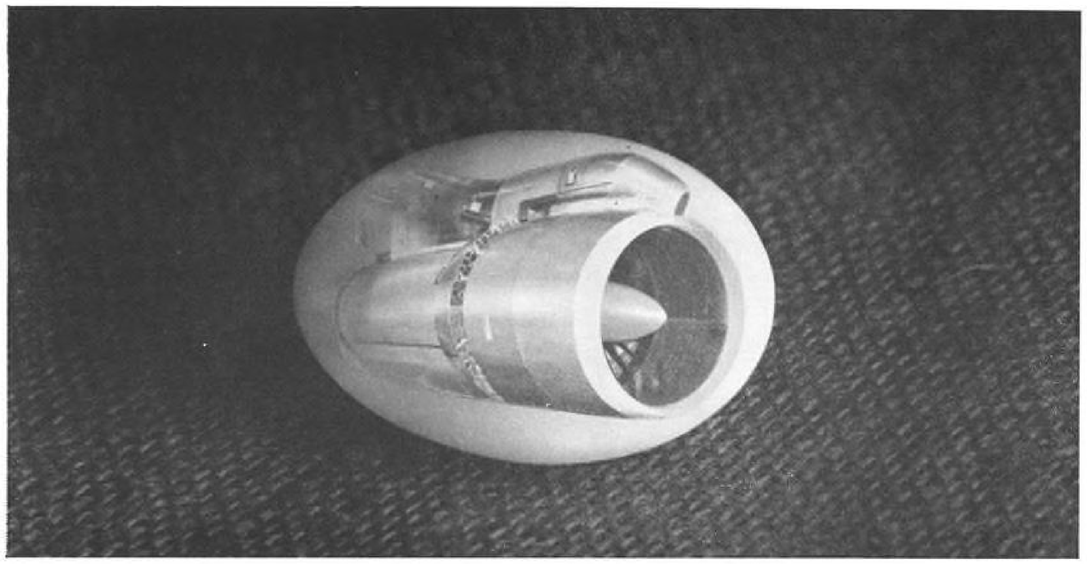

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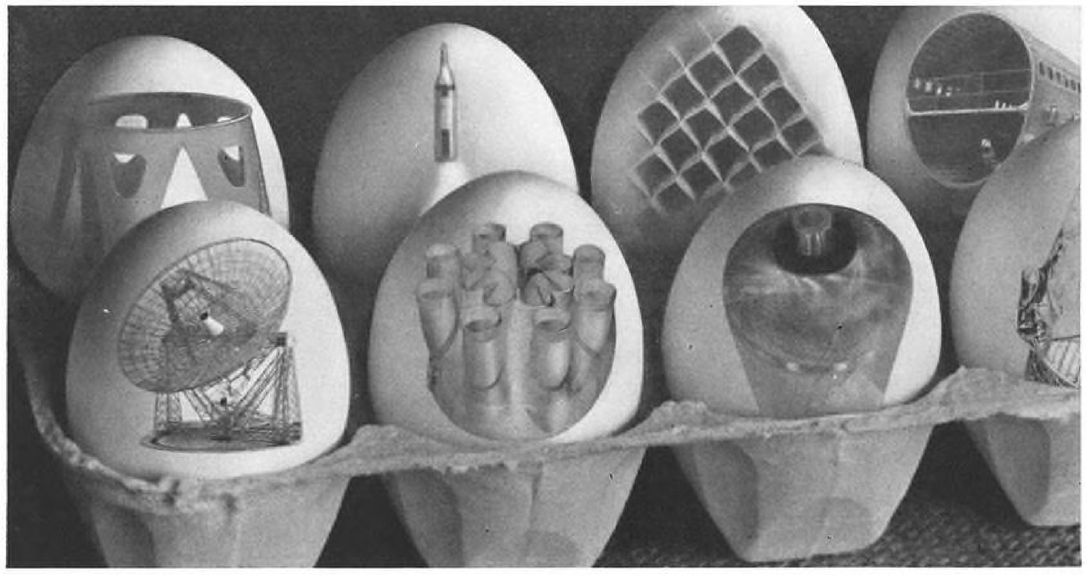

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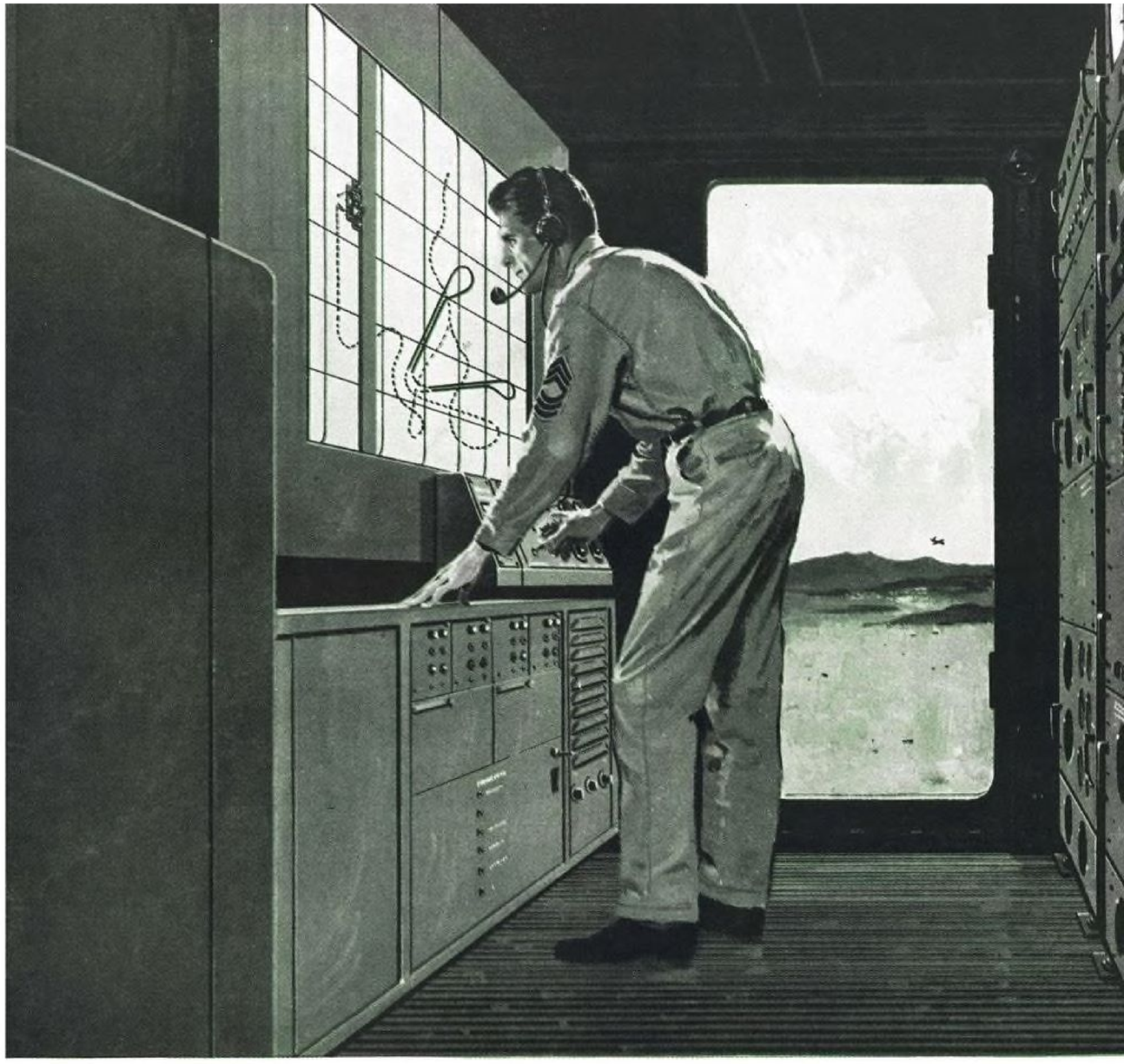

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Aviation Week & Space Technology

Volume 77
Number 19

November 5, 1962

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COVER: Soviet MRBM base at Sagua La Grande, Cuba, located about 150 mi. east of Havana near the northern coast, is shown in low level oblique aerial reconnaissance photo taken Oct. 23 by Navy F8U-1P photo-reconnaissance version of the Vought Crusader. Base is equipped with liquid-fueled Shyster missiles frequently shown in Moscow May Day parades (AW May 30, 1960, p. 94, Nov. 18, 1957, p. 26), and credited with range of 1,000 naut. mi. Launch pads contain missile erector, firing pan and cables to launch control blockhouse.

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EDITORIAL

The Sour Trumpet

Last week we noted on this page that the validity of this nation's position in the Cuban crisis was nearly destroyed by official stupidity in attempting to stop public release of the aerial reconnaissance pictures that proved beyond any shadow of doubt that Soviet ballistic missiles were being emplaced on Cuban sites and aimed at U. S. targets. In the ensuing week, it became apparent that this was just one small facet of a deliberate, barefaced attempt by a political administration to withhold facts and distort news that affect the life and fortunes of every American citizen.

The chief commissar in this newly-formed Ministry of Truth in the Kennedy Administration appears to be Arthur Sylvester, former Washington correspondent for the Newark Evening News who is now assistant secretary of defense for public affairs. We have watched a series of inept, amateur bureaucrats stumble through this job during the past decade, including R. Karl Honaman whose Prussian drill sergeant's philosophy quickly ended his Pentagon career; Robert Tripp Ross who tripped over his brother-in-law's pants in a conflict of interest case; and Murray Snyder who proved to be a blunt tool in executing Presidential Press Secretary James Hagerty's policies in the Eisenhower Administration. But none of these predecessors ever approached the lengths to which Arthur Sylvester has gone to use the Pentagon public information machinery to withhold and distort news of a vital matter beyond the requirements of legitimate military security. Sylvester, whose performance is being financed by taxpayers' dollars, finally shocked every form of communications media into bitter protest of his actions last week.

Two actions in which he blandly admitted his role as a controller of the news to fit political purposes, rather than as a dispenser of facts, were:

• **He issued a directive requiring** all Defense Dept. employes to report to his office by phone or written message the substance of any conversation they might have with a representative of any public media. Since the pile of administrative red tape this would create makes it clear Sylvester did not expect compliance, it is equally clear that this was simply bald intimidation of anyone who would challenge Sylvester as the sole source of the Defense Dept.'s distorted news of the Cuban crisis, even if military security was not involved.

• **He calmly maintained** that his use of censorship and distortion of the news was "justified" because it permitted the "Commander-in-Chief" to speak with a single voice and use news control beyond military security as "weaponry" in the cold war.

These statements by Sylvester evidently surprised many of the mass media executives who have not followed developments in the Pentagon too closely during the past two years. But they were no surprise to Air Force public relations officers who recently heard Sylvester tell them in a closed meeting at the Air Force Assn. convention in Las Vegas that their primary job was to see that credit was reflected on the Kennedy Administration. Nor were they a surprise to regular Pentagon reporters who watched a set of exclusive Cuban missile base photos appear in a weekly news magazine that also contained a story lauding Sylvester's performance as a Pentagon mouthpiece.

Sylvester's solo performance on the Pentagon's brass trumpet during the Cuban crisis has been so bumbling that even if his superiors approve his thought control policy, they can't afford his inept execution of it much longer. Sylvester's Pentagon briefings have been so poor that reporters found more accurate, perceptive and complete briefings on the military situation at the State Dept.

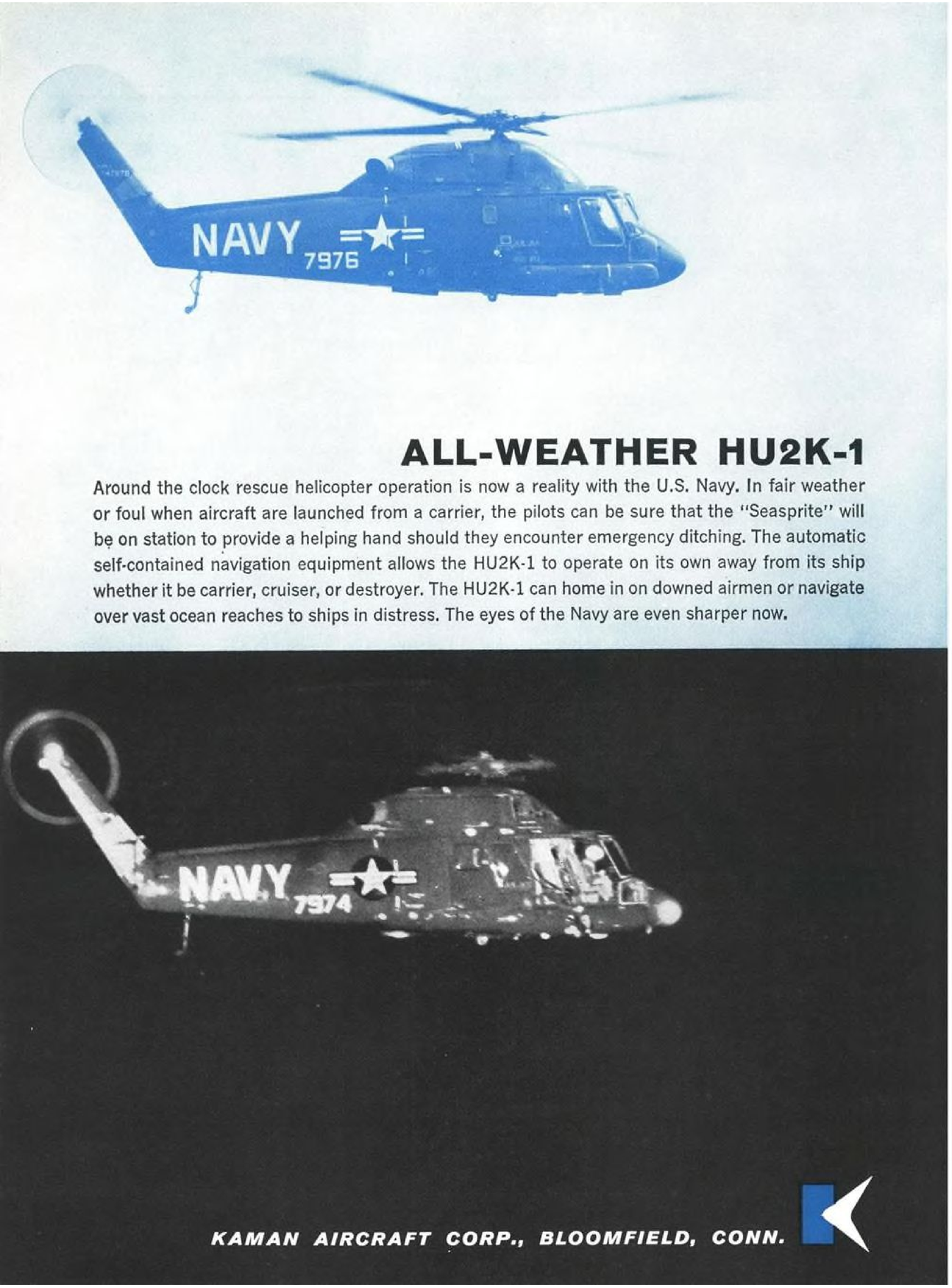
In a larger sense, Sylvester's failure has also been the failure of his boss, Defense Secretary Robert S. McNamara, to understand and handle competently a large and vital part of his role not only as custodian of a $50 billion annual bag of taxpayers' dollars, but also as the principal trustee of the defense and safety of these taxpayers and their families. The Pentagon can certainly benefit from more efficient accounting methods and inventory control, but it also must have a responsible leadership that discharges its full obligations to the American people to inform them of their dangers and their defenses. Messrs. McNamara and Sylvester have failed miserably in their first crucial test in this important role.

But the issues involved in Sylvester's practice of news control to achieve political goals go far beyond the spectacle of a novice trumpet player fumbling with the wrong valves and hitting a succession of sour notes. They strike at the fundamental nature of the American system of government and the validity of the image the American people and our allies abroad think we are fighting for. The basic freedom of American life in thoughts, politics and religion is its strongest attraction for those areas of the world where these freedoms are curtailed or denied. If we are now to allow the power of our own government to be used to suppress the basic elements of that freedom in this country, what a horrible future we have to face! What a dismal prospect we will present to our allies!

Every time we emphasize these freedoms, such as our open shots in the Mercury manned space program and in the admission of space failures, our international stature grows and the pressure increases against the Soviet system of suppression. If our responsible government officials are now striving to adopt the Soviet methods of political censorship, single-source thought control and manipulation of the news for political purposes, what a shabby image we will present abroad and how poorly has our leadership misinterpreted the solidarity of the reaction of the non-communist nations to our initial Cuban stand.

The White House and Pentagon were quick to remind the press of its responsibilities in their guidelines on legitimate military security items in the Cuban crisis. But both agencies were just as quick to forget their responsibility to see that the American people were fully and honestly informed of developments in that crisis within the bounds of military security.

—Robert Hotz



WHO'S WHERE

In the Front Office

A. V. Leslie, vice president-finance and treasurer, elected a director and named to the executive committee of Douglas Aircraft Co., Inc., Santa Monica, Calif. Also: **L. E. Tollefson,** executive assistant to the president, elected corporate secretary.

R. C. Sebold, elected a director of Cohu Electronics, Inc., San Diego, Calif. Formerly vice president-engineering of General Dynamics/Convair, Mr. Sebold now is a consultant to NASA (AW Apr. 30, p. 23).

W. M. McFarland, board chairman, Hazeltine Corp., Little Neck, N. Y., and **R. L. Beam,** president and chief executive officer.

John T. McGraw, executive vice president, Vard Division of Royal Industries, Inc., Pasadena, Calif.

Capt. Robert Adickes, president, Airmans Insurance Associates, Los Angeles, Calif. Capt. Adickes is also president of Aviation Consultants, Inc.

Joseph M. Walsh, a corporate vice president, Lear Siegler, Inc. Mr. Walsh continues as president of the Instrument Division, Grand Rapids, Mich.

Vice President Robert L. Olson, head of the newly established Systems Division of Autonetics, a division of North American Aviation, Inc., Anaheim, Calif.

Col. Norair M. Lulejian (USAF, ret.), a member of the advanced planning staff of United Aircraft Corp., East Hartford, Conn., and assistant to the vice president and chief scientist, Perry W. Pratt. Col. Lulejian retired from the Air Force as deputy for technology in the Air Force Systems Command's Space Systems Division.

Vice President Richard Derus succeeds **Dr. David D. Cherry** as general manager of Alto Scientific Co., Inc., Palo Alto, Calif. Dr. Cherry, a founder of the company, is returning to Stanford University for advanced studies but will continue as an Alto director and a technical consultant.

Thomas P. Hudock, vice president-finance and administration, Cook Electric Co., Chicago, Ill.

Glenn A. Walters, vice president-product research, Cubic Corp., San Diego, Calif.

J. V. Dillard, vice president of operations, Riddle Airlines, Inc.

Henry J. Schmidt, assistant to the president of Thompson Ramo Wooldridge, Inc.

Maj. Gen. Perry B. Griffith, Deputy Inspector General for Safety of the U. S. Air Force, will become Vice Commander of all U. S. Forces in Northeast Atlantic and Mediterranean (CINCNELM) Jan. 10, 1963.

Honors and Elections

Lt. Col. John H. Glenn, Jr. has received the first Alfred A. Cunningham Trophy as the "outstanding Marine aviator of the year." The First Marine Aviation Force Veterans Assn. presented the trophy.

Prof. Howard S. Seifert, of Stanford University and United Technology Corp., has been named recipient of the American Rocket Society's 1962 G. Edward Pendray Award, which is given in recognition of outstanding contributions to astronautical literature.

(*Continued on page 142*)

INDUSTRY OBSERVER

► Technical and funding requirements for development of large solid-propellant rocket motors above the 120-in.-dia. size were discussed last week by National Aeronautics and Space Administration headquarters officials and personnel from the 623A Directorate of USAF Systems Command's Space Systems Division. Technical areas include feasibility studies in thrust vector control, ignition, nozzles, case composition and new facilities —the latter taking the bulk of funding. Industry feeling is that if Defense Dept. and NASA do not agree soon on a coordinated program (AW Oct. 1, p. 16), decision on future of big solid motors will shift entirely to NASA, which probably would go directly to work on a 260-in.-dia. motor.

► Lockheed, one of the four aerospace companies that were selected by Army Missile Command to conduct low-cost studies of a solid-propellant anti-missile missile for the Hardsite defense program (AW Oct. 15, p. 25), has discontinued its efforts and dissolved its study group, apparently because it was unwilling to accept cost-sharing aspects of the proposed contract. The two-stage, high-acceleration missile is called Sprint, an acronym for solid-propellant rocket intercept.

► Air Force is evaluating an advanced, unmanned re-entry test vehicle called SORTIE (super-orbital re-entry test integrated environment) to determine if actual flight program should be undertaken. The 1,500-lb., 13-ft., elliptically cone-shaped SORTIE vehicle has nearly completed theoretical and wind tunnel analyses of aerodynamic heating and stability and control at super-orbital velocity—which is defined as greater than orbital, but less than escape velocity. Work on the program is being conducted by Hypersonic Flight Section of Aeronautical Systems Division's Flight Dynamics Laboratory.

► Air Force hopes to cut the time to man-rate the Titan 2 as a Gemini launch vehicle (AW Oct. 29, p. 23) by qualifying most of the special Gemini systems, such as abort sensing and implementation, during qualification flights of the Titan 2 weapon system.

► North American Aviation's Space and Information Systems Division last week narrowed competition for the propellant loading and unloading system for the Saturn 2 booster to a group of companies believed to include Acoustica Associates, Powertron Ultrasonics and Space Technology Laboratories.

► Army's competition for study to define surveillance aircraft configurations has been canceled. The request for proposal had been issued from Ft. Eustace, Sept. 25, and proposals were due Nov. 5.

► One Army consideration in placement of its Sergeant ballistic missile batteries is that should the enemy be capable of attacking with a 100-kiloton weapon, the Sergeant units must be separated by at least 45,000 ft. to preclude loss of more than one battery from attack with a single nuclear weapon.

► Sikorsky has delivered the first three of a projected initial order of 28 HSS-2 twin-turbine helicopters to the Air Force following that service's decision to purchase the Sikorsky helicopter under the SOR-190 requirement instead of the Vertol 107. The three HSS-2s were delivered to Otis AFB, Mass., to be used in support of USAF's Texas Tower radar stations in the Atlantic Ocean (AW May 7, p. 68). Three other HSS-2s, designated S-61s by the Air Force, are already at Otis under bailment from the Navy. All six helicopters are standard HSS-2 versions minus anti-submarine warfare equipment. Remainder of the planned order of 28 helicopters will feature rear-loading (S-61R) and will be used for logistics support of intercontinental ballistic missile sites.

► Soviet Union may soon launch its first meteorological satellite, perhaps by early next year, in the opinion of American scientists who attended the recent International Astronautical Congress in Bulgaria (AW Oct. 8, p. 38). Russian scientists showed keen interest in discussing U. S. experience with Tiros satellites and implied that the Soviet Union's first meteorological satellite launch is near.

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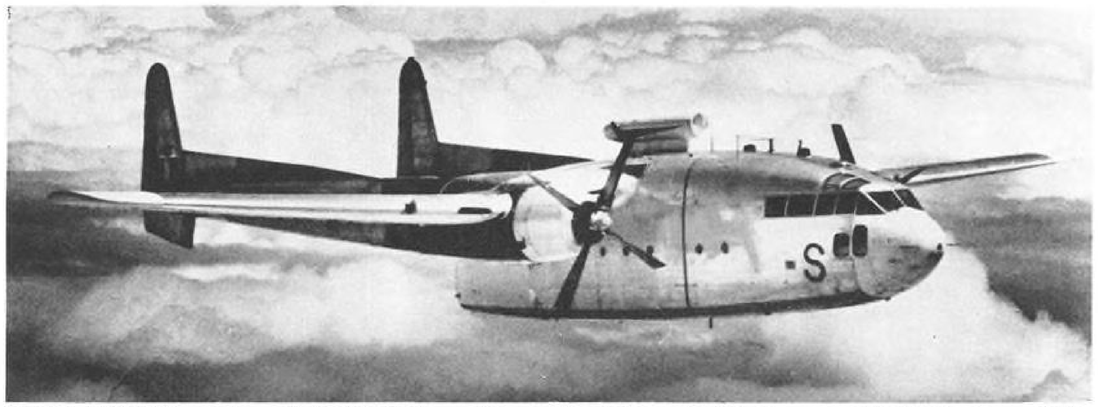


INDIAN AIR FORCE specially-modified C-119 is being used for combat airlift over the Himalayas to embattled Indian troops fighting Chinese Communists in the Ladakh valley. The Fairchild C-119 is powered by two Wright R-3350 piston engines and has a 3,400-lb.-thrust Westinghouse J34 turbojet mounted atop the center wing section. Jet conversion was done by Steward-Davis, Inc., of Gardena, Calif. Six jet-powered C-119s are now operating on the Chinese front, delivering combat cargo to airfields as high as 13,500 ft.

U.S., Britain Begin Airlifting Arms to India

Indian air force shops for transports, helicopters here after Soviet Union reneges on plan to supply MiGs.

By George C. Wilson

Washington—U.S. and Britain last week began airlifting military equipment to India after Russia refused to supply the weapons the Indians needed to fight better-equipped Chinese Communist invaders.

Although first shipments from the West to India were of infantry equipment, Indian officials visited aircraft plants in the U.S. and Canada in what probably is a first step toward obtaining more assault transports and helicopters.

The hurried visits to aircraft plants coincided with the demotion of Indian Defense Minister V. K. Krishna Menon. He long has favored Russia over the U.S., even buying Soviet aircraft when his military leaders recommended American.

Prime Minister Jawaharlal Nehru took over the Defense post himself after Indian newspapers accused Menon of sending his troops into battle with obsolete equipment. Menon was given the title of defense production minister and kept in the cabinet. But his authority, at least during the current crisis, appears to be limited.

U.S. announced the military airlift Oct. 31 and said operational details would be worked out with both British and Canadian officials. Britain on Oct. 29 sent automatic rifles to India in two Royal Air Force Bristol Britannias. France and West Germany also promised India some equipment, but the specific type and method of shipment was still under discussion late last week.

Prime Minister Nehru was forced to shift his traditionally neutral stance and lean toward the West because Russia declared it was going to support Communist China's territorial claims and would not ship arms to India. This apparently means Russia will not supply the 12 MiG-21 jet fighters promised to India and it raised hopes in France that the Dassault Mirage 3 would be bought instead. The first six MiGs were to be delivered this December. Russia's decision most likely also cancels the agreement to help India manufacture VK-7 turbojet engines for the Indian Hindustan 24 jet fighter built at Bangalore (AW May 1, 1961, p. 38).

An Indian evaluation team went to Moscow last summer to study Russian supersonic fighters and discussed the purchase of 24 MiG-21s as well as air-to-air missiles. At that time Lockheed Aircraft Corp. was trying to sell its F-104G to India. There was considerable congressional outcry when India announced it would buy the MiGs instead. VK-7 engine negotiations were still in progress when Red China invaded India. Russia has been trying to sell the engines outright while India pressed for manufacturing them under an export license.

In addition to Menon's opposition to purchases of U.S. aircraft, the Russian government has enjoyed an advantage in the procurement field because it has been willing to accept Indian goods and rupees as payment while U.S. firms have demanded dollars (AW Dec. 26, 1960, p. 63). But all this is being changed as India tries to arm itself as fast as it can.

U.S. State Dept. officials refuse to say whether India will break its tradition of commercial purchases and accept grants of U.S. military equipment, but this and a face-saving deferred payment plan are under discussion. Either procedure would clear the way for the U.S. government to buy aircraft for India. This adds significance to the current Indian visits to aircraft plants in the U.S. and Canada.

Nehru himself indicated he felt it was time to change Indian defense procurement policies. He told a meeting of his administrators that "I don't think I have an adequate answer" to the question of why India was so poorly prepared to fight the invading Communists. India needs all kinds of modern infantry weapons—automatic rifles, mortars, bazookas, utility vehicles—as well as aircraft and helicopters which can operate at high altitudes.

The fighting last week was concentrated on what India calls the North East Frontier Agency, an area north of the Assam Valley on the Tibetan-Indian border in the Himalayas. There are a number of U.S. and British built airfields, many of them abandoned, in the upper Assam Valley that could be used to airlift troops to the northeastern battlefront. These airfields in the Assam Valley were the World War 2 terminus in India for the China hump.

With high altitude and STOL (short takeoff and landing) requirements in mind, Indian officials have been visiting a number of aircraft facilities, including Lockheed's Marietta, Ga., plant and de Havilland's plant at Downsview, Ontario, Canada. The Lockheed C-130 assault transport was demonstrated last week at Andrews AFB, Md., to a group of Indians.

This was the first serious Indian discussion about the C-130 since 1960, when three Indians flew the aircraft and recommended its purchase. But Menon decided to buy Soviet An-12 transports instead.

Reports of the Indian-de Havilland discussions indicated India wants 16 DHC-4 Caribous and is also interested in getting more DHC-3 Otters. The Caribous probably would come off the line from positions released by the U.S. Army.

Right now India is filling some of these transport requirements by using six Fairchild Stratos Corp. C-119s, powered by two Wright R-3350 piston engines and one Westinghouse J34 turbojet mounted atop the center wing section. Steward-Davis, Inc., of Gardena, Calif., did this special conversion job for the Indian air force. The conversion is designed particularly for high-altitude operations and flying heavy loads out of small fields. Eight more C-119 conversion kits were en route to India last week. All told, India has ordered 27. The converted aircraft will be part of the fleet of 53 India acquired from the U.S. several years ago.

Steward-Davis is also proposing to the Indian air force another type conversion of the C-119—installing three J34 turbojets, one under each wing as well as the one atop the center. This conversion is designed to give Indian air force the assault transports it needs in the shortest possible time. The firm recommends that all the Indian C-119s be converted in one of those two ways.

Another Steward-Davis proposal is to supply India with Fairchild C-82s, the earlier version of the C-119, equipped with a J34 for auxiliary power. Trans World Airlines operates such a converted C-82 on a spare parts express service in Europe and Africa. There are 800 C-119s in flyable condition—most of them in the USAF and Marine transport reserve—and 41 C-82s, all in the civil surplus market.

Indian air force is disappointed with the Soviet An-12s because they cannot operate from the small, high-altitude fields in the present combat area. The An-12s are being used only as standard transports for taking troops and equipment up to fields on the Indian side of the Himalayas. Other airlift must be used between those fields and the battlefront. India bought the An-12s specifically for high-altitude and STOL use in the present combat areas.

Nehru, in discussing the purchase in 1960, said because of the Chinese Communist-India disputes along the border that "we are quite worried since this area is extremely difficult to reach and is situated in an undeveloped area 19,000 to 20,000 ft. up in the mountains" (AW Dec. 26, 1960, p. 63). In contrast to the severe limitations of the An-12s, the Indian air force is now operating the converted C-119s from two fields in the combat zone, one at 13,500 ft. with a 4,000 ft. dirt runway and the other at 9,000 ft. altitude.

These same high-altitude, STOL requirements made so critical by the current India-Red China clash are intensifying India's need for more helicopters. Indian air force recently ordered six high-altitude Bell 47G-3s. Delivery is slated for this month and next. India purchased six of these helicopters last year. They are fitted with

Soviet Group Flights

Soviet Air Force Col. Nikolai A. Varvarov said that "flights by single [Russian] cosmonauts will no longer be made" because Vostok 3 and 4 pilots in group flight "found space flight to be far easier than" the Vostok 1 and 2 cosmonauts, who flew singly.

Col. Varvarov, who is chairman of the astronautics section of the USSR Central Aero Club, made this prediction in a recent issue of the publication, Soviet Patriot. He said that at perigee, Vostoks 3 and 4 were separated by only 1.86 mi. Official Soviet sources have placed the closest point of approach at 4 mi. Varvarov said the group flight had "highly beneficial results" on both pilots, including their morale.

SOVIET MI-4 helicopter evacuates wounded Indian soldiers during fighting on the northeast Indian-Chinese border. India is now believed to be trying to buy Western helicopters.

100-1 Thrust Reduction Technique Shown

Technique for throttling liquid rocket engines to reduce thrust by a factor of approximately 100 to 1—reduction of thrust to 1% of initial operating value—while still maintaining combustion stability, has been demonstrated successfully by United Technology Corp., a subsidiary of United Aircraft Corp., in an extensive series of test runs at the company's Sunnyvale, Calif., facility.

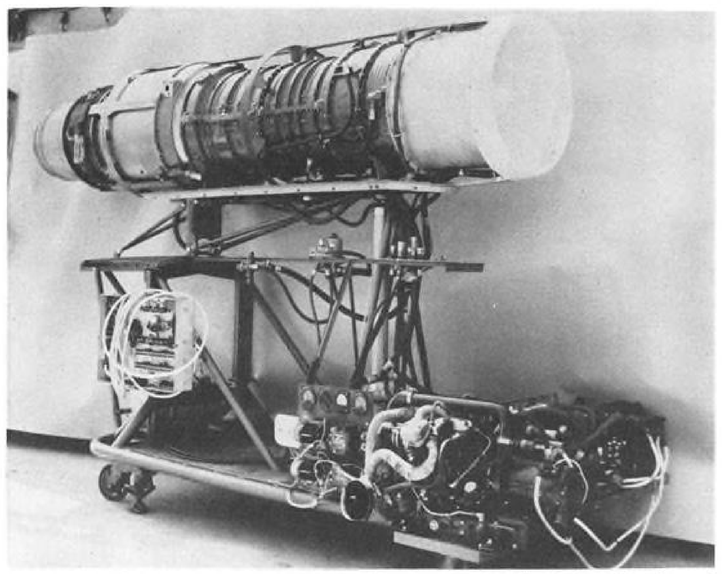
In contrast, throttling by valve closing affords thrust reduction of about 3 or 4 to 1 and introduces an element of instability.

The procedure is seen applicable to space operations such as rendezvous and lunar letdown, where throttling is important to give small impulses.

UTC has briefed the military, National Aeronautics and Space Administration and other interested government agencies on the results of the throttling technique, which was developed under a company-funded program. The technique reportedly is applicable to small and large thrust chambers and any liquid propellant.

Procedure is to inject a gas, such as helium or nitrogen, into the liquid fuel before it enters the combustion chamber and thereby create a low-density, atomized fluid with resultant reduction in thrust. This aeration procedure increases the speed of fluid flow in the chamber and results in substantially higher combustion stability.

Test procedure has demonstrated that injection of a small amount of gas can stabilize an unstable engine. The technique requires an injector design somewhat modified from current types.



TURBOJET CONVERSIONS power pack for Indian air force C-119s developed by Steward-Davis, Inc., of Gardena, Calif. is shown with the Westinghouse J34 engine on top and the engine accessory pack below. Engine is mounted atop the wing center section and accessory pack is housed on special deck inside fuselage for easy access.

dual controls, litters, sling hoist gear and oxygen equipment for high-altitude operation. The latest order for six amounts to about $500,000.

The Indian orders came after Bell, in 1960, flew the helicopter over the 22,000 ft. high Barachala Pass in the Himalayas. The 47G-3 also landed and took off from the Ladakh valley, which is 19,600 ft. above sea level, carrying two passengers and a normal fuel load.

India bought two Sikorsky S-62s in 1960 for testing but then decided to purchase the Soviet Mi-4 in quantity. Reasons given at the time were that the Mi-4 was cheaper—about $150,000 compared with about $260,000 for the S-62—and the fact that Russia would accept rupees and payment in goods while Sikorsky wanted dollars. However, in 1961 the Mi-4 developed severe vibration while in high blower operation, limiting its usefulness for high-altitude operation. This and other shortcomings paved the way for India's switch to U.S. helicopters.

Sen. Stuart Symington (D.-Mo.), a member of both the Senate Armed Services and Foreign Relations committees, is among those in Congress who objected strongly to India's buying aircraft from Russia rather than the U.S. He said Krishna Menon "had made a career, and a successful career—supported by Mr. Nehru—of attacking the United States. He is now buying planes from Russia. We are in pretty bad shape in some parts of our country and do make as good airplanes as anybody. Our friends abroad say: "Why should we be your friend? Why would it not be better for us to be either pro-communist neutrals or at least just plain neutrals, because it looks to us as if we would get more playing it that way than we do when we come out as your friends.'"

This line of reasoning was behind efforts in Congress this year to cut foreign aid to India. Another charge was that India was using U.S. aid funds to buy military equipment from Russia. State Dept. leaders earlier this year urged continued non-military assistance, predicting there were serious clashes ahead between India and Communist China. Phillips Talbot, assistant secretary of state for Near Eastern and South Asian affairs, told the Senate Foreign Relations Committee: "A Communist India would be very, very much more destructive to American interests in Asia and American global interests than an India which is nonaligned but which causes us some trouble sometimes."

India's turning toward the West for help—even though it was a desperation move—makes it easier to persuade lawmakers that India should receive heavy U.S. support.

The Kennedy Administration responded quickly to India's request for arms and said it would do everything possible to help that country repel the Chinese Communists.

Soviet Premier Nikita Khrushchev, in letters to Nehru and Red Chinese Premier Chou En-lai on Oct. 22, suggested an immediate cease-fire and talks to settle the dispute. The Chinese offered to withdraw 12¼ mi. and hold discussions. But Nehru refused to enter any negotiations until Communist troops observed the McMahon Line, drawn in 1914 and recognized as the India-China border by the U.S. The 12¼-mi. withdrawal would leave the Chinese on India's side of this border. India has been pressing for withdrawal to the positions held before Sept. 28, when the border fighting began.

INDIAN AIR FORCE marked Il-14s airlifting Indian troops to border battle zone have two large navigation-type bubbles behind cockpit and oversize left side rear door that do not appear on most versions of this Russian-designed transport. A similar configuration was seen on one of two Il-14s supplied to the Congolese Republic (AW Sept. 19, 1960, p. 41). Egyptian Il-14M paratroop transports also have this configuration. V.K. Krishna Menon, (left, in fur coat) who sponsored Indian purchase of Russian aircraft is shown inspecting the troops prior to his removal from post as defense minister.

Mark 12 Development Plan May Change

Course of a multi-million dollar development program for the next generation of Minuteman ICBM re-entry vehicles was hinged to the outcome of a top-level meeting at Norton AFB, Calif., earlier last week as Defense Dept. Research & Engineering and Air Force officials gathered to resolve differences on the technical requirements for the Mark 12 re-entry vehicle.

There were strong indications that development of the Mark 12, which was to be initiated by a contractor selected on the basis of a recent industry competition (AW Sept. 10, p. 23) may be altered or held up temporarily while an alternate, more sophisticated re-entry vehicle concept is explored.

Ballistic Systems Division evaluation board had been scheduled to present its findings on proposals submitted to it Oct. 5 for development of the Mark 12. Proposals were submitted by Aeronutronic, Avco, General Electric and Chrysler.

DDR&E, very much concerned with improved ballistic missile penetration capability, had expected BSD to proceed with a development study for Mark 12 aimed at producing a jump in re-entry vehicle technology. The study was to include penetration aids, such as decoys. Stepping into the picture after proposals were submitted in response to a BSD proposal request, DDR&E expressed criticism of the BSD development plan, targeted to produce the Mark 12 as a larger, heavier, lower-cross section re-entry vehicle, as insufficiently advanced.

Meeting at Norton last week were officials from DDR&E, USAF headquarters, Systems Command Headquarters, BSD, Aerospace Corp. and Space Technology Laboratories. Speculation in industry was that they would agree to proceed on Mark 12 development somewhat along these lines:

- **One, or possibly two contractors would be selected from among the four bidders to conduct further studies, not actual development, of the BSD concept of Mark 12.**
- **One, or possibly two contractors would be picked to conduct design studies of a more advanced re-entry vehicle capable of containing decoys.**

U.S. Pacific Nuclear Test Series Is Considered Highly Successful

Washington—U.S. is nearing the end of what is considered a highly successful Pacific nuclear test series, which by Nov. 1 included 35 atmospheric detonations since testing was resumed last Apr. 25.

High altitude tests in the Operation Dominic series were held July 9, Oct. 22, Oct. 26 and Nov. 1. The Oct. 22 device was launched by a vehicle powered by a Sergeant solid propellant rocket motor after four launch attempts with a Thor had failed. The other three high altitude tests were launched with Thor boosters.

The Nov. 1 test, described as a submegaton explosion, was detonated at an altitude of 20 to 30 mi. over Johnston Island. It created an unexpectedly bright fireball, which witnesses in Hawaii described as more intense than that of the 250-mi. high megaton test on July 9.

Atomic Energy Commission also reported a total of 56 nuclear tests had been conducted at the Nevada test site since testing resumed. A British nuclear device was tested in Nevada in March. Total yield of U.S. test devices is estimated at about 145 megatons. The Soviet test series, which began Aug. 5, included 26 detonations by Oct. 31 with a yield estimated at 310 megatons.

One U.S. official described Operation Dominic as "fantastically successful," despite the problems encountered in attempting high altitude launches. He said a "very dramatic breakthrough" has been achieved in yield-to-weight ratio as a result of the Pacific tests.

Soviet series continued with the detonation of the 26th announced device in the atmosphere on Oct. 30. AEC said it does not report all Soviet tests that it detects.

Soviet public press has not reported any of the current series of tests, but the Russian armed forces newspaper Red Star published a speech by Defense Minister Rodion Malinovsky Oct. 25 that referred to the tests.

Malinovsky said the Soviet military establishment was in its highest state of battle readiness, and that the current tests were proving "the high perfection and gigantic destructive force of new types of nuclear armaments and the precision of our rockets." He said these weapons have nuclear yields as high as 50 to 60 megatons.

The Russian test series (AW Oct. 1, p. 15) has included at least four detonations with yields approaching 30 megatons. AEC said the Aug. 5 test was 30 megatons, and a test Sept. 27 was close to that figure. The other "multi-megaton" detonations took place Sept. 19 and Sept. 25.

Space Agency Picks POGO Experiments

Washington—Nineteen experiments have been selected for the first polar orbiting geophysical observatory (POGO), scheduled to be launched in early 1964 by a Thor Agena B vehicle from the Pacific Missile Range.

Experiments and experimenters selected for the payload by National Aeronautics and Space Administration are the following:

Radio astronomy measurements at 2.5 and 3.0 mc., F. T. Haddock of the University of Michigan; very low frequency (0.2 to 100 kc.) measurements, R. Helliwell of Stanford University; very low frequency emissions and whistlers, M. G. Morgan and T. Laaspere of Dartmouth University; relationship between very low frequency emissions and high energy (5 to 100 kev.) electron bunches, J. Winckler and R. Gallet of the University of Minnesota and the National Bureau of Standards; magnetic field fluctuations, R. E. Holzer and E. J. Smith of the University of California at Los Angeles and Jet Propulsion Laboratory; and measurement of ionization over polar regions, H. V. Neher and H. Anderson of the California Institute of Technology and Jet Propulsion Laboratory.

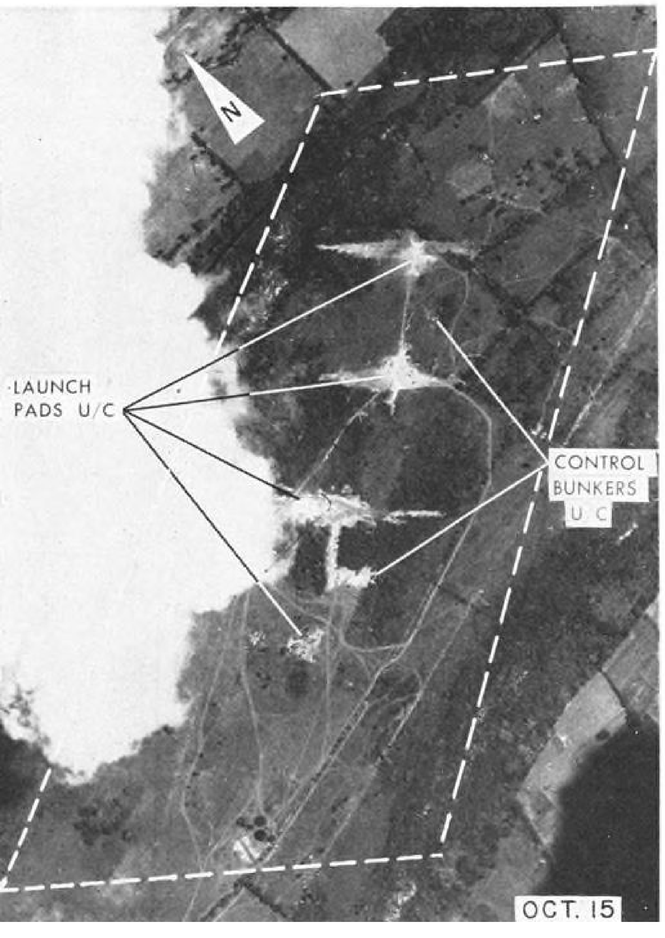
Low-energy charged particle spectrum, J. A. Simpson of the University of Chicago; galactic and solar cosmic ray energy spectrum and charged particle composition, W. R. Webber, University of Minnesota; measurement of downflux of corpuscular radiation in auroral zones and polar caps, J. A. Van Allen of the State University of Iowa; Lyman-alpha and ultraviolet airglow measurements between 1,230 and 1,350 angstroms, P. M. Mange, T. A. Chubb and Herbert Friedman of the Naval Research Laboratory; airglow measurements between 1,100 and 3,400 angstroms, C. Barth and L. Wallace of JPL and Kitt Peak National Observatory; ion and neutral gas mass spectrometer, L. M. Jones and E. J. Schaefer, University of Michigan.

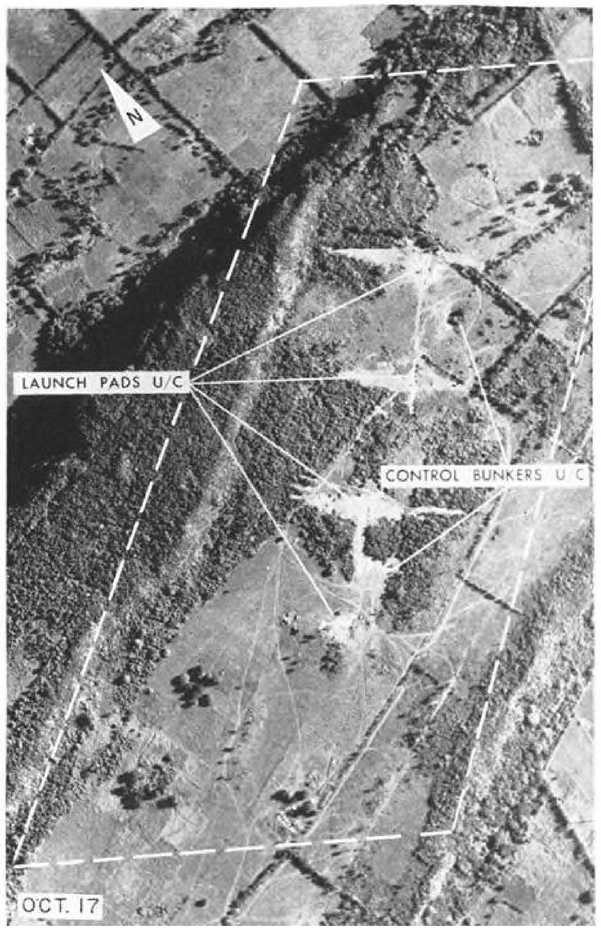
Experimenters from NASA's Goddard Space Flight Center, which has project management, are J. Heppner, H. R. Boroson and J. C. Cain, a magnetic survey using rubidium magnetometers; H. Taylor and H. Brinton, a Bennett ion spectrometer; G. Newton, a Bayard-Alpert density gage; W. M. Alexander, C. W. McCracken, O. E. Bert and L. Secretan, micrometeorite mass velocity and charge measurement; Robert Bourdeau, measurement of ionospheric charged particles and solar ultraviolet radiation, and E. Reed, airglow measurement.

Collaborating with Reed is J. Blamont of the University of Paris.

Latest Photos Show Speed Of IRBM, MRBM Buildup in Cuba

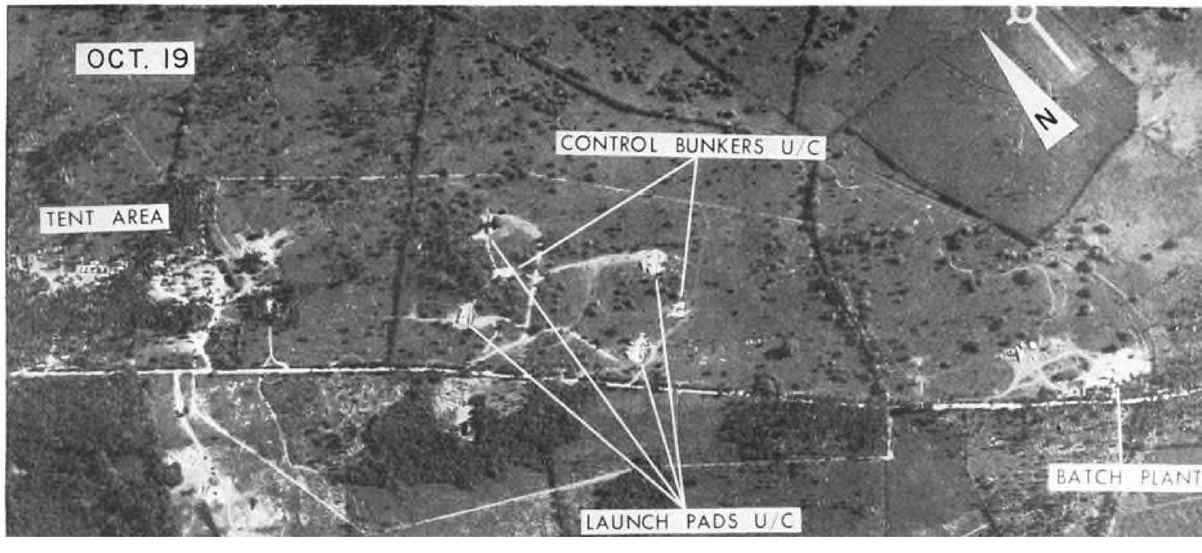
Heavily wooded ridge located near Guanajay is devoid of any military activity at the end of August when aerial reconnaissance photo (left) was taken. Six weeks later, the same wooded ridge is focus of intense excavation and grading for construction of four intermediate-range ballistic missile launch pads and two control blockhouses, one for each pair of launch pads (below, left). Two days later (below, right), construction of the blockhouses themselves is well along, and the launch pads are taking shape. Site is one of two at Guanajay. See other Cuban photos, pp. 54-55 for the other Guanajay IRBM site.





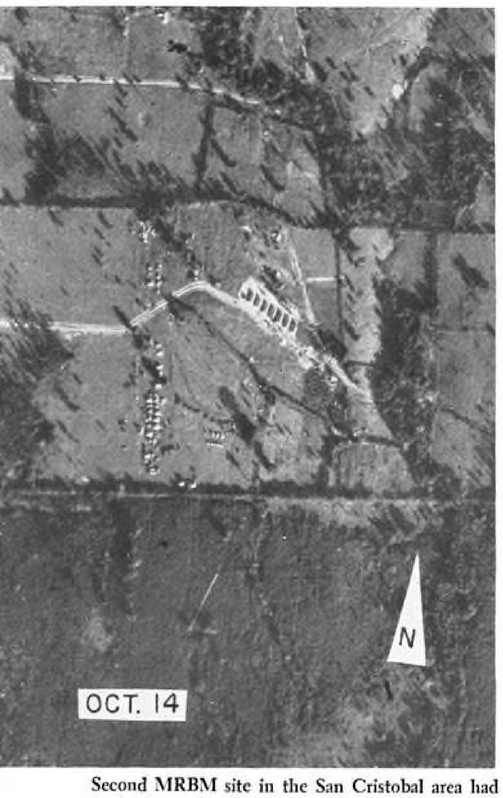
Another future IRBM site, this one near Remedios in Central Cuba, shows nothing but wooded countryside early in September.

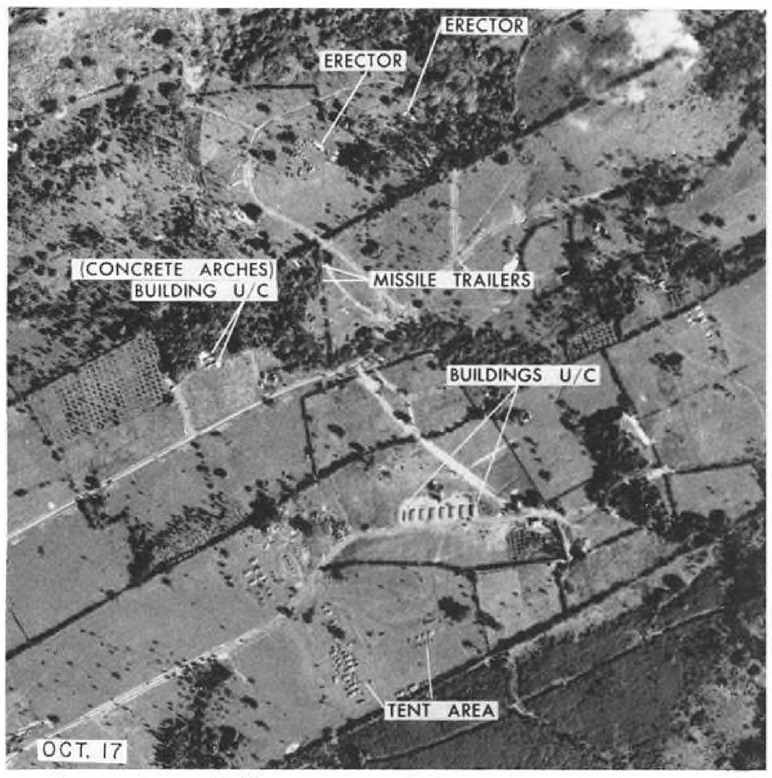
Six weeks later (above), feverish construction activity is under way. Ground has been bulldozed for launch pads, excavation has begun for semi-buried blockhouse construction, and a security fence now encloses the site. Concrete making plant has been built at right along the road. Two days later (below), the concrete batch plant at extreme right has been expanded and is in operation. Concrete footings have been poured for major sections of pads and blockhouses and scarring can be seen for placing of cable conduits from blockhouses to pads. Across road from bottom left launch pad, semi-buried structure is being covered with earth, probably for nuclear warhead storage.

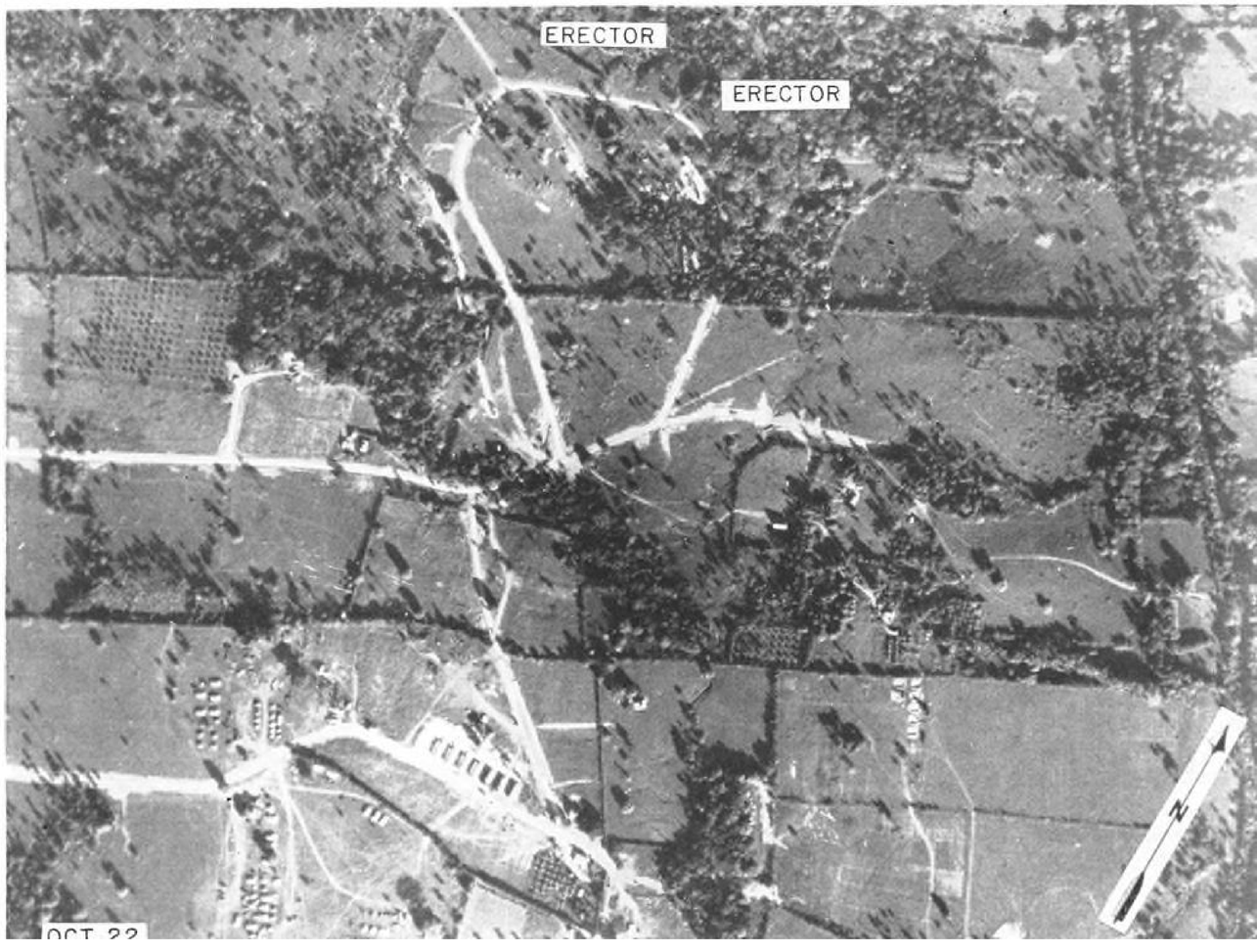


Large number of fuel trucks and mobile oxidizer tanks seen in this low level oblique photo of one of two medium-range ballistic missile sites in the San Cristobal area indicate capability to support a sizable missile launch salvo. Launch pad in the background has a missile erector under a canvas cover, a theodolite for guidance alignment and cables to a launch control building.

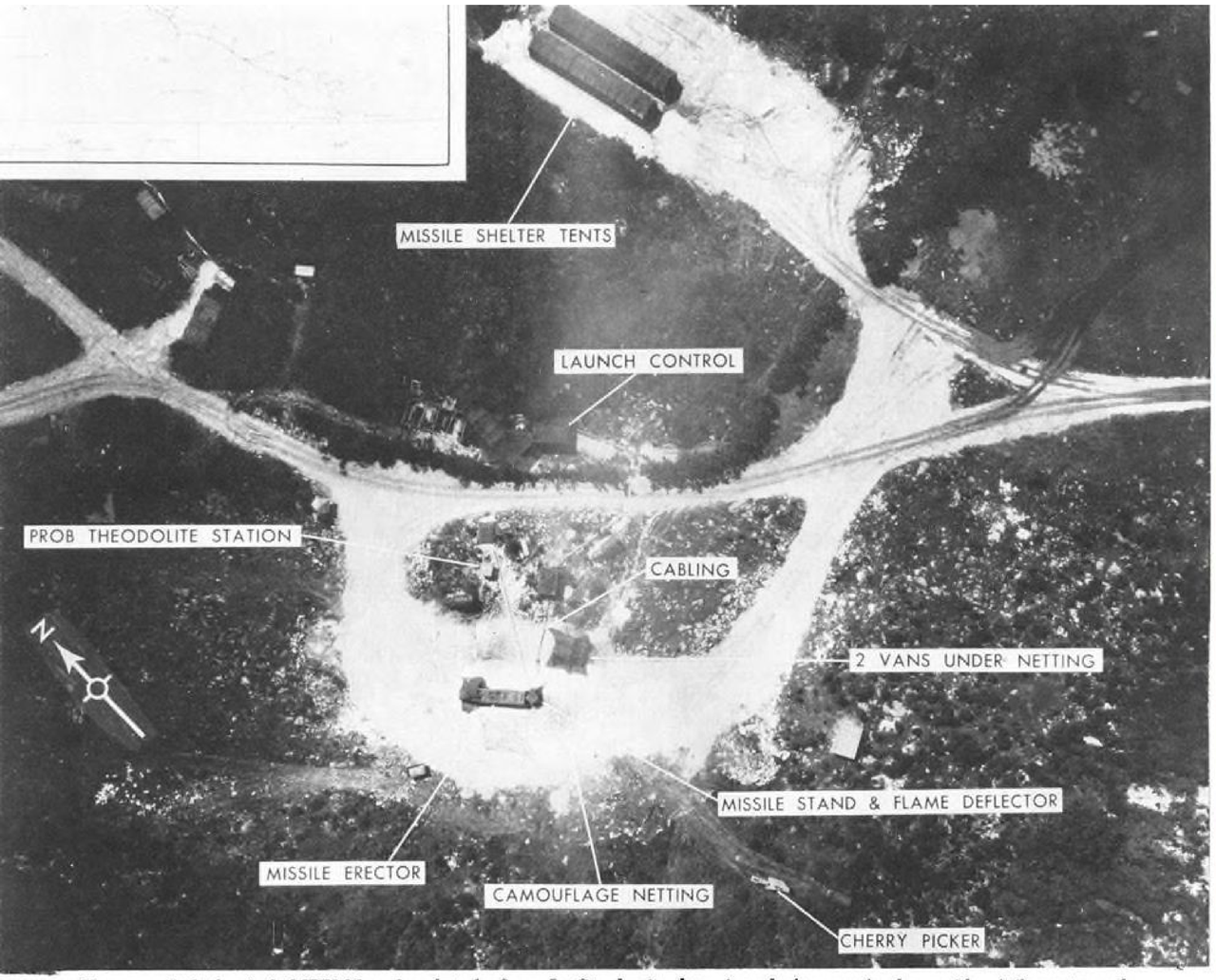
Initial camouflage attempts are evident in a second low oblique at San Cristobal. Camouflage netting covers five trucks at left and another five under trees, right. Site is same as that in the low oblique on the previous page, but shows another launch pad in operational status with erector, theodolite. Note cable to launch control van, out of sight to left.







Second MRBM site in the San Cristobal area had construction crews in tents building permanent prefab housing for missile crews and beginning to lay out a service road network in mid-October (left). Three days later (right) launch area is nearing completion and missile trailers and erectors are at the site. Concrete armament storage buildings are under construction. Final photo in the sequence of the second San Cristobal MRBM site (opp. page) shows continued rapid construction. Four launch pads are completed and ready for firing, service road construction has made further progress and pre-fab housing is near completion. Defense Dept. did not indicate launch pad sites, but locations of two are apparent from previous photo.



Closeup vertical of a single MRBM launch pad at the Sagua La Grande site shows it ready for operational use with missile erector and firing pad in place, cables from launch pad to control blockhouse for launch sequence and theodolite lining up the missile on its trajectory toward a major U. S. city 1,000 mi. away. Notice the camouflaged vehicles and the cherry picker mobile missile service gantry. This is closeup of one of the two pads shown in cover photo. Note tracks into one of the missile shelter tents indicating presence of a missile in a high state of readiness. Camouflage netting is being stretched out near erector prior to stringing across the site.

Russian Shyster medium-range ballistic missile emplaced in Cuba is a later version of this missile photographed during a Bolshevik anniversary parade in Moscow. New version has flared skirt, smaller fins and external plumbing, but general configuration is the same.

2 MILES DOWN WITH NO STRINGS ATTACHED

In the lightless depths of the sea, a strange craft swims. One of its mechanical arms holds a powerful light. Its beam sprays the ragged ocean floor. Another arm reaches down, and with precise steel fingers, plucks an organism from the dark sand.

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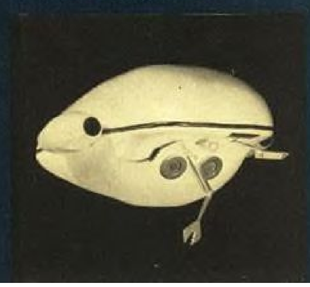

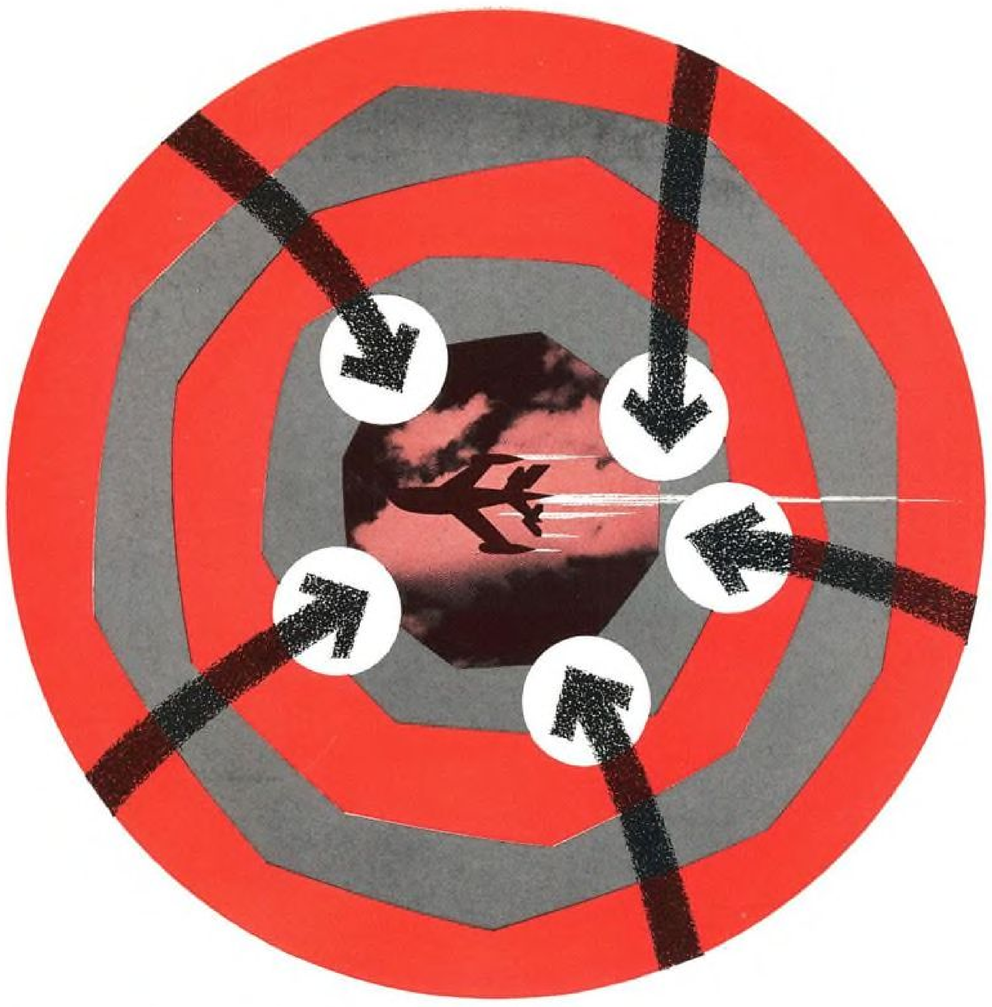

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Cuban Crisis Appears Far From Settled

Washington—Cuban crisis remained far from over last week in spite of indications that Russian technicians were rapidly dismantling Soviet missile bases there. Russia and Communist China increased their support for Cuban demands that the U.S. withdraw from the Guantanamo Naval Base, raising the probability that this would still be an issue long after the missile base question was settled.

Blockade and surveillance of Cuba were resumed by the U.S. on Nov. 1 after a two-day suspension while Acting United Nations Secretary General U Thant talked in Havana with Cuban Premier Fidel Castro about arrangements for UN supervision of the dismantling of Soviet installations.

Russia's decision to send First Deputy Premier Anastas Mikoyan to Cuba with an 18-man delegation on Nov. 2 brought speculation that he had instructions to bring Castro into line with Soviet efforts to resolve the current crisis. But propaganda broadcasts by Soviet and Chinese government radios reflected the opposite—a stronger stand by both nations behind the five demands Castro laid down as conditions for accepting Soviet-U.S. attempts to settle the missile base issue.

U Thant had hoped to leave a part of his 19-man party in Cuba to begin supervising the withdrawal of Soviet weapons. But the entire party returned to the U.S., and it appeared that Russia intended to remove its weapons without letting any U.S. or UN observers near them.

Soviet Chairman Nikita Khrushchev, in agreeing to their removal on Oct. 28, had not specifically agreed to President Kennedy's stipulation that the weapons be dismantled and returned to the Soviet Union "under United Nations verification." The wording of Khrushchev's reply (see box) left open the possibility that UN observers might be shown no more than abandoned sites after the missiles and Ilyushin bombers were gone.

Premier Castro said shortly after the U.S. request for UN participation in the removal was first announced that any UN observers who came to Cuba had better come "prepared for combat." Following the apparent acceptance by Khrushchev of U.S. proposals, however, he made detailed demands—withdrawal from Guantanamo, an end to the blockade and all economic blockades and pressures, an end to air and naval space violations, invasions, infiltrations, etc.

U Thant said on his return from Havana that the talks had been "fruitful," but his statement indicated Castro still stood in the way of any specific

Chronology of Events in Cuban Crisis

Washington—Key events in the Cuban crisis since President Kennedy's speech of Oct. 22 demanding removal of Soviet offensive missiles and bombers from Cuba (AW Oct. 29, p. 26) have included:

• Oct. 24—Blockade of Cuba begins.

• Oct. 25—Soviet oil tanker Bucharest encountered blockade but was allowed to proceed. Missile propellants and chemical compounds capable of being used to power missiles added to list of prohibited goods. A dozen Soviet vessels turned back but others continued toward Cuba. Work proceeded on both medium-range and intermediate-range missile sites. Soviet Chairman Khrushchev told Acting UN Secretary General U Thant that Russian ships would avoid the blockade. President Kennedy told U Thant that the U.S. would avoid incidents at sea beyond the blockade but insisted the missile bases must be removed.

• Oct. 26—Lebanese freighter Marucla intercepted and boarded but allowed to proceed to Cuba with general cargo. Russia rejected note adding missile fuel to embargo list. Talk of bombing or invading Cuba increased in Washington. White House said "rapid" buildup of bases continued and camouflage efforts had begun.

• Oct. 27—Strategic Air Command U-2 lost over Cuba (see p. 38). U.S. warned it would protect reconnaissance planes. Khrushchev admitted bases were Soviet, tied dismantling to removal of U.S. Jupiter missile bases in Turkey. Kennedy said the real issue was dismantling of Cuban bases. Blockade area defined (see map on p. 39). Defense Dept. called eight troop carrier squadrons and six aerial transport squadrons of USAF Reserve to active duty effective Oct. 28, increasing speculation here that invasion was imminent unless Khrushchev acted swiftly.

Text of a letter from Kennedy to Khrushchev, in reply to a letter that Khrushchev had sent on Oct. 26 but had not made public, revealed that the President was willing to end the blockade and give Russia assurances against invasion of Cuba if Russia agreed to remove its offensive weapons "under appropriate United Nations observation and supervision and undertake, with suitable safeguards, to halt the further introduction of such weapons systems into Cuba."

• Oct. 28—Moscow radio broadcast a Khrushchev message to President Kennedy saying that the Soviet government, "in addition to earlier instructions on the discontinuation of further work on weapons construction sites, has given a new order to dismantle them" and return them to the Soviet Union. Khrushchev did not say UN observers could supervise the dismantling. Instead, he said: ". . . We are prepared to reach agreement to enable representatives of the United Nations to verify the dismantling of" the bases—possibly after the fact. Khrushchev also said he was prepared to exchange views on a relaxing of tensions between the North Atlantic Treaty Organization nations and Warsaw Pact nations; said Russia did not absolve itself of responsibility for rendering assistance to the Cuban people; and warned against violation of Soviet and Cuban airspace (see p. 38). Khrushchev also said he was sending Vasily V. Kuznetsov as his special delegate to the UN.

Cuban Premier Fidel Castro set a number of conditions for acceptance of a Soviet understanding with the U.S., including withdrawal of the U.S. from the Guantanamo naval base; end of all violations of air and naval space; and of "pirate attacks" from bases in the U.S. and Puerto Rico; end of "all subversive activities, dropping and landing of arms and explosives by air and sea, organization of mercenary invasions, infiltration of spies and saboteurs . . .;" end of "economic blockade and all measures of commercial and economic pressure" from the U.S.

• Oct. 29—NATO Permanent Council announced that it had asked USAF Gen. Lauris Norstad to stay until next Jan. 1 as commander in chief, Europe, instead of retiring Nov. 1. Army Gen. Lyman L. Lemnitzer was to become commander of U.S. forces in Europe on Nov. 1, and will succeed Norstad in January. Russia names Gen. Pavel I. Batov, former commander of occupation forces in Hungary, as chief of staff of the joint armed forces of the Warsaw Pact countries. He presumably also would be first deputy chief of staff of Soviet armed forces.

• Oct. 30—U Thant and party of 19 went to Havana for first talks with Castro. U.S. blockade and air surveillance were suspended temporarily.

• Oct. 31—U Thant returned with his party saying he had reliable information that the bases were being removed and that dismantling should be completed by Nov. 2.

Khrushchev Warns U.S. on U-2 Flights

Washington—Soviet Chairman Nikita Khrushchev has charged that a U.S. reconnaissance aircraft flew over Russia's Chukotka Peninsula on Oct. 28 and has warned President Kennedy that violation of either Russian or Cuban airspace could "lead to dangerous consequences."

Khrushchev's warning came one day after a USAF Strategic Air Command Lockheed U-2 was lost on a photo mission over Cuba.

President Kennedy blamed the new violation of Soviet airspace on "a serious navigational error" and said: "I regret this incident and will see to it that every precaution is taken to prevent recurrence." The President also said the aircraft, presumably a U-2, "was engaged in an air sampling in connection with your nuclear tests." Russia detonated a nuclear device at high altitude over Central Asia on Oct. 28 (see p. 29). No U. S. official has stated publicly before that U. S. aircraft were monitoring the Russian tests.

Khrushchev's charge came in his long message to President Kennedy on Oct. 28 agreeing to remove Soviet offensive missiles and bombers from Cuba. He told the President that "an intruding American plane can be easily taken for a nuclear bomber and this might push us to a fateful step, all the more that the U.S. government and Pentagon long since declared that you maintain a continuous nuclear bomber patrol."

The Soviet leader recalled Francis Gary Powers' U-2 flight over Russia in 1960 and the U-2 flight over Sakhalin Island last August. Then he charged that "a still more dangerous case" occurred over the Chukotka Peninsula, and asked the President if this was "a provocation . . . at such an anxious time . . . when everything has been put into combat readiness." He asked the President to "take appropriate measures to prevent this from becoming a provocation for touching off a war."

Khrushchev then turned to the Cuban situation, and said he had learned "through my officers who are in Cuba" that the U. S. was violating Cuban airspace. He said he was concerned for his "officers, instructors" and other specialists there, and added:

"I should like to consider, Mr. President, that violation of the airspace of Cuba by American planes could also lead to dangerous consequences. And if you do not want this to happen, it would be better if no cause is given for a dangerous situation to arise. We must be careful now and refrain from such steps which would not be useful to the defense of states involved in the conflict but could only cause irritation and even serve as a provocation for a fateful step."

On Oct. 27, the Defense Dept. recalled the Oct. 23 resolution of the Organ of Consultation of the Inter-American System (part of the Organization of American States) that the security of the Western Hemisphere required continuous surveillance of Cuba. The department said: "Any interference with such surveillance will meet counteraction and surveillance will be enforced." Spokesmen refused to comment on whether any reconnaissance aircraft had been shot at.

Three hours later, the department announced that a "military reconnaissance aircraft" was missing and presumed lost on a photo mission over Cuba. It refused through late last week to identify the type of aircraft or to say what had happened to it. But on Oct. 28, Gen. Thomas S. Power, commander of SAC, notified the father of U-2 pilot Maj. Rudolf Anderson, Jr., 35, that his son was "long overdue and must now officially be declared missing in action." Gen. Power awarded Maj. Anderson the Distinguished Service Medal for "performance of one of the most important duties connected with the current crisis."

When Acting United Nations Secretary General U Thant returned to New York last week after two days of talks in Havana with Cuban Premier Fidel Castro over arrangements for UN supervision of the dismantling of Soviet missile bases, he said: "At my request, the Cuban government has agreed to return on humanitarian grounds the body of Maj. Anderson to the United States."

This was the first indication that Cuba had Maj. Anderson's body. The Oct. 27 announcement by the Defense Dept. that it would protect reconnaissance aircraft (see chronology, p. 37) had caused speculation that Soviet surface-to-air missiles had knocked down the U-2, but other reports said Maj. Anderson lost power and came down at sea too far from U. S. forces to be rescued. The government still refused late last week to clarify the situation.

President Kennedy said in his reply to Khrushchev's Oct. 28 message that the plane which flew over the Chukotka Peninsula was "without arms or photographic equipment." He said its course was direct from Eielson AFB, Alaska, to the North Pole and return.

"In turning south, the pilot made a serious navigational error which carried him over Soviet territory," the President said. "He immediately made an emergency call on an open radio for navigational assistance and was guided back to his home base by the most direct route."

arrangements. "There was agreement that the United Nations should continue to participate in the peaceful settlement of the problem," he said.

"During my stay in Havana, I was reliably informed that the dismantling of the missiles and their installations was already in progress that the process should be completed by Friday (Nov. 2)," Thant said. "Thereafter there would come their shipment and return to the Soviet Union, arrangements for which are understood to be in hand." Thant also announced that Cuba would return the body of a Strategic Air Command U-2 pilot whose plane was lost on a photo mission (see box).

On Nov. 1, as the blockade and surveillance resumed, Moscow Radio said in a broadcast to North America that Castro's "suggested measures" to ensure Cuba against harassment "would provide a good basis for a lasting peace in the Caribbean."

Two days earlier, Moscow Radio said U. S. military bases in Turkey jeopardize peace in the Near and Middle East" and said the interests of peace "require the liquidation of these bases." President Kennedy has rejected a swap proposed by Khrushchev in which the U. S. would remove Jupiter missiles from Turkey in return for removal of Soviet weapons from Cuba.

Peking Radio took an even stronger position on Castro, saying his stand was "absolutely just, absolutely necessary and entirely correct," and urging him to continue to insist on his conditions. Red China's Minister of Foreign Affairs Chen Yi said in a note to the Cuban charge d'affaires in Peking that the U. S. guarantee against an invasion of Cuba cannot be valued as long as the U. S. had not fulfilled Castro's demands.

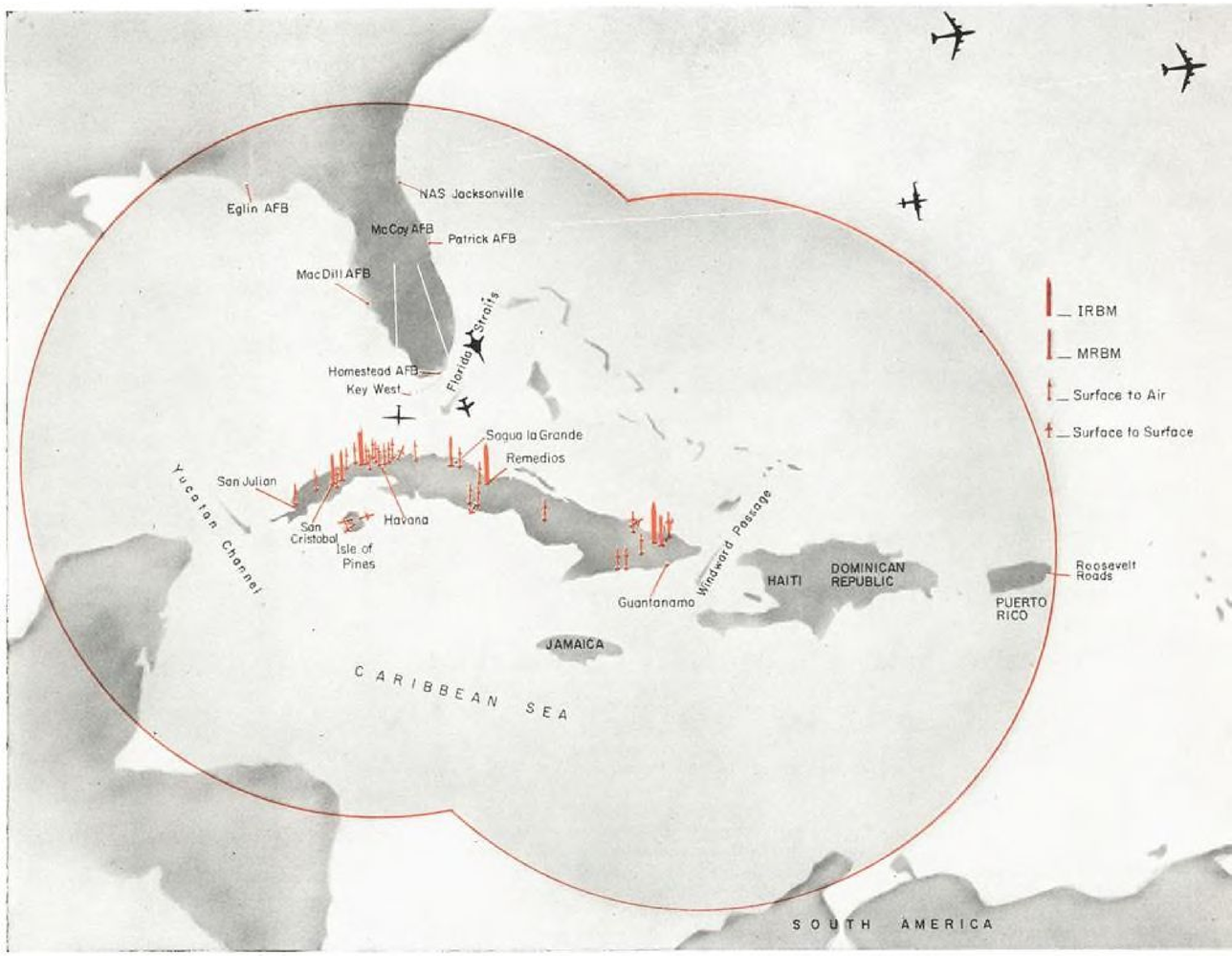
"The struggle for Cuba is by no means isolated," Chen said. "The U. S. imperialist provocation against you is also a provocation against us."

Mikoyan's trip, which was to include a brief stopover in New York, was described by Moscow as an economic mission. Although there was some speculation that Russia intended to compensate Cuba for the loss of offensive weapons through some increase in economic aid, Mikoyan's mission was considered far more likely to be a political one. He is the Kremlin's top political troubleshooter.

U. S. reconnaissance aircraft flew over Cuba on Monday, Oct. 29. As surveillance resumed last week, the White House refused to say whether aircraft were involved. The Administration held comment on Cuban affairs to a minimum through the period of Thant's talks, but there was no relaxation of military readiness. President Kennedy met with the heads of all three services and met three times in two days with the executive council of the National Security Council. The two meetings in one day coincided with U Thant's return from Cuba.

The U. S. still has not ruled out invasion of Cuba if Castro should further inflame the political situation elsewhere in Latin America—even though Soviet offensive weapons might have been withdrawn. Administration sources blamed Castro for the sabotage of Venezuelan oil production plants that followed Khrushchev's decision to remove Russian weapons.

If the Cuban situation should be settled to the satisfaction of the U. S. and Russia, however, government sources here expect that Kennedy and Khrushchev will have a summit meeting sometime this year. The real subject of such a meeting would be Berlin, however, and not Cuba, officials here believe. If and when Russia makes a power play for Berlin, the North Atlantic Treaty Organization will be under the greatest pressure to date. Kennedy and Khrushchev discussed an easing of tension between NATO and Warsaw Pact countries in their exchange of notes on Cuba.



HIGH AND LOW LEVEL U.S. photo reconnaissance over Cuba by Air Force Lockheed U-2s and McDonnell RF-101s and Navy Ling-Temco-Vought F8U-1Ps documented the rapid Soviet missile buildup on the island. Missile sites located include intermediate-range ballistic missile emplacements near Guanajay, Remedios and eastern Cuba and medium-range ballistic missile sites in the San Cristobal and Sagua La Grande areas. At least eight ballistic missile sites of both types were located. Map also shows 24 surface-to-air missile sites, six surface-to-surface anti-shipping cruise missile sites and the San Julian airfield where Russian Il-28 Beagles were being assembled. Naval blockade zones are two 500-naut.-mi.-radius circles, one centered at Havana and one on the eastern tip of Cuba. Strategic Air Command Boeing B-52s and Navy Lockheed P2Vs have ranged far beyond this zone into the Atlantic to monitor shipping approaching Cuba. Also shown are bases in Florida being used by the U.S. in its current air buildup.

Mariner 2 Trouble

Interplanetary science experiments in the Mariner 2 spacecraft were turned off by ground command Oct. 31 because of voltage regulator trouble but National Aeronautics and Space Administration expected these experiments and two radiometer experiments to turn on automatically 10 hr. before the spacecraft reaches Venus next Dec. 14. The incident occurred in the 66th day of flight with the vehicle 12 million miles from earth.

First Batch of F-104Js in Final Assembly

Twelve F-104Js are in final assembly at the Komak plant of Mitsubishi Heavy Industries, Reorganized, Ltd., prime contractor for Starfighter production in Japan. One aircraft has already been delivered to the Japanese Self Defense Agency; 12 other F-104Js are in subassembly at Mitsubishi's Oye plant and at Kawasaki Aircraft Co.—prime subcontractor in production program. Over-all, 200 of the aircraft have been programed by the Japanese.

Most Aerospace Firms Unaffected By New NASA Patent Proposals

Washington—National Aeronautics and Space Administration will hold a public hearing Dec. 10 on a proposed liberalization in the granting of patent titles to industry to promote widespread use of space inventions.

The proposal, circulated last week, would open the doors for patent title claims by NASA contractors whose general business is non-government. It would have little effect on aerospace firms whose work is and has been predominantly for the government.

The proposal first lists three categories of inventions for which NASA will waive patent title to the contractor. Then it stipulates that NASA will keep title to "inventions in a field which has grown predominantly as a result of government sponsorship." This classification would embrace most aerospace firms.

Patent Titles

Two other types of inventions for which NASA would also keep patent titles are:

- **Inventions likely** to be required by law or regulation for public use. An example would be a safety device for aircraft required for all commercial planes by government regulation.
- **Inventions primarily** related to a government program designed to develop goods or services for use by the public This would include communications satellites developed for commercial broadcasts.

The three invention categories eligible for title waiver by NASA would be:

- **Those that fall** within the established commercial area of the contractor.
- **Inventions which** would require such a substantial expense to develop that exclusive ownership would be warranted as an enticement.
- **Inventions for which** the contractor had filed a patent application before signing a NASA contract.

Licensing Regulations

NASA also put into effect last week new licensing regulations for patents held by NASA. Under these, NASA may grant non-exclusive, royalty-free licenses to all applicants within two years after the issuance of a patent. If the licensees do not commercially develop the invention within the two years, their licenses may be revoked and an exclusive license granted to a single firm to encourage development.

NASA Administrator James E. Webb anticipated that the new licensing regulations and the waiver proposal will contribute to NASA's objective "of developing the full potential for commercial purposes of the technological advances which are developed, of stimulating inventions, and of providing incentives for their use."

New Semiconductor Laser Is Developed

Discovery of a new type laser which produces coherent infrared radiation from a semiconductor crystal by direct excitation with extremely high conversion efficiency has been reported by scientists at the General Electric Research Laboratory, Schenectady, N. Y., and by scientists at International Business Machines' Watson Research Center.

The new laser achieves coherent emission from a gallium arsenide diode, cooled to liquid nitrogen or helium temperature, at a wavelength of about 8,400 angstroms. Lasing action occurs when a voltage is applied to the diode.

Several months ago Lincoln Laboratory scientists discovered that the application of a voltage to the same material caused it to emit intense infrared radiation at the same wavelength (AW July 16, p. 34). But they did not report any evidence of coherence in the radiation, the characteristic which distinguishes the emission of lasers and makes them of such widespread interest.

GE scientists achieved laser action by constructing the gallium arsenide diode in an optical cavity with parallel reflecting surfaces which encourage the build-up of coherent radiation. GE says it also exercised improved control of the impurities in the gallium arsenide crystal.

Compared with conventional gaseous and crystal lasers, which so far have been able to convert only about 1% of their excitation energy into coherent radiation, Lincoln Laboratory measurements of non-coherent energy from gallium-arsenide diodes indicates a conversion efficiency of nearly 100%. This suggests the new technique may open the door to extremely high power lasers.

In GE experiments, scientists have applied currents as high as 20,000 amperes per square centimeter of crystal surface, but these have been applied in periodic pulses of 5 to 20 microsec. duration to prevent overheating and damage to the semiconductor crystal.

IBM reports it has achieved laser action with current densities ranging from 10,000 to one million amperes per sq. cm., also applied in short pulses.

Evidence which indicates that coherent radiation is being produced includes the sharply beamed radiation pattern of the emitted radiation, the abrupt increase in beam intensity when excitation exceeds a critical value, and the pronounced narrowing of the spectral distribution of the beam.

Another important advantage of the new type laser is that it is far easier to modulate at high frequencies than previous types. The laser can be modulated directly by modulating the voltage applied to the diode.

North American Must Repay $16.5 Million

By Katherine Johnsen

Washington—U.S. Tax Court has ordered North American Aviation, Inc., to refund $16.5 million as excess profits on government business for 1953 and 1954. The figure was $3.5 million less than that originally sought by the Renegotiation Board.

In its opinion, the Court gave a resounding endorsement to North American's efficiency and the quality of its products—principally the F-86 and F-100 fighter aircraft—and severely criticized the Renegotiation Board for not recognizing these assets.

It was the Tax Court's second aerospace renegotiation decision. The first, handed down in January, required a $13 million refund by the Boeing Co. (AW Jan. 22, p. 32). It is still being contested, and Boeing currently has a petition pending for a change of venue from here to Seattle, Wash.

Other aerospace cases pending before the Court total over $100 million. They include $24.3 million in additional determinations against Boeing and $13 million in additional determinations against North American.

North American fared notably better than Boeing with the Court. The $16.5 million refund was $3.5 million less than the $20 million originally asked by Renegotiation Board, and $21 million less than $37.5 million sought by Justice Dept. when the case began.

The $13 million decision against Boeing was $3 million more than Renegotiation Board's original $10 million determination.

North American said that under the ruling, its net loss of profits after taxes would be $5.8 million. The company estimated its net loss after taxes under the Board's original $20 million determination at $6.8 million.

Under these estimates, North American stands to gain $1 million in profits as a result of the judicial litigation which has been under way almost six years. The Board issued its order on the company's 1953 business in February, 1957, and on 1954 business in April, 1958.

The most outstanding feature of the Court's opinion was the unrestrained and extensive praise given North American's performance and the severe criticism dealt Renegotiation Board for underestimating it. The Court noted that favorable consideration for excellence of performance is mandatory under renegotiation law, and indicated that this was a major factor in its reduction of the profit refunds asked by the Board and Justice Dept.

"As to efficiency of operations, quality of products, ability to meet production schedules and pricing on government contracts," the opinion declared, North American "has at all times here materially stood at or near the top of the aircraft industry. In general, as a builder of military aircraft," it continued, North American during 1953-54 "was not excelled by any other member of the industry and equaled by only a few, if any."

The Court flatly rejected Renegotiation Board's contention that North American "in the performance of most of its major contacts . . . was inefficient in its operations, that the quality of its products was deficient, that it failed to reduce costs and was not economical in the use of materials, facilities, and manpower."

The Court said: "The evidence of record is overwhelmingly to the contrary. It shows that in each of these categories North American was at or near the top of the aircraft industry. . . ."

North American's profit picture for 1953-54 was:

- **On sales of $634 million** for 1953, the company earned a 6.5% profit. For 1954, $646 million sales yielded 8.4%.
- **On book net worth** of $57 million in 1953, the company's return was 72%. In 1954, the return was 83% on $65 million book net worth.

On the perennial controversy over whether profits should be measured against sales or against net worth, the court re-affirmed its middle-road position in the Boeing case. It doubled North American's book net worth—and thus cut the profit percentage in half—to reflect the company's assets in "know-how" and give a more realistic picture of net worth.

In commenting on Renegotiation Board's primary contention that North American's profits were excessive because they constituted an unreasonable return on book net worth, the Court explained:

"However, in our consideration of this factor we have . . . increased [North American's] net worth figure by the value of its design and manufacturing know-how, which we feel is of the value of all its book assets combined."

The preponderance of North American's 1953-54 business, totaling $640 million, was for F-86D and F-86F Sabrejet fighters. Other sales were:

- **FJ-2s and FJ-3s,** Navy version of the F-86 series—$126 million.
- **AJ-2P Navy** photo-reconnaissance and AJ-2 Navy long-range attack aircraft—$86.5 million.
- **F-100A advanced fighters** incorporating the Pratt & Whitney J-57 jet engine—$46.5 million.
- **Guided missiles**—$63.7 million.
- **Rocket engines**—$24.6 million.
- **Electronics** and electro-mechanical equipment—$40.5 million.
- **Atomic energy projects**—$12.7 million.

The Court challenged Renegotiation Board's contention that the F-86 series, its Navy versions, and the F-100 were all "of inferior quality."

"The evidence as a whole refutes this contention," the court declared, noting that the F-86 series "pioneered in the field of modern fighter aircraft. They were used extensively in the Korean conflict with outstanding success and contributed largely to the air supremacy of the United Nations forces. The victory ratio of the F-86s over the Russian built MiG-15s was over 10 to 1 . . . They were the backbone of the U.S. air defense for several years thereafter.

"The F-100 was the first operational airplane to exceed the speed of sound in level flight," the court said. "Its advent is considered a milestone in the development of aviation.

"The FJ-2s and FJ-3s were rated as the best Navy fighters of their time," the Court said. "All of these airplanes admittedly fell short of perfection—and all of the witnesses agreed that no perfect airplane has ever been built—but they were the best of their types produced up to that time."

The Court commented that North American "showed commendable diligence and resourcefulness in improving the quality and performance of its airplanes."

The Court criticized Renegotiation Board for wanting to deny North American "any credit whatsoever for contributions to the defense effort in the production of its airplanes in 1953 and 1954. . . ."

Record NASA Contract

Washington—National Aeronautics and Space Administration has awarded a formal $319.9 million contract to North American Aviation Space and Information Division for development and production of the S-2 second stage of the Saturn C-5 launch vehicle. It is the largest single contract yet awarded by NASA.

North American was selected a year ago as stage contractor (AW Sept. 18, 1961, p. 26) and has been developing the stage under a preliminary contract. The S-2 will be powered by five J-2 engines, being developed by North American's Rocketdyne Division.

USAF Plans to Buy Gemini Spacecraft

Philadelphia—Air Force now is seeking authority to buy several Gemini spacecraft with which to conduct purely military experiments in orbit, Lt. Gen. James Ferguson, USAF deputy chief of staff for research and technology, said here last week.

A signal that Air Force has shifted its space aspirations may be contained in Gen. Ferguson's announcement. Earlier (AW Oct. 15, p. 32), an officer responsible for USAF space projects reported that the service preferred to work closely with National Aeronautics and Space Administration on Gemini rather than embark on a separate program. At that time, however, the comprehensive space plan prepared by Air Force for Defense Secretary Robert McNamara may have been in a fluid state.

According to Gen. Ferguson, Air Force wants "preliminary information on how man can perform certain space tasks" even before the first manned orbital X-20 (Dyna-Soar) flights are attempted, probably in late 1965. "The earliest vehicle which could help us in this is the NASA-developed Gemini—and the Air Force proposes to acquire some, perhaps as early as 1964," Gen. Ferguson told a symposium sponsored by USAF's Office of Scientific Information and General Electric here.

Early military experiments with Gemini—such as "assessing inspection techniques, appraising command and control problems and even experiments in maintenance and repair of military satellites"—could save valuable time, Gen. Ferguson said. His other remarks stressed the need for an early military capability in the technologies of maneuverable re-entry and the precise recovery of spacecraft returning from orbit.

S-3B Data Useful Despite Spin Problem; ANNA Performs Well

By George Alexander

Cape Canaveral—Two scientific satellites—one for geodetic research and the other for a thorough examination of the artificial radiation belts created by the July 9 high-altitude nuclear explosion in the Pacific—were orbited from here last week as the U. S. continues to increase its knowledge of the earth and its atmosphere.

ANNA (Army-Navy-National Aeronautics and Space Administration-Air Force) 1-B satellite was successfully launched Oct. 31 at 3:08 a.m. EST by a two-stage Thor Ablestar launch vehicle. On Oct. 27 at 6:15:01 p.m. EST NASA used a three-stage Delta to place Explorer 15 (S-3B) in orbit to study the energies, densities and decay rates of fission particles deposited in the earth's magnetic field July 9.

As of late last week, both satellites were telemetering useful data, although Explorer 15 was spinning at a rate higher than anticipated and ANNA experienced some ground-based computer difficulties.

ANNA 1-B, a 36-in. dia., 355-lb. sphere, carried three separate systems—optical, radio ranging and radio Doppler—to fulfill its mission of pinpointing various land sites within about 330 ft.; locating the center of the earth's mass and measuring the earth's magnetic fields. About 42 ground stations, including some in foreign countries, are expected to participate.

Army provided the radio ranging system, which, by comparing the phase between signals transmitted to ANNA by several ground stations simultaneously and then received by those stations, will allow precise calculation of distances between stations. Navy's radio Doppler unit, already used in the Transit program, uses four ultra-stable frequencies. Ground stations will determine range-rate information from the Doppler shift noted in the frequencies as the satellite passes overhead.

USAF provided four 8-million candlepower flashing lamps as ANNA's optical system. Lamps are flashed five times each, with a 5.6 sec. delay between flashes. Because of their extreme power consumption, the lamps are expected to be used only about once each day. Lamps will be activated when passing near the Naval Observatory in Washington, D. C. and Air Force and NASA stations equipped with stellar cameras so the flash may be photographed against known star patterns. Analysis will lead to fairly precise siting of the camera sites, determination of the satellite's orbital perturbations, estimation of earth surface points relative to the center of the earth's mass and clarification of the earth's size and shape.

The lamps were not to be triggered until early Nov. 4 so as to allow all residual air trapped within the spacecraft to escape and thus preclude arcing over of the equipment.

ANNA 1-B, which is managed overall by the Bureau of Naval Weapons, with technical assistance from the Applied Physics Laboratory of Johns Hopkins University, was the backup spacecraft for the unsuccessful ANNA 1-A launched last May 10. As of late last week, the satellite was in a near circular orbit of 600-640 naut. mi. (690-736 stat. mi.) and was expected to have a lifetime of about six months to a year.

Explorer 15, launched four days earlier than ANNA 1-B, was transmitting useful data through last week, although its high spin rate appeared to be adversly affecting some of the satellite's experiments.

The satellite, launched by NASA's Goddard Space Flight Center, was spinning at approximately 60 rpm. instead of the programed 6 to 10 rpm. Goddard program officials believe that the high spin rate was caused by failure of the de-spin mechanism and was adversely affecting the data gathering of secondary experiments aboard the satellite.

De-spin device is a weight attached to a line wound around the shaft of the parasol-shaped Explorer 15. Normally, it is released and unwinds counter to the satellite spin after burnout of the Delta launch vehicle's third stage. Reaction of the unwinding weight drops the satellite's spin from an initial rate of about 150 rpm. to about 20-22 rpm. and the unfurling of the solar paddles further reduces the rate to between 6 and 10 rpm. It is suspected that Explorer 15's weight device was not released.

Initial rate of 150 rpm. is imparted to the third stage and payload, shortly after separation from the second stage, by several small spin rockets at the base of the third stage. The spin is intended both to stabilize the payload and its stage prior to orbital injection and to nullify any thrust misalignment during third stage burning.

Deployment of the solar paddles was believed to have dropped the spin from 150 rpm. to 60 rpm. and although atmospheric drag is expected to reduce this rate further, it is doubted that the desired level of 6-10 rpm. will be achieved during Explorer 15's estimated lifetime of 60 days.

With a perigee of 193.7 mi. and an apogee of 10,760 mi., Explorer 15 is expected to paint a reasonably accurate picture of the artificial radiation belts created by the July 9 high-altitude blast, and, in so doing, provide criteria for the design of future satellites as well as to add to the general scientific knowledge on the earth's atmosphere.

Principal experiments aboard the 99.6 lb. Explorer 15 are an electron energy distribution device; electron and proton omnidirectional detector; electron angular distribution determiner; and electron directional detector. Also aboard are a magnetrometer; ion-ion-electron detector; solar cell damage indicator; and an optical aspect sensor for sun-orientation of the satellite.

Bell Telephone Laboratories provided the unit to measure the range of electron energies in the artificial radiation belts. This experiment consists of two directional and two omnidirectional silicon P-on-N junction particles detectors. Levels being examined run from 0.4 to 2.5 mev.

Similar in function to BTL's device is one prepared by the University of California at San Diego. It consists of two omnidirectional counters, one for electrons above 3.5 mev. and the second for protons above 35 mev.

BTL also built the experiment which is determining the angular distribution of the electron particle flux. The theory is that natural particles, because they have been trapped in the earth's magnetic field, should show a similarity in the angle formed between their spin axis and a local line of force. Particles with widely divergent angles may prove, in correlation with other data, to be man-made, rather than natural.

Particle directional detector, with a threshold level of 0.5-to-0.8 mev. for electrons and 5.0-to-5.2 mev. for protons, also was built by the University of California, San Diego, and will determine the direction from which the greatest number of particles strike the satellite.

The ion-electron detector and magnetrometer carried by Explorer 15 are similar to these flown aboard Explorer 14 (AW Oct. 8, p. 31).

But the threshold levels of the former generally are higher and the latter is measuring the earth's magnetic field only between 1.7 and 3.5 earth radii.

BTL provided a third experiment on solar cell damage. This consists of four groups of 32 small cells each, covered respectively with 10 mil, 30 mil, 50 mil and 80 mil sapphire, the latter being the thickest protective shield flown to date on a solar cell. Scientists hope to correlate damage with the incidence of artificial particles.

Because Explorer 15 was designed to fly into the heavier radiation of the artificial belts, in addition to the natural Van Allen zones, the cells on the spacecraft's solar paddles are protected by 60 mil quartz glass. In comparison, Explorer 14 (S-3A) carried only 6 mil quartz glass in its solar cells.

With experiments able to detect electrons between 0.1 and 10 mev. and protons above 35 mev., Goddard scientists hope to sort out artificial from natural radiation over the next several months as they analyze telemetry data.

It is believed that natural electrons seldom exceed 3 mev. and so particles above this probably originated in the July 9 blast. To differentiate between natural and man-caused radiation at the same energy level, Goddard will study the particles for signs of population, density and decay rates. Particles caused by the explosion, it is theorized, should be more closely grouped and should decay faster than natural electrons.

Explorer 15, built largely from back-up units for Explorer 14, was successfully launched by the three stage Douglas-built Delta vehicle. The Delta's record now stands at 13 payloads successfully orbited out of 14 attempts.

Flight profile for Explorer 15 was considerably different from that of its predecessor, which had a similar perigee of 175 mi. but an apogee of 61,000 mi. Explorer 15 was to swing no more than about 18 deg. north and south of the equator, so as to sample the largest possible concentrations of artificial particles trapped above the earth. To achieve this desired ephemeris, the Delta vehicle was launched at an azimuth of 100 deg. on a low flat trajectory.

Thor first stage burned for about 145 sec. Second stage, built by Douglas but powered by an Aerojet-General Corp. liquid engine, then separated and burned for about 115 sec. as the protective shroud surrounding the payload was jettisoned.

Following second stage shutdown, a 10-min. coast period ensued during which the vehicle—with the spent second stage still attached—was pitched down 15 deg. and then yawed 48 deg. to the left so as to place the spacecraft in the correct injection orientation for the desired low-inclination orbit of 18 deg.

Ranger Review Team

Washington—Members of the Ranger technical review board, headed by Cdr. Albert J. Kelley as chairman, began a four-week study Oct. 30 which will result in a complete analysis of the five Ranger failures (AW Oct. 29, p. 33). Board secretary is Dr. John Walker of National Aeronautics and Space Administration Headquarters.

Other members are James Koppenhave of Headquarters, Herman Lagow of Goddard Space Flight Center, John Foster of Ames Research Center, Frank Smith of Langley Research Center, F. J. Bailey and Dr. Arthur Rudolph of Manned Spacecraft Center, and John Hornbeck of Bellcom. Advisers are Newton Cunningham, Ranger program chief, and Walter Jacobowski, Ranger program engineer, both of Headquarters.

Workers at Two Firms Vote Down Union Shop

Los Angeles—Labor union hopes of winning a union shop in the West Coast aerospace industry suffered a severe jolt recently when workers voting in elections conducted by the National Labor Relations Board at North American Aviation and General Dynamics facilities failed to give the union shop proposal a necessary two-thirds majority.

Under terms of recent contracts (AW Oct. 8, p. 41), management of North American, General Dynamics and Ryan Aeronautical agreed to an employe vote on a union shop recommendation by a presidential fact-finding panel.

Workers at Ryan Aeronautical were scheduled to go to the polls Nov. 1 in a union shop election.

News Digest

Soviet Russia launched a 1,965-lb. spacecraft called Mars 1 from a parking orbit toward the planet Mars on Nov. 1. It will attempt to photograph the planet's surface and relay photos to earth. Russia apparently used an improved booster of the type tested last Oct. 16 and 17 (AW Oct. 22, p. 27). Russia failed on Oct. 10 and Oct. 14 of 1960 in attempts to send probes to Mars. Optimum date that year was Oct. 1. Optimum date this year is Nov. 16, meaning the Soviets fired almost two weeks early.

Third Hawker P.1127 prototype (AW Sept. 17, p. 54), was slightly damaged last week in an emergency landing at wartime Tangmere station in Sussex England. Pilot Hugh Merewether landed after experiencing partial loss of thrust of Bristol Siddeley BS.53 vectored-thrust engine.

Eagle-Picher Co. has been awarded the Apollo spacecraft battery system subcontract by North American Aviation, Inc., Apollo prime contractor. Battery system will supply power during and after re-entry for life support and recovery systems. Fuel cells will power systems during the remainder of the mission.

Vice Adm. Robert B. Pirie, who retired last week as Deputy Chief of Naval Operations for Air, has joined Aerojet-General Corp. as executive assistant to the president, Dan Kimball.

Eger V. Murphree, president of the Esso Research and Engineering Co. and long-time scientific adviser to the government, died Oct. 29 in Summit, N. J. In 1956-57, he served as special assistant to Defense Secretary Charles E. Wilson. He also was a member of the Office of Scientific Research and Development Committee which played a key role in formation of the Manhattan Project for developing the atomic bomb in World War 2.

Air Force-Martin Co. Titan 2 made a successful 5,000-mi flight down AMR Oct. 27.

International Fares Compromise Reached

IATA traffic conferences agree on 5% increase in round-trip fares and expansion of promotional rates.

By L. L. Doty

International airlines last week reached a compromise on fares by making slight concessions to high-fare advocates and by expanding group and promotional rates to satisfy those carriers seeking to answer public demands for lower fares.

After almost five weeks of negotiations at Chandler, Ariz., International Air Transport Assn. traffic conferences were able to reach some agreements, although North Atlantic fares still are not settled and a number of other problems remain unresolved. Essentially, all round-trip fares throughout the world will be raised by 5%, but group fares will be reduced and expanded to embrace a number of additional routes (AW Oct. 22, p. 36).

Demands by Scandinavian Airlines System and Pan American World Airways for piston-aircraft fares as low as those charged by non-IATA Loftleider, the Icelandic airline, failed to win any support, but threatened to throw the conferences into a stalemate (AW Oct. 29, p. 42).

Last week, Pan Am withdrew its demands and SAS, although refusing to surrender its position, agreed to accept the North Atlantic fares tentatively, subject to a 45-day review by SAS of the rate on its North Atlantic route. SAS is now expected to seek a government order directing it to reduce piston-aircraft fares to the level of Loftleider's.

Such a move would prevent a final agreement on rates established by the conferences, since all fare resolutions must be approved unanimously by IATA carriers. The fare reduction also would require U. S. approval to be effective.

However, the U. S. began negotiations last week with Iceland on a bilateral transport agreement. Prime purpose of these talks is to attempt to persuade Iceland to sign a Bermuda-type agreement which, automatically would force Loftleider to raise its rates to IATA standards.

Although Defense Dept. has requested the State Dept. to refrain from pressing too hard on this issue because of defense considerations, the latest SAS move will undoubtedly have some influence in steering the Icelandic delegation toward accepting the Bermuda principles.

If the fare structure in the North Atlantic area is approved, round-trip discounts will be decreased from 10% to 5%, which means, for example, that the present one-way London-New York jet economy fare will remain at $270, but the round-trip fare will be increased from $486 to $513.

Group fares for the New York-London round trip will rise from $300 to $310 and provisions for "spontaneous" groups will be eliminated. Excursion fares will be available from Oct. 1 to Apr. 30 instead of the current Oct. 1-Mar. 31 period, and travel time will be extended from 17 to 21 days.

Family fares, permitting a reduction of $150 on round-trip jet economy fares and $300 on jet first-class fares, will be available for members of a family traveling together with one member of the family holding a full-priced ticket.

Reduction of 30% will be granted emigrants from Europe to North America and from the United Arab Republic to Canada. If approved, the agreements will run from Apr. 1, 1963 to Mar. 31, 1965.

Most of these fares were approved during the earlier sessions of the conferences, but the final decision was delayed by disputes over the Loftleider issue and the "malpractice" resolution. Thus, the new fare level reflects an industry fear that lowering fares may slice into revenues without generating new traffic. Although the drive for higher fares was strong during the opening days of the conferences, with only Lufthansa German Airlines taking a position for lower fares, most carriers are content that the status quo has been maintained.

This industry attitude suggests that the future is still blurred by an erratic traffic growth pattern, continuing problems of excess capacity and by an expense level that continues to climb despite real efforts to control it. As a result, airlines apparently are not ready to commit themselves to lower fares, which might only keep revenues the same in the face of mounting costs.

Proponents of employing lower fares to attract new traffic thus have been largely ignored, and this group is not likely to be mollified by the few moderate adjustments to the promotional fares now in effect. It is possible that, during the next two years, new promotional fares will be proposed if traffic volume fails to show some recovery.

The Chandler conferences seem to indicate that protection of revenue yield is uppermost in the minds of most airline officials and that no move that would risk reducing that yield will be made. Experimentation with lower fares as a means of developing new traffic will be undertaken cautiously, as it has in the past.

During the IATA Annual General Meeting in Dublin (AW Sept. 10, p. 36), demands for revamping the overall international fare structure ran high, particularly with respect to fares on the European legs of transatlantic trips. As a result, the conferences adopted resolutions to reduce "mileage giveaways" which result from circuitous routings in Europe between various points at little additional cost to the passenger.

Beyond that, however, no basic rate changes were made. Most adjustments were confined to expansion of the group fares and to a lowering of North Atlantic first-class round-trip jet fares so that the reduction of the round trip discount would not reflect an increase in these fares.

Round-the-world fares for groups of 15 or more were introduced and approved to reduce standard economy rates by 30%. Group round-the-world trip rates will fall below the $1,000 level for the first time. Standard round-the-world passenger fares remain unchanged.

Excursion Points

Regular passenger fares between North and South America also remain the same.

However, 17-day excursions are established between eastern Canada and Mexico and from Caribbean points to major Canadian cities.

Groups of 25 or more will be granted 20-25% discounts on trips between the U. S. and Caribbean points including Bermuda, Nassau, Jamaica and Trinidad.

A number of round-trip fares between the U. S. and South America will be decreased to absorb the reduction on round-trip discounts.

Group discounts will run as high as 50% on some routes in Africa and the Middle East. Group fare discounts on tickets from Europe to India, Pakistan, Ceylon and Nepal will be increased from 22% to 36% and the maximum group limit is increased from six to nine persons.

Transpacific Flight

Group fares will be introduced on transpacific flights on a seasonal basis and tour fares 22% below normal will be introduced from Australia and New Zealand to other parts of Asia and the Far East.

The once-controversial issue of fare differentials for piston-engine aircraft and jet aircraft drew very little attention as a result of the rapid phase-out of piston-engine equipment on regularly scheduled transatlantic flights. Until Mar. 1, 1964, a differential of $20 for economy flights and $60 for first-class flights will apply on propeller-driven aircraft.

Transatlantic Capacity

London—High cost of transatlantic air fares has created an excess capacity that last year was the equivalent of operating 11,000 transatlantic flights without a payload, or 30 empty jet flights per day, the British Royal Aeronautical Society was told last week.

Harvey J. Wexler of the U. S. Air Transport Assn., speaking independently, said that U. S. travelers have tentatively booked all available space through 1964 on ocean freighters sailing from the U. S. to Europe. He said it is somewhat ironical that while air transportation suffers, "consumers' demands for a similar service at substantially lower rates are going unsatisfied."

He said that there appears to be no lack of funds for travel by U. S. citizens, since hotel and motel businesses are booming. He concluded that the cost of air transportation has confined travel on both sides of the Atlantic to continental rather than transatlantic travel.

Lufthansa-Olympic Pool

Cologne—Lufthansa West German Airlines and the Greek carrier, Olympic Airways, have agreed to pool services on several of their individual routes. The agreement, which became effective Nov. 1 for an indefinite period, may later be extended to cover the joint operation of certain new route extensions planned by either or both carriers, according to a Lufthansa spokesman.

CAB Unit Seeks Less Competition Among U.S. Caribbean Airlines

Washington—Reduction of competition among U. S. airlines in the Caribbean is being sought by Civil Aeronautics Board attorneys in recommending that the area be divided into a series of long- and short-haul routes.

CAB's Bureau of Economic Regulation counsel in the United States-South America Route Case urged that future determination of routes into South America should be conditioned upon the following changes in the Caribbean:

- **Elimination of operating** certificates held by U. S. carriers for points where service has not been inaugurated.
- **Elimination of competition** between U. S. airlines to foreign points within the Caribbean.
- **Division of the traffic** area into seven long-haul and island-hopping routes.
- **Increased service** from Puerto Rico to interior U. S. cities.

Because of the current situation, the Bureau eliminated Cuba from its route recommendations. Service into Mexico and Bermuda was also excluded.

Five of the suggested long-haul routes would generally connect the gateway cities of New York and Miami with San Juan, Puerto Rico, and New Orleans and Houston with the northern coast of South America via Mexico City and points in Central America. Los Angeles and San Francisco would enter the route system to South America at Guatemala City.

The two short-haul routes would involve island-hopping service through the Bahamas from Miami and West Palm Beach and routes serving the Virgin Islands, Barbados and Caracas from San Juan.

The Bureau's recommendations to eliminate competition among U. S. carriers could result in one-carrier service into Caracas, currently served by Delta and Pan American; Balboa, served by Braniff and Pan American and Jamaica, served by Delta and Pan American.

San Juan is a focal point of much of the Bureau's findings, which emphasize the importance of the city as a traffic point and the need to expand its present three-carrier service.

One airline should be granted authority between New York and San Juan as part of a long-haul South America route, a second should have nonstop and through service beyond New York from San Juan and a third should include stops at Port-au-Prince and Aruba on the New York-San Juan routing, the Bureau said.

The attorneys also recommended direct service from Miami and New Orleans to connect San Juan to the interior and West Coast of the United States.

To provide a direct express service for U. S. vacationers to most of the remaining Caribbean resort areas, the Bureau recommended that one airline be authorized to provide a nonstop service from both New York and Miami to Nassau, Montego Bay, Kingston, Santo Domingo, Barranquilla, Maracaibo, Curacao, Caracas and Port of Spain.

Dulles Service Needs Studied by 11 Airlines

Washington—Eleven airlines are analyzing a detailed survey of passenger boarding figures for the entire Washington-Baltimore area in an effort to determine the amount of service that will be required at Dulles International Airport, scheduled to open Nov. 19.

Results of the study, which was financed jointly by the carriers and the City of Baltimore, have been released by the Civil Aeronautics Board with a notation that the information will form the basis for future schedule planning at Baltimore's Friendship International Airport and Washington National Airport, in addition to Dulles.

The survey, which was conducted for one week in August, showed that more than 77% of the total flights scheduled from both Friendship and Washington National produced 37,881 completed questionnaires. The inquiries covered the passenger's residence, which airport was used and the type or transportation used to arrive at the airport.

Statistics indicating passenger preference for either Friendship or Dulles have not yet been developed, the Board said.

Breakdown of the survey figures shows that 10,608 passengers who returned questionnaires were residents of the Washington-Baltimore area and 11,743 were visitors, for a total of 22,351 passengers boarding at National and Friendship. In addition, there were 6,362 connecting passengers at the two airports and 7,500 through passengers. Among the resident and non-resident total, 12,736 boarded at Washington National while 6,651 boarded at Friendship.

Transportation to the airport for 7,402 passengers at both airports was by private auto, while 2,642 apparently drove their own cars and parked them at the airport for the duration of their journey. Another 4,934 passengers arrived at the airports by taxicab and an additional 3,467 used the airport limousine service.

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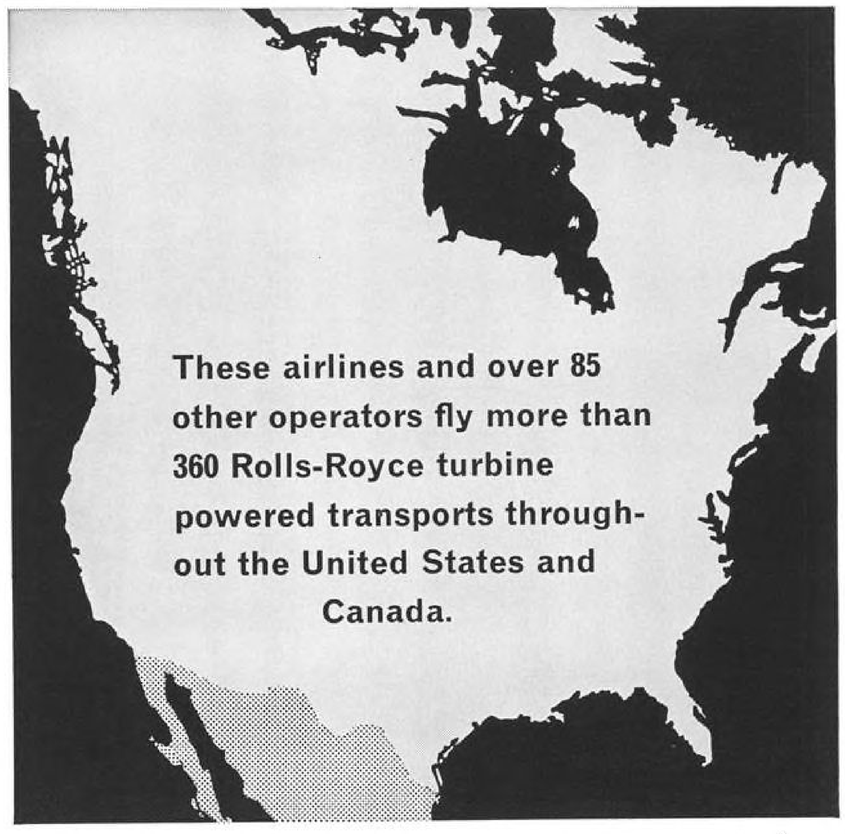

Rolls-Royce turbofan, turbojet and turboprop engines are being overhauled at Dallas, Denver, Los Angeles, Millville N.J., San Francisco and Washington D.C. in the United States, and by Rolls-Royce of Canada and operators at Montreal and Winnipeg. More than 50 Rolls-Royce field service engineers are stationed with aircraft operators across the North American Continent.

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Pilots Voice Auto-Landing Requirements

By Herbert J. Coleman

Amsterdam—Manufacturers of automatic landing equipment learned here that the toughest customer may not be the airlines, but the pilot who pushes the system buttons.

In a two-day meeting sponsored by the International Federation of Air Line Pilots Associations, manufacturers of U. S. and British automatic landing systems, heard, in no uncertain terms, that:

- **Pilots resent the manufacturers' term** "Keep the pilot in the servo loop" as unnecessary sales jargon. Pilots also complained about the tendency to make them only systems managers.
- **Pilots want up-to-date progress** reports on developments in automatic landing techniques and testing, based on competent technical reports, preferably in the realm of flight testing, and not in sales brochures.
- **Heads-up situation display** in the cockpit will be a necessity.
- **Automatic landing research** and development should be a joint effort by manufacturers, pilots and operators, in view of its commercial potential.
- **Primary concern by pilots** is the ultimate safety factor involved in the so-called black box landings, rather than any resistance to automatic landing devices as another move to reduce pilot responsibilities.

Last point sparked off considerable debate on the design and efficiency of monitoring devices, particularly at the last 100 ft.

There was some feeling that at today's jet landing speeds, the moment of decision at 100 ft. had passed from the pilot to the black box, come what may.

Annual Meeting

The Amsterdam IFALPA meeting was a comparatively informal gathering to assimilate the developments for a study group which will report at the IFALPA annual meeting in Southern Rhodesia next March. The meeting, however, was monitored by various European governmental aviation groups, such as British, French and Dutch ministries of aviation, and a number of weather experts.

Meanwhile, International Civil Aviation Organization (ICAO) is currently forming a specialist panel to resolve problems of automatic landing systems operational requirement effort on acceptance.

Gist of the symposium was summed up by Capt. F. Ormonroyd, flight technical superintendent of British European Airways, who said both the pilots and the operators want an autopilot and authority. Capt. Ormonroyd said:

"Pilots are sick and tired of disconnecting at 200 ft. This is the time when you want all the help you can get."

Ormonroyd added that complete all-weather landing capability would save BEA $185,000 a year at London (Heathrow) airport alone. He recalled that 12 straight days of low visibility weather in the winter of 1958-59 had cost the state-owned airline more than $750,000.

Ormonroyd also stressed that in the jet age, the pilot's main function is that of a manager who sets up a system and then determines how it will be used. He also claimed that automatic throttling, an integral part of all the landing systems, is the biggest saver of airplanes yet, and the sooner it gets on the big jets as a retrofit, the better.

During the session, pilots were addressed by technical representatives from Eclipse Pioneer Division of Bendix, Elliott Brothers, Smiths Aviation Division, Sperry Gyroscope Co., Ltd., Standard Telephones & Cables, Ldt., and Lear Siegler.

With the exception of the Lear Siegler system, all developments under way are predicated on either duplex or triplex channels, with automatic switchover and monitoring in the event of failure.

Automatic Landings

Lear Siegler system, a single-channel development using a Lear L-303 autopilot, has made 60 completely automatic landings in a Sud Caravelle now undergoing test at Toulouse. Landings have been made using existing azimuth and glide slope equipment, and in cross-winds up to 10 kt. Lear Siegler philosophy on single-channel is that such a system reduces electronic complexity and that any failure will be soft, to eliminate a hard-over control condition.

Smiths Autopilot System is under test in the No. 2 de Havilland Trident and also will be flight tested in two Sud Caravelles. System is triplexed and has been fitted in a Federal Aviation Agency Douglas DC-7 now based at Atlantic City, N. J. (AW Aug. 20, p. 98).

Early next year, Smiths will conduct a series of operational tests under actual blind landing conditions, using a triplexed system installed in a company-owned Vickers Varsity transport. Tests will include an intensive investigation into the psychological aspects of using a completely automatic landing system under blind conditions, as opposed to hooded or simulated conditions.

Both the Trident and the Vickers VC.10 four-jet transport, which uses Elliott Brothers duplex system, were designed for automatic landing from the date original specifications were laid down (AW Jan. 22, p. 67). Duplex system for the VC.10 probably will be flight tested in tandem with certification tests, although Vickers and Elliott Brothers had, at one time, considered a testbed similar to the Smiths Varsity.

As far as the pilots at Amsterdam were concerned, an important phase of automatic landing, from the cockpit point of view, will be visual aids for the pilot, either by a heads-up display or instrument panel situation presentation of what the manufacturers call outside world conditions.

Display System

Furthest along in this phase is Sperry, with its windshield display system (AW Oct. 15, p. 91), which provides the pilots with cues identical with ones in the outside world, and that merge with the actual cues, such as horizon points, when the pilot goes visual.

Considering all these factors, from safety to pilot presentation, IFALPA told manufacturers that automatic landing, approach and taxiing should consider these factors:

- **Total mathematical probability** of a failure rate in the system as a whole should not exceed, during any one approach, the equivalent of 1 to 10^{-8} per flight. ICAO target is 1 to 10^{-7}, or one failure in 10 million landings.
- **Monitoring**, during initial development, should be in two sections: down to critical height, it should be possible by means of instruments in the cockpit, and below critical height, defined as 100 ft., adequate visual guidance should be provided.
- **Automatic go-around capability** should be provided down to start of the actual flareout. Emergency go-around should be available, with correct presentation on the flight director system, up to touchdown, and should be available automatically by opening throttles to takeoff power.
- **Before the airplane** reaches the point of decision, when reliance must be placed on the automatic landing system, the crew should be able to make a complete in-flight check for proper functioning of the equipment.
- **Ground radio equipment** should be duplicated and should have automatic switchover capability in the event of failure of one transmitter. Radio frequencies should be selected from a band which will not be affected significantly by stray signals.
- **When crew selects automatic** landing

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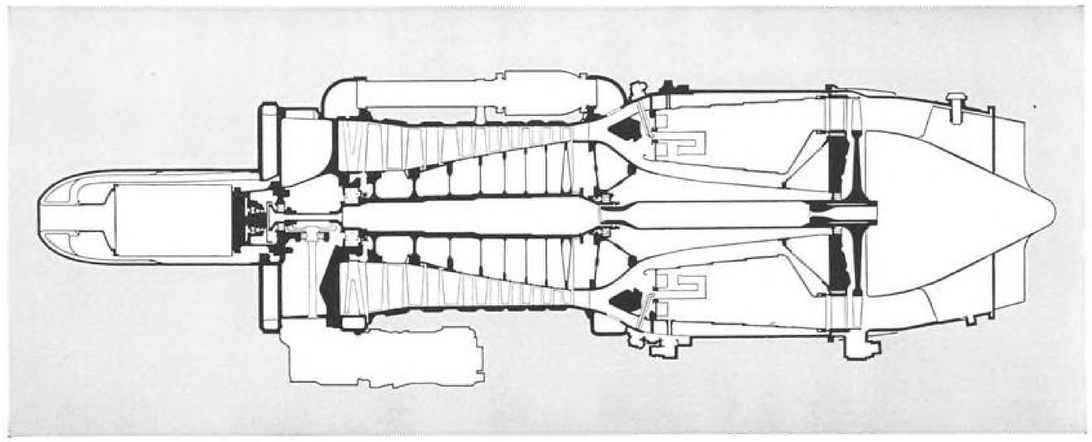

The Bristol Siddeley Viper 20 is now at an advanced stage of development for the next generation of light executive transports. This new version is basically a Viper 11 with a "zero" stage added to the compressor which gives a 20% increase in mass flow, a reduced turbine entry temperature and an improved specific fuel consumption. Like all its predecessors, the Viper 20 retains the basic design concepts of a simple, reliable engine with high thrust at high altitude and *low first cost*.

Delivering 3,000-lb thrust at take-off for a sea-level specific fuel consumption of 0.985 lb/lb/hr, the Viper 20 has potential for development to still higher thrusts and lower specific fuel consumptions.

Piaggio/Douglas 808 executive transport.

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system phases, it should not be necessary for them to tune any of the equipment. In final landing phases, during early evaluation, it will be necessary for the pilot only to monitor the equipment, and not to adjust it.

Ground Radio

In the ground radio phase, Standard Telephones & Cables reported considerable progress with the Stan 7 horn equipment (AW June 11, p. 43), a 24-element horn array mounted at Hurn Airport in England with some funding from British Ministry of Aviation. Testing has concentrated on lowering the angle of beam to 7-10 deg. above the horizon and appreciably reducing the possibilities of interference by overflying airplanes.

F. H. Taylor, of Standard Cables' design team, told the pilots that reliability now is being studied, but that the problem of an adequate form of monitoring still has to be solved. The team has found that peak strength is 4 deg. from centerline of the runway and Taylor said this strength is "the best we can do and it would be fruitless to go further."

Another step will be to reduce total power from 10 w. to 3 w., which would allow transistorizing of the entire system. In numerous flight tests, with Ministry and civil aircraft participating, reliability of the Hurn Stan 7 system has reached the point where Standard Telephones & Cables is offering it for flight test to any operator.

Taylor said the facility will be available after Nov. 6 to operators with an aircraft fitted with proper calibration equipment.

The company's radio altimeter has flown considerable time on a KLM Douglas DC-8 in a continuing series of reliability tests, according to W. L. Garfield. Accuracy has been maintained to ±1 ft. in the critical range starting at 60 ft. altitude.

All companies involved also are testing for the effects of windshear at critical points below 100 ft., coupled with considerable data collected in the past two years on automatic aircraft runway alignment to compensate for crosswind, just before touchdown and after the automatic flare has started.

Sperry, for instance, has landed its Douglas DC-3 in a 15-kt. crosswind blowing 90 deg. off the runway, and John T. Long, engineering test pilot at Great Neck, L. I., told the pilots it aligned itself, but it was nerve shaking.

Long, the only test pilot to address the group, stressed that the basic point in Sperry's philosophy was to keep the pilot in the loop, adding:

"For the foreseeable future there will be a human in the cockpit, and as long as he is in there it will be very difficult to keep him out of the loop. . . . We have to recognize that he holds an almost irrevocable veto power."

Pilot comments, although constructive, contained an element of show-me philosophy, exemplified by a warning from KLM Capt. C. M. Ramsey, who said the industry may be entering the area of "Look, Ma, no hands."

There was general agreement when Ramsey, commenting on the single-channel system taking over at 100 ft., said that if this was to be so, then the autopilot should include a special pocket for a prayer book.

Additional Factor

Another factor, raised by Capt. C. C. Spencer, of Air Line Pilots Assn., was that passenger must be assured that his trip is not entirely committed to black boxes, in a reference to the pilot's command decision role. Capt. Z. L. Zeyfert, KLM pilot who was symposium chairman, pointed out that he believed the pilot will accept automatic landing, as he accepted the automatic pilot and flight direction, if he always is in charge of his flight. The question, Zeyfert asked, is whether a pilot should be asked to accept blindly that the automatic pilot does his thinking for him.

First BAC 111 Fuselage Completed

External fuselage structure of the first BAC 111 twin-jet transport has been completed at Vickers-Armstrongs' Hurn, England, factory, where final assembly of the short-to-medium-range airliner is being carried out. Tail section, constructed by Bristol Aircraft, has been mated. Next step will be addition of wings built by Hunting Aircraft at Luton. All companies are members of British Aircraft Corp.

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SHORTLINES

► **Air-India** Chairman J. R. D. Tata recently piloted a de Havilland high-wing Leopard Moth monoplane between Karachi and Bombay in 7 hr. to commemorate his flight 30 years ago that began India's first scheduled airline service.

► **Air Transport Assn.** has renewed its drive to have scheduled airlines handle all first-class mail between major cities separated by substantial distances. ATA President Stuart G. Tipton said that the ability of airlines to move first-class mail has been proved over a nine-year experimental period.

► **Allegheny Airlines** has reported a 21% increase in the number of passengers carried for the first nine months of 1962 over the same period last year. During the same periods, cargo volume increased 33%.

► **American Airlines** President C. R. Smith has predicted that the United States will build supersonic transports "because we cannot be without them," but that they will not be in scheduled passenger service within the next 10 years.

► **Braniff Airways,** Northeast Airlines and Northwest Airlines will open their new joint terminal at New York International Airport within the next two weeks.

► **Continental Air Lines** last week reported a net income of $737,000 for the first nine months of the year, compared with $882,000 for the same period last year. Third quarter profit was $361,000, compared with $340,000 in 1961's third quarter.

► **Eastern Air Lines'** Air-Shuttle recorded an on-time record of 96.3% from Apr. 30, 1961 to mid-October this year. In September, the Air-Shuttle operation handled more passengers than in any single month since the service was started 18 months ago.

► **Pan American World Airways** showed a 31% increase in the volume of transatlantic air freight handled during the first nine months of 1962, compared with the same period last year.

► **U. S. trunk** and all-cargo airlines flew 48.5 million ton miles of air freight in domestic operations during September, an 18.3% increase over the 41 million ton miles carried in the same month last year.

AIRLINE OBSERVER

► White House study group has privately concluded that many of the problems cited by international carriers regarding relations with foreign flag carriers are without foundation. Thus, the steering committee on a policy for U. S. international air transportation continues to be reluctant to let the airline industry review its first draft of the policy developed from the original study (AW Oct. 29, p. 49). Chief concern is that the airlines will re-introduce problems which the study group's findings suggest do not exist and weaken support of the policy as it is now conceived.

► **Watch for Federal Aviation Agency to publish a proposed rule that would require U. S. airlines to install improved landing gear warning systems in all transports. In current airline aircraft, when throttles are retarded beyond a certain point and landing gear is either up or not fully extended, a horn sounds. FAA feels that pilots should be given still greater warning of possible gear malfunction, perhaps through an independent, supplemental system. The rule, if enacted, probably will apply to all U. S. aircraft with retractable gear.**

► When American Airlines announced its plans to purchase four Boeing 320C turbofan freighters for an all-cargo domestic service (AW Oct. 29, p. 43), another major trunkline was in the middle of a survey designed to prove that a fleet of all-cargo jet transports would be unprofitable.

► **United Air Lines has reduced depreciation expense on its jet fleet by extending the depreciable life of four-engine jet aircraft from 10 to 14 years. Depreciation expense for the first nine months of 1962 thus was reduced by $3 million to increase earnings for the period by $1.4 million. Residual value of the aircraft has been reduced from 15% of the original cost of the aircraft to $100,000 for each hull and $1,000 for each powerplant. United's net earnings for the first three quarters of the year totaled $6.1 million.**

► Length of average passenger haul on Soviet Russia's state-owned airline Aeroflot is shorter than the average passenger trip by U. S. scheduled airlines, according to data released by the Soviets for the first time. In 1961, average passenger haul by the Russian carrier was 467 mi., compared with 681 mi. by U. S. domestic trunklines. Aeroflot still has relatively little long-haul traffic across Russia's largest land mass—Siberia—compared with U. S. transcontinental traffic. Soviet carrier's long-haul international business is also relatively small. While the U. S. scheduled airline industry's average passenger haul has increased steadily during recent years, Aeroflot's average has remained fairly constant. In 1960, it was 469 mi.; 1959, 463 mi.; and 1958, 481 mi.

► **Communist China has reported the opening of regular passenger air service between Vientiane, capital of Laos, and Phnom Penh, capital of Cambodia. Initial frequency is one flight weekly.**

► Scandinavian Airlines System pilots plan to demand less flight time and better pay to offset the increased strain of jet operations. Pilot groups are now seeking a complete study of medical problems involved in long-distance, short-turnaround jet flights.

► **Japanese government has told the Soviet Union that Russian rocket tests in the Pacific will seriously impair operations of Japan Air Lines and cause a heavy financial loss. Japan asked that Russia notify it 96 hr. before each test to keep losses at a minimum, and demanded that confirmation be made 24 hr. prior to launching. The tests, which began Oct. 16 (AW Oct. 22, p. 27), are to continue through November.**

► Local service airlines are divided in their reasons for rejecting the trunk carriers' no-show penalty plan. Cost of adopting the plan would be prohibitive for most because of the small yield of average tickets. A few locals are using their rejection of the idea as a sales instrument to attract more passengers. Meanwhile, some trunk carriers have suggested they may drop out of the plan if locals don't accept it.

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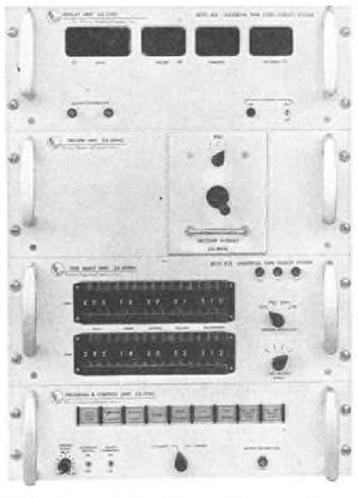

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EE 2-53

Sabena Will Resume Helicopter Schedules

Brussels—Sabena World Airlines is reviving its international scheduled helicopter service on a reduced basis despite an earlier ruling by the carrier's board of directors to suspend the financially unsuccessful operation for an indefinite period (AW July 23, p. 31; Sept. 10, p. 125).

New decision, largely prompted by appeals against the planned suspension from a number of cities along the route structure, was made after Sabena had sold its fleet of eight Sikorsky S-58 helicopters to the Belgian air force. Two of these are being re-acquired by the airline on a lease basis to provide a seven-city network with a total of 27 round trips per week.

Network before the planned suspension of the service at the end of 1962 summer schedule had included 10 cities. Those eliminated under the new plan are Paris, Antwerp and Dortmund, West Germany. The schedule, which became effective last week, provides for these flights from Brussels:

- **Three a week** to Duisburg, Germany, via Cologne, with an optional stop at Liege, Belgium, and/or Maestricht, Holland.
- **Six a week** to Cologne, also with an optional stop at Liege and/or Maestricht, based on passenger demand.
- **Six a week to Rotterdam,** with an increase to 12 per week under a new schedule which becomes effective Feb. 4. All flights will include stops at Endhoven, Holland, a major passenger point on the network.
- **Twelve a week** direct to Endhoven.

Sabena spokesman says that scheduling plans for next summer, when the traffic potential should rise sharply, are being held in abeyance until the carrier can determine just what types of helicopters may be available on a lease basis.

For this period, the airline would like to obtain more economical turbine-powered equipment to replace the S-58s, possibly the Boeing Vertol 107.

BOAC Investigation

London—Minister of Aviation Julian Amery has contracted with private firm of certified public accountants to carry out an investigation of complicated financial structure of British Overseas Airways Corp. Move has the support of Sir Matthew Slattery, BOAC chairman, who recently referred to BOAC's finances as "bloody crazy" (AW Oct. 15, p. 38). Slattery has been pushing for government permission to completely write off capital costs of the airline's de Havilland Comet 4B and Bristol Britannia fleets to save interest charges.

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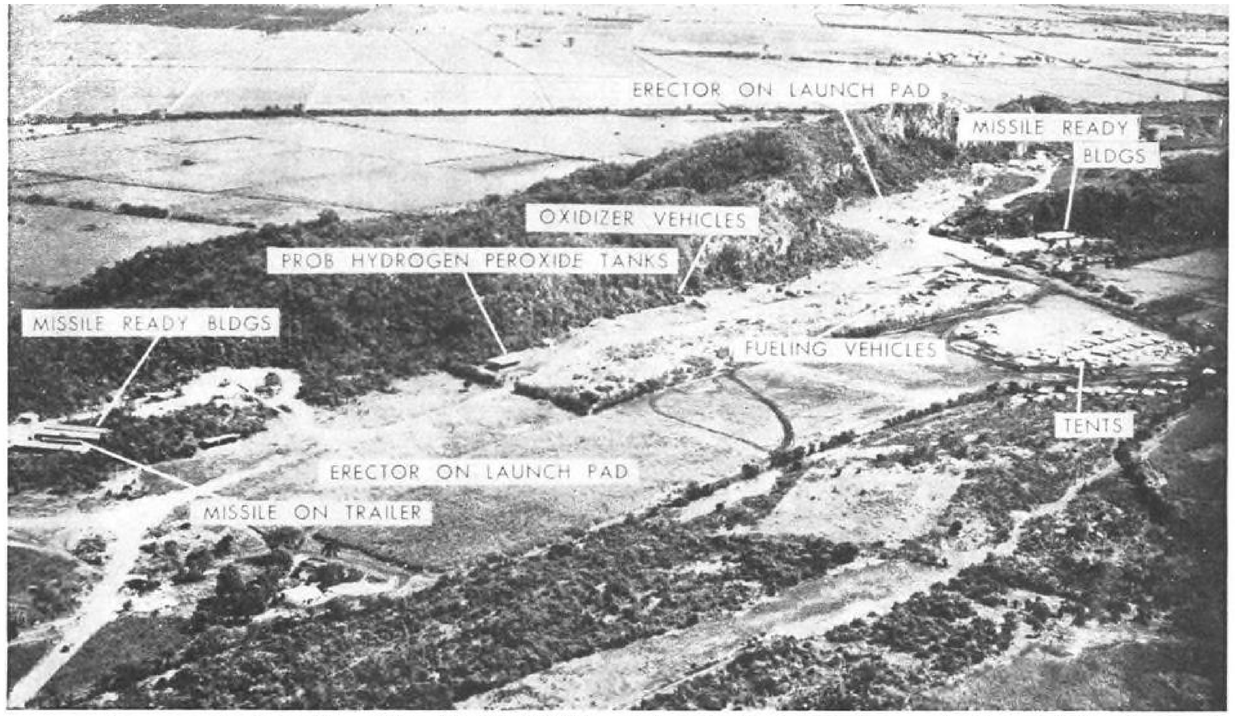
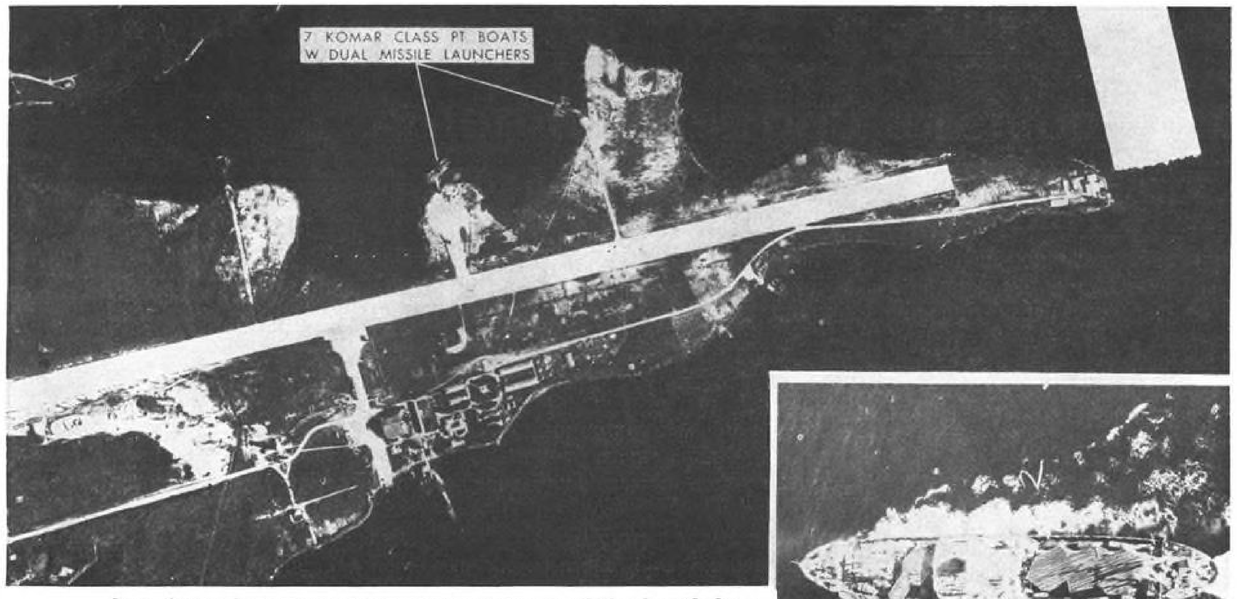
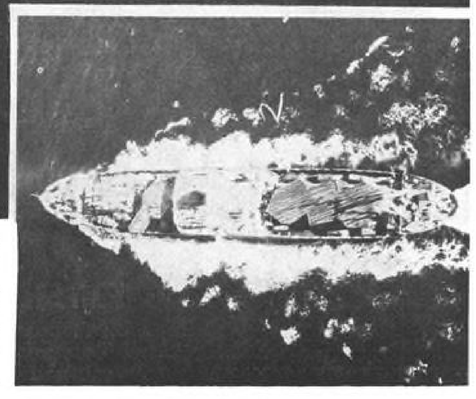


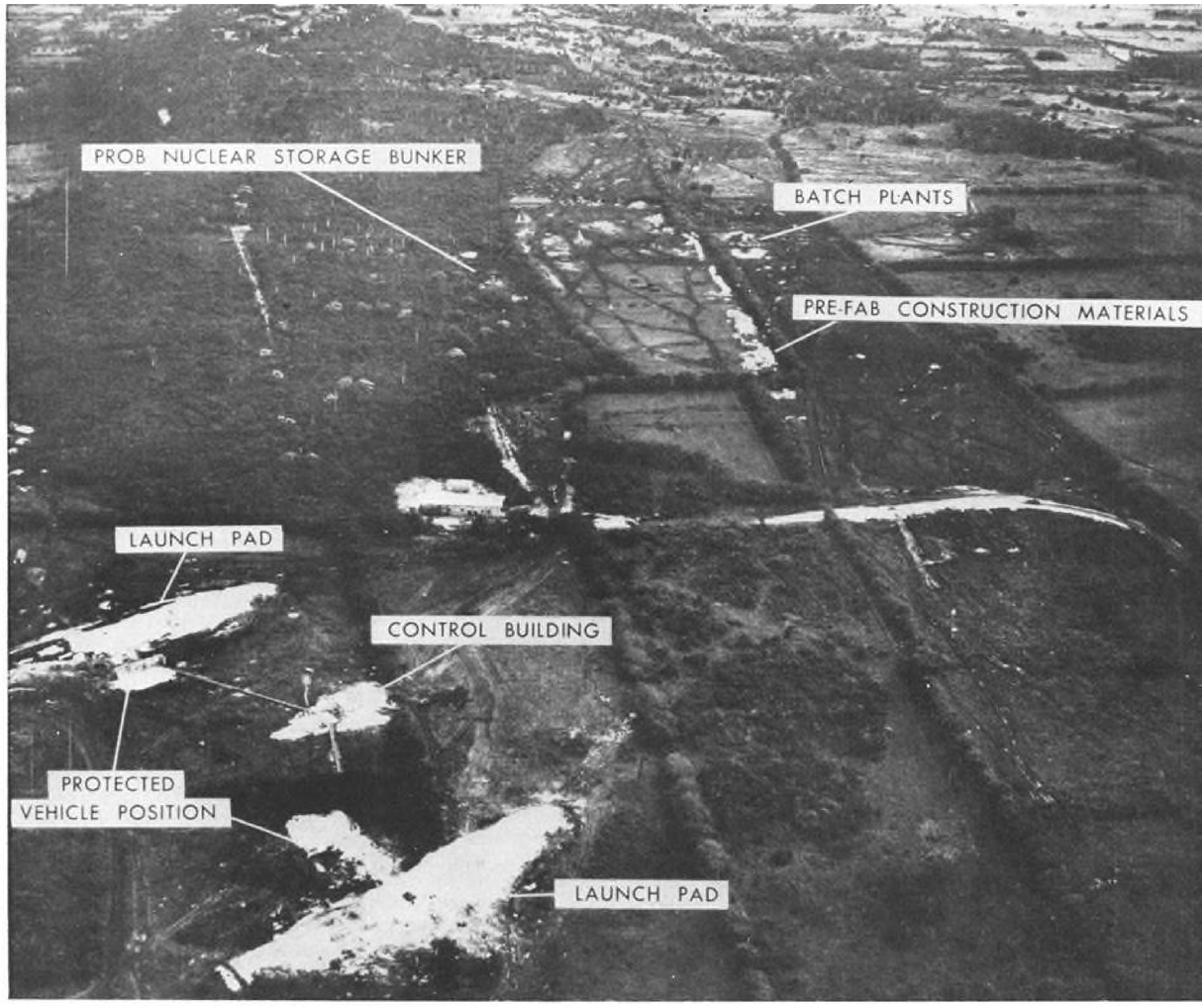
Longer range low-level oblique photo of Soviet MRBM base at Sagua La Grande, Cuba (see cover for closer view) shows launch pads for the Shyster 1,000 naut. mi. range liquid fueled missile carefully sited for blast protection from rocky ridges. Hydrogen peroxide plant services mobile oxidizer trucks parked at foot of wooded ridge for easy camouflage. Both launch pads shown here are in operational status with erectors, theodolites for guidance alignment, flame deflectors and servicing gantry in place. Cables connect the firing sites with central camouflaged launch control center in wooded area.

Low-Level Photos Pinpoint Cuban Missile Sites

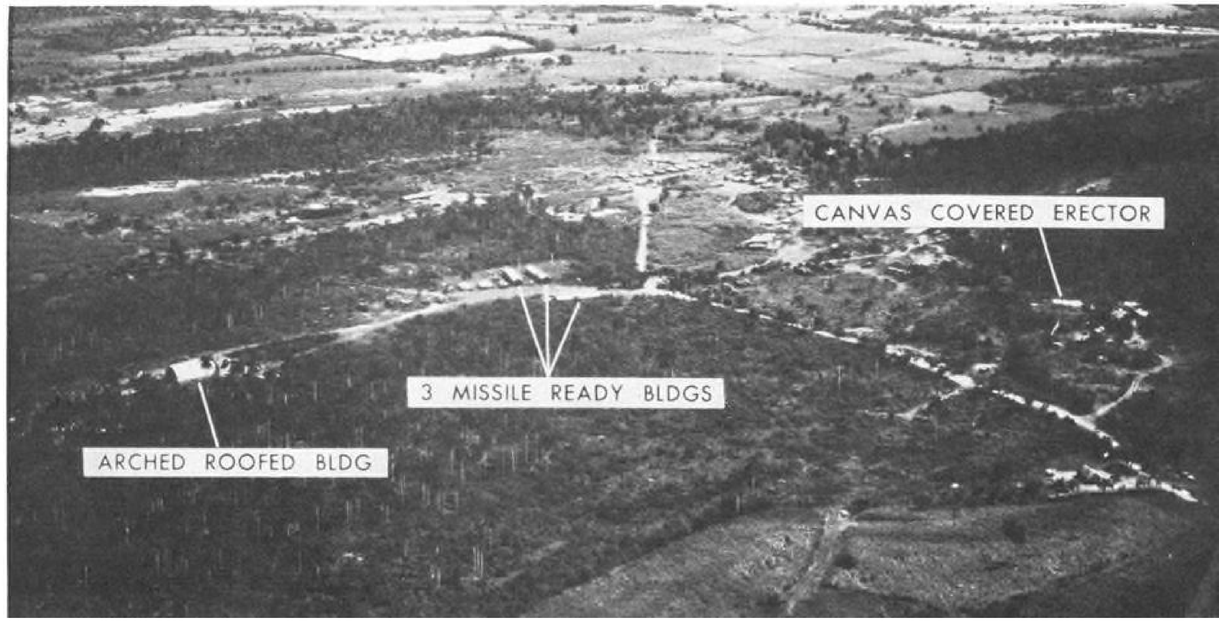




Seven Russian built Komar class PT boats are shown at docks alongside large coastal airstrip and port believed to be used for receiving nuclear warheads from Soviet ships for Cuban missile sites. Komar boats each carry two missile launchers for short-range solid propellant missiles plus twin 40 mm. cannon mounted in a forward turret. Soviet freighter (right) inbound for Cuba in early October before the U. S. blockade cut off flow of offensive weapons to Cuba carries deckload of crated Il-28 Beagle bombers for San Julian airfield (AW Oct. 29, p. 28).



IRBM base (above) under construction near Guanajay, Cuba, to launch 2,000 naut. mi. range Russian ballistic missiles shows two "soft site" concrete launch pads still under construction with cable ducts leading to central control building. Nuclear storage bunker is sited into heavily wooded hillside and surrounded by heavy wire security fence. Low-level oblique photo (below) taken by Navy F8U-1P shows cluster of missile check-out buildings at a Cuban MRBM base with a canvas covered erector housing a Shyster type missile.



Honeywell Pushes Vehicle Controls Effort

By Edward H. Kolcum

Minneapolis—Minneapolis-Honeywell Regulator Co. is bidding for an active competitor role in the expanding space vehicle control market both as an engine supplier and as a prime manager for complete space vehicle attitude control systems.

Honeywell has conducted several relatively low-keyed Air Force and company-funded reaction control projects since 1956, but decided only recently to make a strong competitive move into the reaction jet industry. A company spokesman said Honeywell waited until it had made a significant advance before entering the market, and the decision to enter now stems from what the company considers fairly broadly-based improvements across the board in reaction engines, components and propellant feed systems.

Simple Engine

Key to the Honeywell research effort is an engine which incorporates a relatively simple injector consisting of a single solenoid, which drives the valves for both fuel and oxidizer feed lines in a hypergolic propellant system. Engine combustion chamber and nozzle can be varied to fit thruster location and mission, with thrust ratings from 1 lb. to 100 lb.

Reaction control systems used to change the attitudes of the Mercury capsule and the X-15 aircraft use hydrogen peroxide and hydrazine monopropellants, which have the disadvantage of requiring a catalyst to decompose the propellant into steam. In addition, the specific impulse rating of this propellant is about 280 sec.

Honeywell is looking into what it considers the next generation of control engines which are simple, reliable and use hypergolic bipropellants. Specific impulse of liquid hypergolics under study by the company range from 311 sec. for unsymmetrical dimethyl hydrazine to 413 sec. for nitrogen hydroxide. For hypergolic gas systems, specific impulses range as high as 489 sec. for hydrogen and fluorine combinations.

Mario W. Cardullo, senior development engineer in the reaction control systems group, said Honeywell is striving for a control system which uses high energy propellants and also has long-time storageability, compatibility with system components and rapid ignition under extreme environmental conditions.

Among the major characteristics of the Honeywell injector assembly, according to Ray E. Michel, staff engineer, are its high response and negligible tail-off. Response time from signal on to valve open, he said, is 8 millisec., and from signal off to valve closed, 2 millisec. Michel said although other companies have development programs for similar systems, Honeywell's is the only system which uses one coil to actuate both fuel and oxidizer valves, a factor which he said increases simplicity and system reliability.

Injector assembly for a 25-lb. thruster weighs 0.82 lb. and has an envelope of 5.35 in. Electrical power requirement is 41 watts and the open loop frequency response is 167 cps. Scale-up of this same fundamental system to raise the thrust level to 100 lb. would add 1 lb. to weight and double the envelope size, Michel said. Power requirement would be 160 watts.

Honeywell also is experimenting with the smaller dual valve injector as the first stage of a two-stage injector and has achieved thrust levels of 150 lb. with this system.

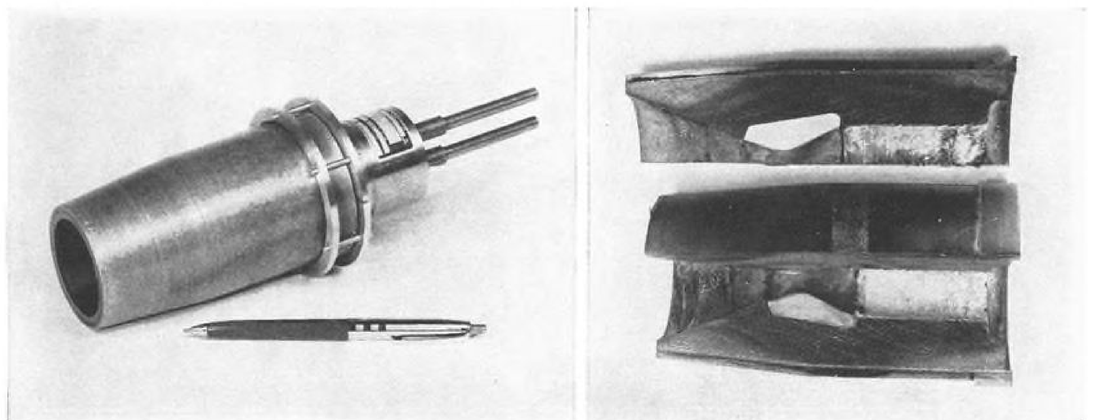
Honeywell has mated the injector system to several types of thrust chambers and nozzles and is testing them at 150 psi. chamber pressures and 10 lb. thrust levels. Ablation-cooled chambers and nozzles are being specified for space vehicles where reaction jets are located near components and systems that would be affected by the heat generated from rocket engines. Ablation chambers consist of 80% silica and 20% phenolic resin.

Composition of radiation chambers tested by Honeywell is 80% tungsten infiltrated with 20% silver.

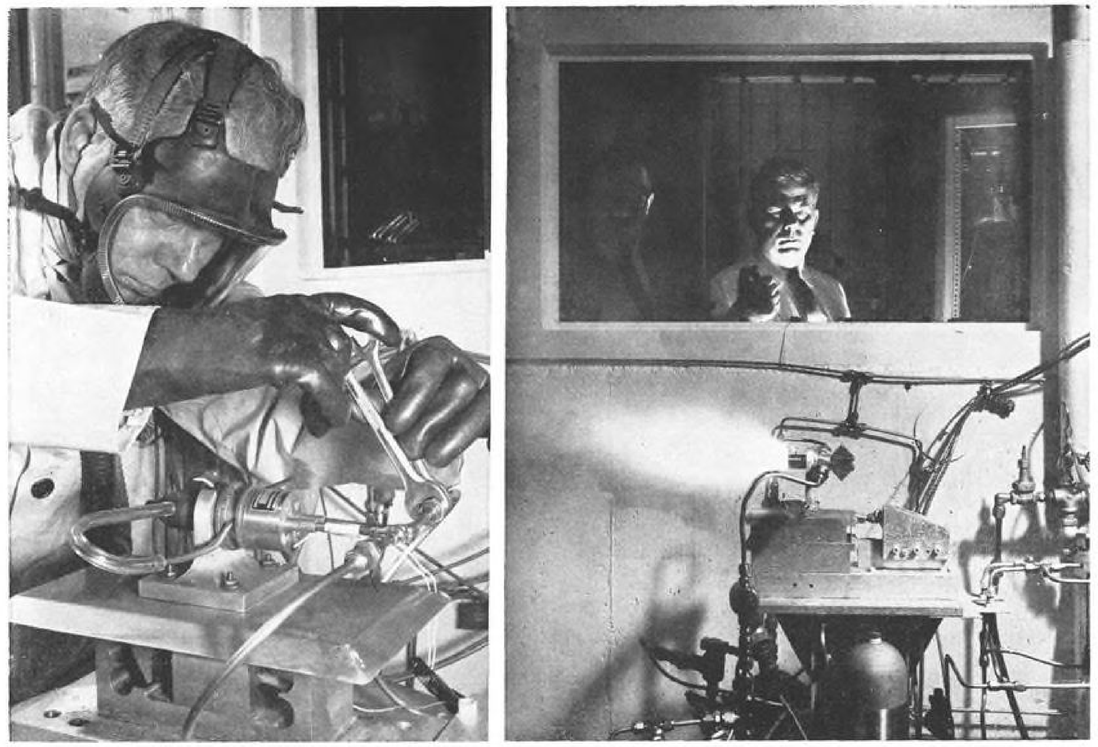
Attitude Controls

Cardullo said Honeywell has investigated 13 different gases and gas mixtures for bipropellant attitude controls. Among them are ammonia, chlorine trifluoride, diboraine, perchloral fluoride, fluorine, hydrogen, nitrogen difluoride, oxygen and propane. Lockheed Aircraft Co. is working on a program with Honeywell by testing both gaseous and liquid perchloral fluoride using the Honeywell injector.

Honeywell also is conducting development tests on a pulse reaction jet engine, which it calls a detonation jet. This system is designed to provide pulses of extremely short width. Combustion process in the detonation jet takes place supersonically, and in ground tests, engine pulses sound like bursts from a machine gun.



SINGLE SOLENOID INJECTOR, left, developed by Minneapolis-Honeywell incorporates an ablation-cooled thrust chamber-nozzle. In photo at right, chamber and nozzle have been sliced open to show the amount of charring after use.



FINAL ADJUSTMENTS ARE MADE, left, by Minneapolis-Honeywell technician on a propellant feed line in a rig to test the company's bipropellant, dual-valve, single-solenoid injector for a reaction control jet engine. Photo at right shows a test firing of a detonation reaction jet engine. Detonation jet combustion process takes place supersonically, and sounds of engine pulses are similar to machine gun bursts. Engine uses hydrazine as fuel and nitrogen peroxide as oxidizer.

Engine developed by the company uses hydrazine as fuel and nitrogen peroxide as oxidizer and has been operated at 5 psi. atmosphere to provide 10-lb. thrusts.

Detonation pulses have a width of about 3-4 millisec. compared with a conventional pulse of 20 millisec. with a 20-millisec. tail-off.

Considerable amount of effort in Honeywell has gone toward the development of systems to expel propellants out of tanks when the vehicle is in a zero-gravity environment.

The company has designed and tested a system which uses 0.01 in. aluminum, convoluted and installed at the after end of the tank.

Pressurization by a gas such as helium, or by electricity, causes the aluminum diaphragm to unfold, thereby forcing the propellant into the feed lines.

Honeywell is presently developing an 18-in. aluminum expulsion diaphragm for University of California's Jet Propulsion Laboratory.

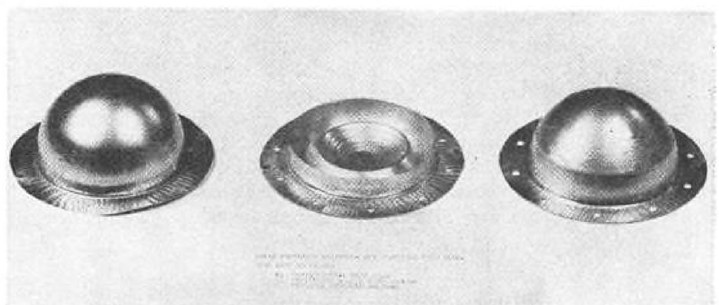
Michel said Honeywell's entry into the space vehicle attitude control market is a logical evolution of the systems management responsibility the company has had in manned aircraft autopilot and missile inertial guidance systems.

In 1956, Honeywell won an Air Force contract to develop a hot gas reaction generator using a solid propellant-hydrazine monopropellant. This system requires a catalyst, and the company funded its own hot gas bipropellant generator in 1958 to develop a system with a fast startup. Simultaneously, Honeywell began an in-house servo development program using nitrogen as the hot gas.

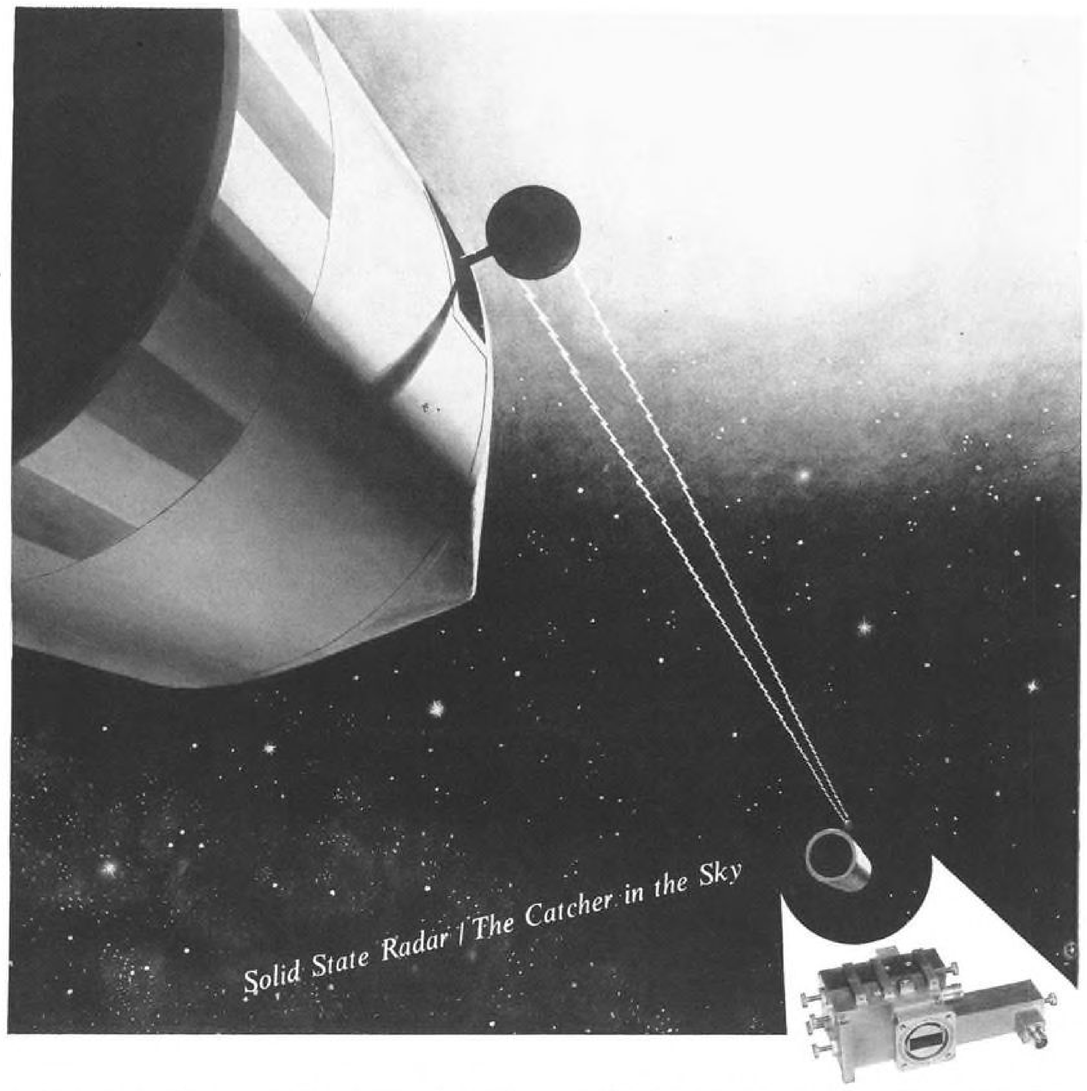
Company continued developing a systems capability as a subcontractor for hydrogen peroxide reaction jet studies for Mercury, Scout and X-15 programs, and as a subcontractor for low thrust, cold gas systems for stabilizing the gondola for an Air Force balloon program and for the USAF Athena space test vehicle.

This rocket formerly was called the Trailblazer.

Bipropellant hypergolic jet development and tankage program, funded by the company, has been under way since mid-1959.



CONVOLUTED ALUMINUM DIAPHRAGM, center, is under study by Minneapolis-Honeywell as positive expulsion system for reaction control fuel tanks in space vehicles. Gas or electrical energy system would unfold convolution and push propellant through feed lines.



A new solid state radar system built by STL engineers and scientists can send out and receive signals at X-band frequencies to help man rendezvous and dock vehicles in space. STELATRAC is its name. It is the first solid state system of its kind. The X-band transmitter is shown above. It has successfully passed temperature and vibration tests. STELATRAC can also be used as a command link between vehicles in flight. By altering its module design, the flexible radar system operates as an altimeter and doppler velocity sensor to guide spacecraft safely to the surface of the moon and planets. Today STL is busy on many such projects as STELATRAC. STL is also prime contractor for NASA's OGO and a new series of classified spacecraft for Air Force-ARPA. And STL continues Systems Management for the Air Force's Atlas, Titan and Minuteman programs. These activities create immediate openings in Theoretical Physics • Systems Engineering • Radar Systems • Experimental Physics • Applied Mathematics • Space Communications • Antennas and Microwaves • Inertial Guidance • Analog Computers • Solid State Physics • Computer Design • Telecommunications • Space Physics • Digital Computers • Guidance & Navigation • Electromechanical Devices • Engineering Mechanics • Aerodynamics • Propulsion Systems. For Southern California or Cape Canaveral positions, write Dr. R. C. Potter, Department A24, One Space Park, Redondo Beach, California, or Box 4277, Patrick AFB, Florida. Your inquiry will receive a prompt reply. STL is an equal opportunity employer.

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Weather Forecasting Aids Noise Control

(The following discussion of noise problems associated with testing large vehicles was written for Aviation Week and Space Technology by Richard N. Tedrick and Wade D. Dorland of National Aeronautics and Space Administration's Marshall Space Flight Center. The report is based on the experience Marshall has obtained in static tests of the Saturn S-1 booster stage.)

Rapid increase in size of rocket boosters during the past few years, and the resultant increase in the noise level generated by static firings and launches of these rockets has made the prediction and control of sound generation an important phase of missile development. This has particularly been true in the case of the Saturn S-1, which has been described as the world's largest man-made steady state noise generator.

Most sources of sound are created by vibrating bodies causing disturbances in the air. Other sources, such as the Saturn booster, generate sound by inserting rapidly moving hot gases into the atmosphere. Such sounds have become relatively familiar to most Americans with the advent of both military and commercial jet aircraft. Rocket noise is not too unlike that from a jet, except that it is usually lower pitched than the jets' distinctive whine.

The noise environments which can be expected from the test firing of large rockets have now become important considerations in planning test sites and the surrounding supporting communities.

One can consider the problem to consist of three distinct parts, each of which must be solved to achieve a complete solution. The first of these is the noise source itself. The Saturn generates a tremendous volume of exhaust gases moving at supersonic velocities. These gases moving through a relatively still atmosphere cause large amounts of low frequency sound to be generated. Part of the answer to reducing noise levels might lie in muffling the noise produced at the test stand, thus helping to lower the amount of energy originally radiated into the atmosphere. However, for the present, as larger and larger boosters are being developed, this cannot be suggested as the entire solution to the problem.

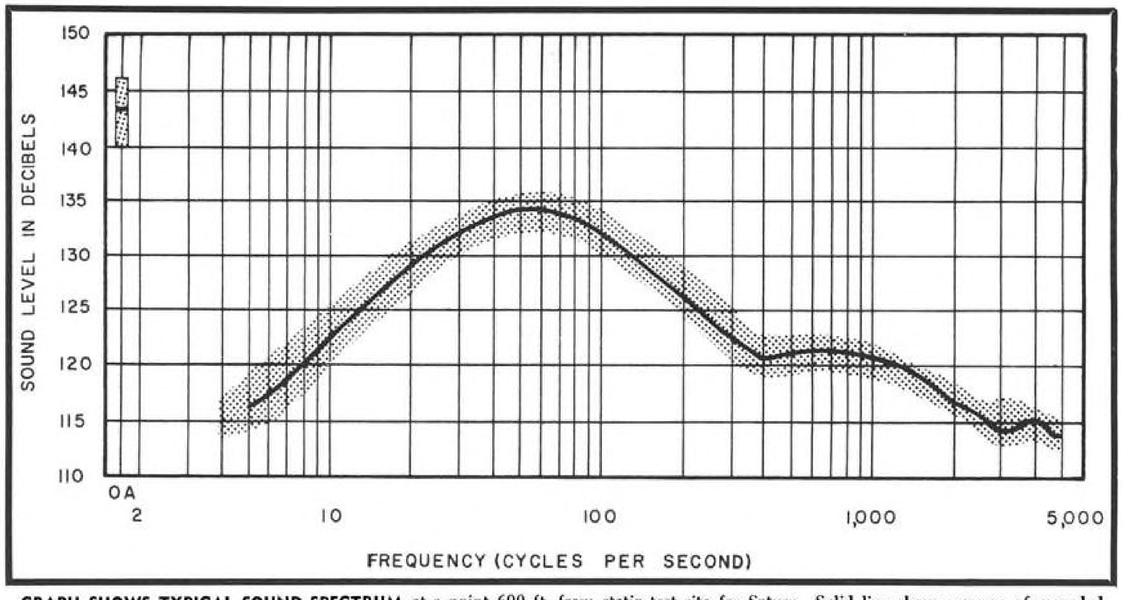
The second aspect of the noise situation concerns the ability of the sound to reach the civilian communities which always spring up around any major missile site. The most obvious solution to this is simply to buy up all of the land around the missile base for about twenty miles. Unfortunately, this is not often feasible since most of the bases were begun a few years ago when missiles and missile sounds were not nearly so large. As a result, small cities were built up within a few miles of most launch and static test facilities.

Another solution to this matter of the transmission of missile sounds concerns the role of weather in such transmission. It is possible to greatly lower the sound level at a point several miles distant from a sound source simply by choosing the meteorological conditions under which the test is to be performed. Similarly, the sound pressure levels can be raised materially by good propagation conditions at the time of a test. It is in this particular field where the best results can be anticipated for noise control.

The third and last factor of the noise problem lies with the "receiver," or the individual who will be exposed to the noise and to its effects. A large part of the question can be resolved by an examination of the attitude that people on the receiving end of the propagation path have toward the noise. For instance, while the sound from a missile test may be no louder than that created when the man next door uses his power lawn mower, still if the test is held at 2 a.m., it may be expected that the reaction will be unfavorable. Hence good public relations will help to solve the noise problem.

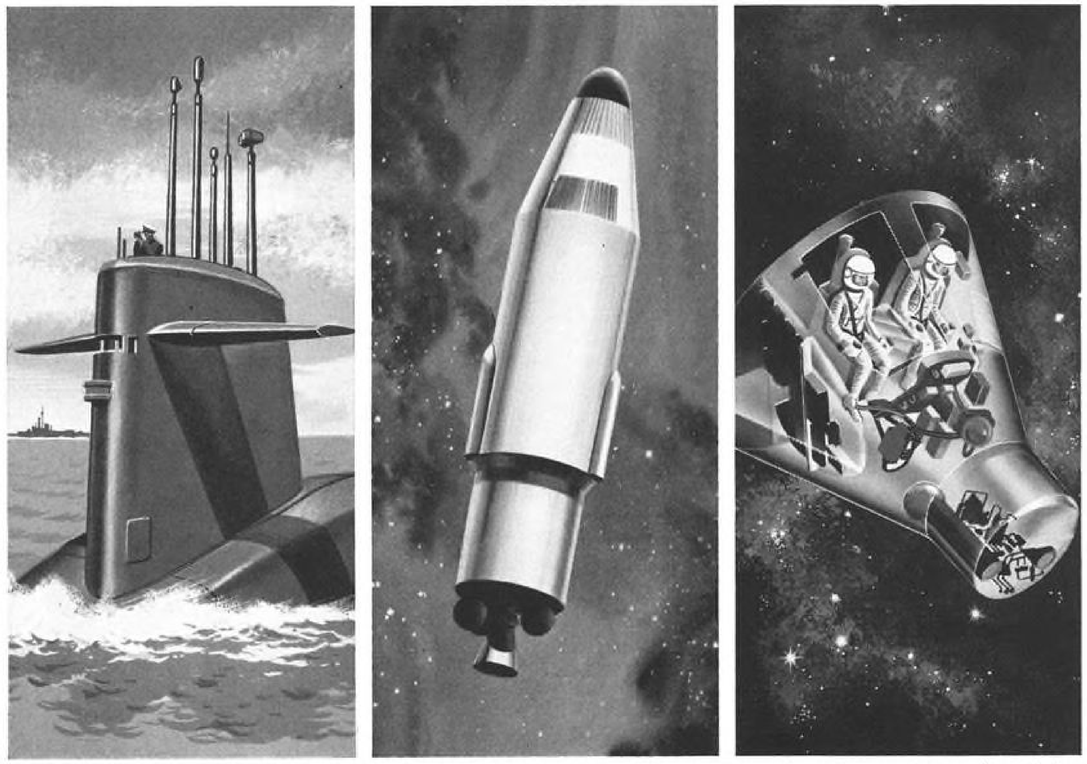
The rocket vehicle, both guided and unguided, has since its inception been primarily a military weapon. With the impetus of wartime development, there usually was little concern with civilian discomfort. Also, since the early rockets were relatively small, so were the sounds. The amount of unused "buffer" land ordinarily utilized around military installations to maintain reasonable military security proved in most instances to be quite satisfactory to attenuate the sound of missile tests.

(Continued on p. 63.)



GRAPH SHOWS TYPICAL SOUND SPECTRUM at a point 600 ft. from static test site for Saturn. Solid line shows average of recorded sound levels from 10 tests. Shaded area shows range of recorded sound levels. Note that loudest sounds are in frequency range below 100 cps.

HONEYWELL SYSTEMS



Under the sea or in outer space, the demand for more sophisticated navigational systems continues to grow. Honeywell's goal: to advance the art and science of guidance and navigational equipment and continue to produce quality systems at the lowest costs.

X-20 (Dyna Soar) to be guided by Honeywell system

The Air Force's X-20 (Dyna Soar) program, presents challenging guidance and flight control problems. A Honeywell system will supply accurate navigation, guidance and pilot's display information from self-contained measurements and computations made within the glider. By means of this display, the pilot is able to evaluate the capability of the gliders reaching a given selected destination and, if necessary, can choose an alternate destination. The system will operate from launch until landing and provide uniform control of the craft through a vast range of speeds and altitudes.

Honeywell-developed guidance and/or

flight control systems are also in use or slated for use on the X-15, Mercury, Gemini, and Apollo.

Honeywell project: exploring the art of celestial navigation

Optics is the key to the future in celestial navigation of space vehicles, and optical devices of many types and varied uses are being developed at Honeywell. One system being studied would actually track several planets by means of high-powered radar-like Laser devices. Range and range rate to the planets would be determined by the tracking devices and the information used to orient the vehicle on its proper course.

Consistent with celestial navigation system development, other far-reaching new ideas are being conceived and evaluated to maintain Honeywell's leadership in the navigation and guidance field.

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For tomorrow's systems capable of performing rendezvous-in-space maneuvers, Honeywell offers a wealth of experience in the development of navigation systems. Many of our nation's most demanding projects are using Honeywell-developed guidance and control systems: Gemini, SD-5 Drone, and X-20 (Dyna Soar). Honeywell is also building guidance systems for Polaris.

As space missions become more and more complex, the guidance equipment aboard the various vehicles must be capable of more complicated maneuvers. Systems are needed that do more and weigh less. Today's sophisticated systems must precisely measure everything that happens to a moving vehicle and guide and control it with precision on an exact course from one place to another, almost anywhere in the universe. All this must be done independently of any earth-based equipment. The need for accuracy is most vital. (A slight error can throw a vehicle thousands of miles off course.)

Honeywell has pioneered in all phases of design, development, fabrication, test and use of such inertial guidance and navigation systems and components. The tasks have been many and varied. They range from aerospace to terrestrial to marine navigation.

Currently, many advanced navigation systems are under development at Honeywell. New sub-miniature inertial platforms (one-third the size of conventional miniature platforms) are now being readied and offer complete capabilities with no sacrifice in performance or reliability. Companion sub-miniature computers and components are also being developed.

Honeywell navigation systems are adaptable to either analog or digital modes. They can incorporate star trackers, horizon scanners, infrared and other optical components where needed for special applications such as superaccurate missiles and deep-space missions.

In addition to complete systems, Honeywell can supply computers, computer components, inertial platforms, and inertial components built to your own or to Honeywell's design.

For more information on how Honeywell can assist you in the development and/or manufacture of navigation systems contact your nearest Honeywell Military Products Group representative, or Minneapolis-Honeywell, Aeronautical Division, 13350 U.S. Highway 19, St. Petersburg, Fla. Phone HEmlock 5-1151.

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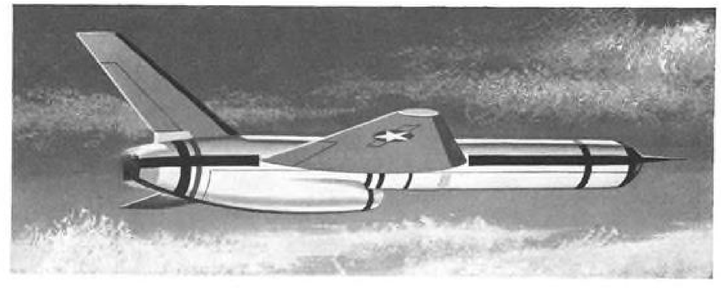
Honeywell system guides Army SD-5 drone

For the Army SD-5 surveillance drone Honeywell designed, managed, and is manufacturing the inertial navigation system.This compact drone can find its way hundreds of miles behind enemy lines, locate battle-area targets and report back on its reconnaissance missions.

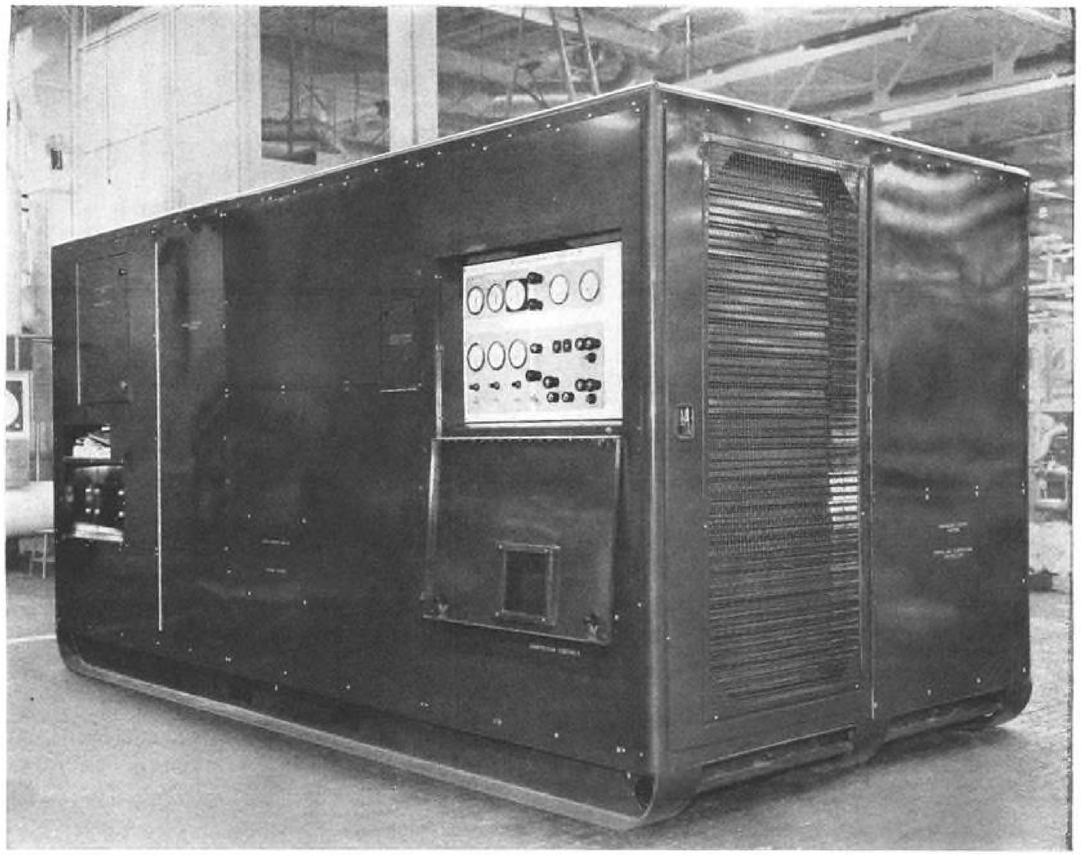
The system can guide the drone over several target areas in each flight without need for any radio or radar commands from the ground. After completion of its mission the Honeywell system guides the drone to its home base. The SD-5's terrestrial inertial navigation system is an all-digital type. And because the system is completely self-contained it is not subject to "jamming" or interference by enemy countermeasures.



Honeywell

H HONEYWELL *Military Products Group*

Engineers and Scientists: Explore new professional opportunities: Write Honeywell, at address above.



Automatic temperature control GSE for Titan II missile propellant

This new environment control package was designed and produced by Hamilton Standard for the Air Force's Titan II missile, made by Martin. It automatically stabilizes propellant temperature at 60 ± 5°F within a 20,000 gallon storage vessel. The unit electrically heats or mechanically cools a glycol and water heat transfer liquid, and then circulates it to the storage vessel heat exchanger. It is built to perform reliably in ambients of −35° to +115°F, and from sea level to 6,000 feet.

The Titan II Propellant Temperature Controller is evidence of Hamilton Standard's ability to meet environment control GSE assignments. It typifies the results attainable when engineering capabilities in pneumatics, hydraulics, electronics, and packaging, are combined with specialized manufacturing skills.

A NEW BROCHURE describing Hamilton Standard's environment control GSE capabilities for aircraft and missiles is available. To learn how this solid foundation of experience can be your key to dependable GSE, write: Sales Manager, Ground Support Equipment Department, Hamilton Standard, Windsor Locks, Connecticut.

Hamilton Standard DIVISION OF UNITED AIRCRAFT CORPORATION

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

However, the development in recent years of larger rockets such as the Jupiter, Atlas and Titan has ensured that occasionally some nearby residents would be jolted out of their sleep. Nonetheless, the importance of the programs to the national defense precluded any major shifts in either tests, sites or test schedules just because of the noise.

Civilian Program

With the creation of the National Aeronautics and Space Administration, a large civilian rocket program was undertaken for the first time, which, because of its very nature, must remain sensitive to community reaction. Assigning the responsibility for large booster development to Marshall Space Flight Center focused the noise problem from these vehicles on the community supporting this installation. Since the city of Huntsville, Ala., lies 5-10 mi. northeast of the Saturn static test tower, the noise from such static tests has occasionally been not only heard, but felt, in Huntsville.

It was found that this has been due primarily to the weather conditions under which these tests have been performed. When strong temperature inversions have been reinforced by winds toward the city, the sound is actually focused meteorologically much in the same manner as sunlight is focused by a magnifying glass. This can result in sound pressures in both the business and residential areas of Huntsville of up to about one hundred times normal. However, exactly opposite conditions have also existed and at those times not even a whisper of the Saturn test was heard.

Amount of Noise

It has also been learned from experience that the townspeople are not nearly so alarmed or jolted when they have been forewarned. Therefore it has become standard procedure to announce via the local newspaper, radio and television stations when a test will be held.

It has been found that about one-half of one percent of a rocket's power goes into the form of acoustic energy. This amounts to nearly 40 million watts of acoustic power for the Saturn. (A hi-fi set or radio produces usually about 25 watts.)

Therefore, the larger the space vehicle which is being tested, the larger is the amount of sound which is radiated into the atmosphere.

However, there are two additional factors which greatly affect the response which may be anticipated from the surrounding communities. One of these is the frequency content of engine noise (charts, pp. 59, 67, 69). It has been shown that as thrust of

How you can avoid three costly mistakes in the selection of a scientific or engineering computer

And the one sure way
to find the computer that suits you best

Selecting a computer can be one of the most important decisions an executive can make. Almost any computer can reduce costs by solving problems, and saving time, but some are far more efficient than others.

This then should lead to a careful study of available computers. And the study must avoid becoming overconcerned with "nuts and bolts" and concentrate instead on overall suitability and purpose.

Basically, the decision has to depend on finding the computer that best serves your needs. The Recomp® line of solid-state scientific and engineering computers has been found ideal for many leading companies. Perhaps it could best meet your needs. The following common mistakes may offer some guidance in your choice.

(1) "Get the cheapest computer"

Just as there is no such thing as a cheap pair of shoes, there is no "cheap" computer. Scientific problem-solving computers sell from $40,000 and up. They lease from $1,000 and up a month. But, much more important than initial cost is how much a computer will save you over a period of time.

A computer feasibility study showed that a Recomp computer could save almost $70,000 more than a lower-priced competitor in a year on a given project. In addition, Recomp offers a broad price range. The Recomp III computer is ideal for small-scale needs. And you can lease one for $1,495, complete. For medium-scale needs, Recomp II starts at $2,495. A complete line of peripheral equipment is available for both computers.

(2) "Buy the fastest one"

Naturally, speed is important. But computer operating speed is just a small part of the story. Save a few microseconds here and there and you haven't saved much. More important is **total** problem solving time.

The Recomp line of small and medium scale computers mark their savings in terms of hours . . . not microseconds. Recomp computers can save hours in problem solving time because they're simple to program, easy to operate, and have an exceptionally large memory.

(3) "Hire specialized computer personnel"

Not always necessary. Some computers do demand specialized programming personnel to operate them. However, others are so simple to use that engineers can program their problems directly. This ease of programming saves time and increases computer use.

One of the easiest computers to program and operate is Recomp. Engineers with less than eight hours instruction are able to use Recomp computers profitably.

The one sure way to select a computer

The computer requirements of every company are unique. The best way to find the computer that fits your own specialized requirements—without making costly mistakes—is through a computer feasibility study. This is the only way to know exactly what computer suits you and your company best.

Put Recomp side by side with any comparable computer on the market. Let the facts speak for themselves. You'll see why no computer feasibility study is complete without Recomp.

We'll be glad to help you get the facts. Write today for a "Management Guide to a Computer Feasibility Study."

Recomp

Recomp is a product of Autonetics Industrial Products
Autonetics is a Division of North American Aviation

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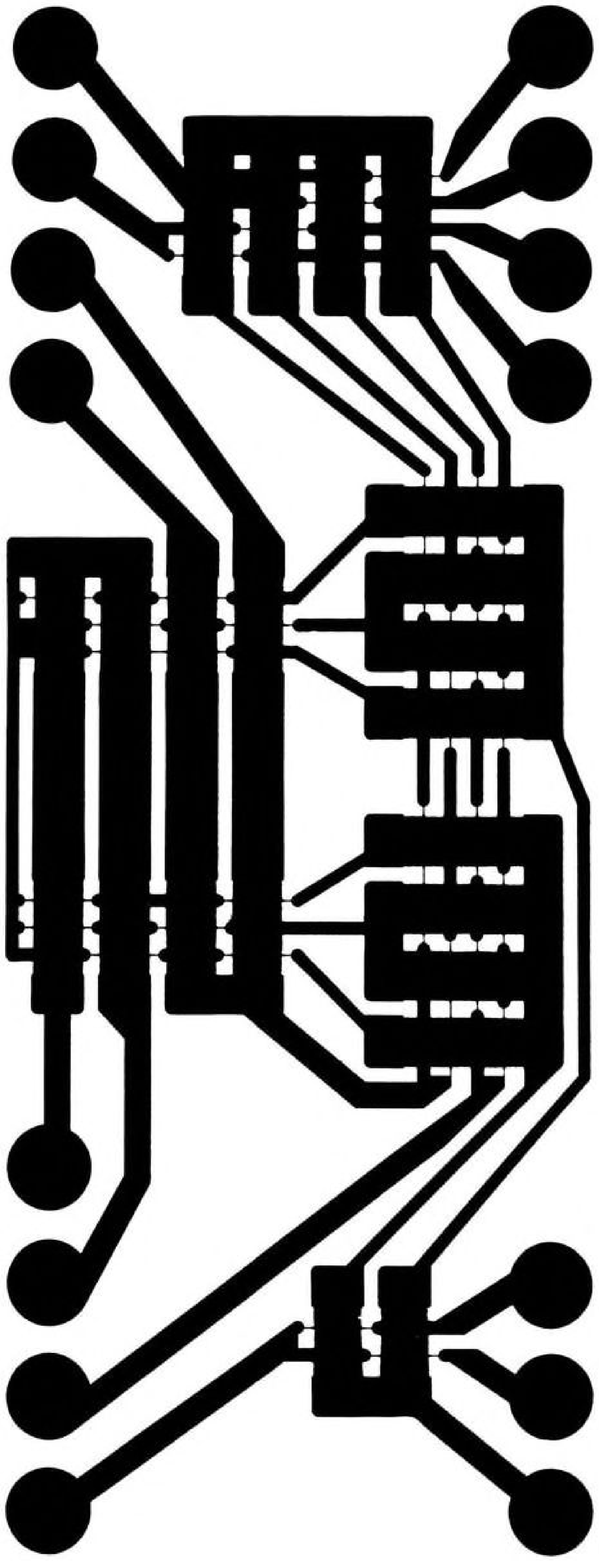
Please send me a "Management Guide to a Computer Feasibility Study."

NAME _____
POSITION _____
COMPANY _____
ADDRESS _____
CITY _____ ZONE _____ STATE _____



NEWS ... OF DEFENSE TECHNOLOGIES

GUIDANCE

There are vast differences between the techniques required to guide missile flights and those needed for space ventures. Entirely different problems are presented in the tasks of guiding an air-to-air missile having a few thousand yards range, sending an ICBM to a target thousands of miles away, and boosting men and instruments to the frontiers of space. Experience in each is invaluable in satisfying new mission requirements.

General Electric is producing infrared guidance for the Sidewinder, inertial guidance for the Polaris, and the radio-command system for Atlas ICBM's. It was this phenomenally accurate radio-command guidance that helped put the Mercury-Atlas into earth-orbit.

This wide range of guidance experience is enabling General Electric to apply new devices and techniques (such as electrostatic gyros and cryogenics) directly to existing problems, thus providing continuous and significant upgrading of guidance technologies and capabilities. Current activities include development of reference navigational systems for space and exploration of the best combinations of basic guidance forms for the sophisticated missiles and space vehicles of the future.

CRYOGENIC PROGRESS in inertial guidance is typified by this 32-gate logic element for smaller, faster, more reliable computers. Other current cryogenic work includes high-precision gyros and accelerometers.

ELECTROSTATIC GYROS are being developed to meet future requirements for accuracies up to 1000 times greater than those attainable with present gyros. Other advantages will be simplicity and long life.

STAR-FIELD TRACKER correlates a viewed star pattern against a stored reference map for spacecraft attitude control. This device may replace the inertial table as an attitude sensor because of its zero drift.

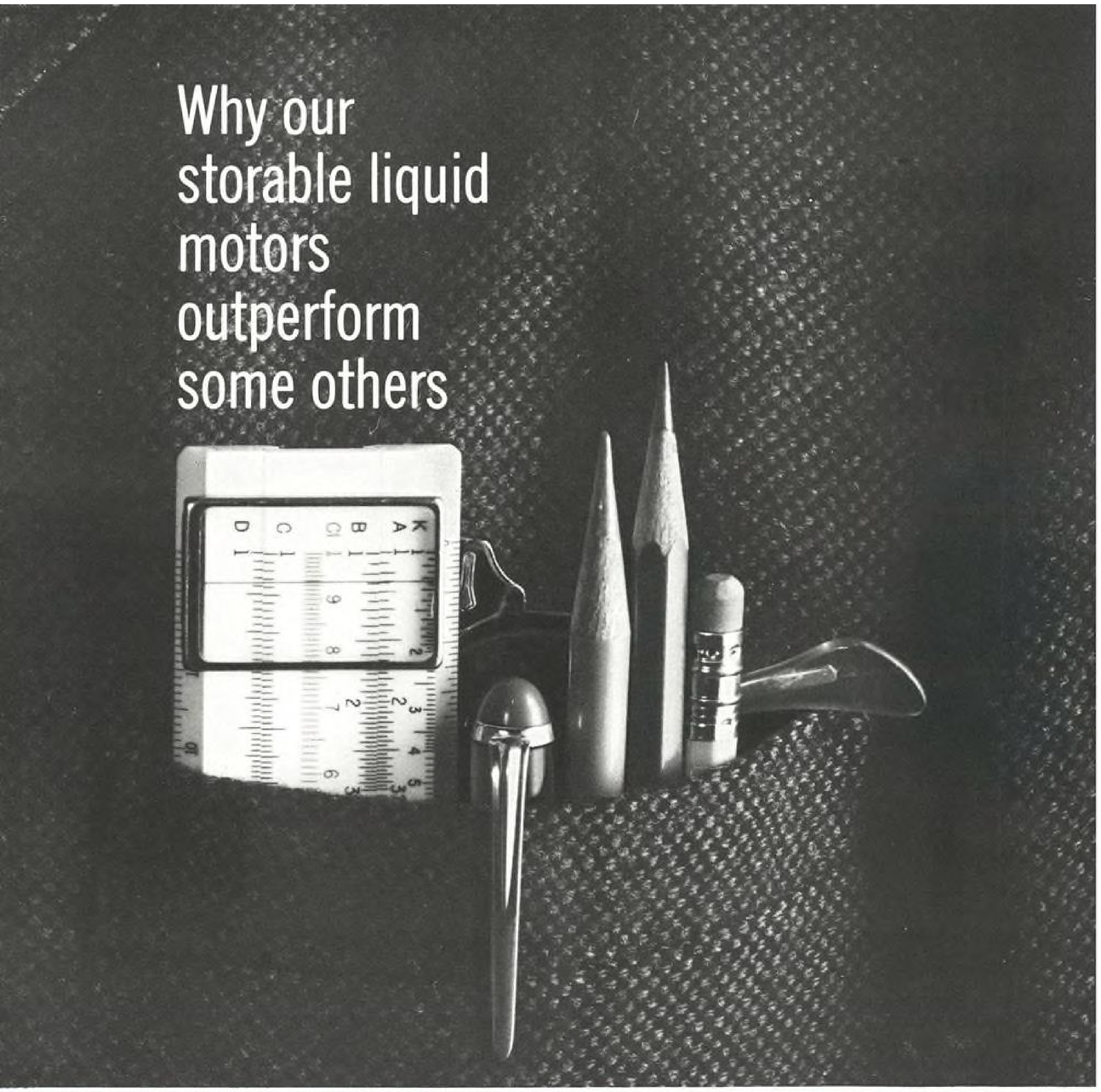
INERTIAL GUIDANCE for Polaris has been extremely successful. Designed by M.I.T. and produced by General Electric, the small MK 2 system will help to extend the range of the advanced Polaris missile to 2500 miles.

RADIO-COMMAND GUIDANCE, already operational and proved accurate and reliable in ICBM and manned orbital flights, is currently being applied to booster programs and missile range instrumentation.

Progress Is Our Most Important Product

GENERAL ELECTRIC

DEFENSE ELECTRONICS DIVISION



CHEMICALLY SPEAKING, OUR STORABLE LIQUID PROPELLANTS ARE PRETTY MUCH LIKE OTHER PEOPLE'S STORABLE LIQUIDS. STILL, UTC MOTORS (ABLATION-COOLED, PRESSURE-FED, WITH FILAMENT-WOUND FIBERGLASS CASINGS) CONSISTENTLY OUTPERFORM OTHER MOTORS USING SIMILAR HYPERGOLIC PROPELLANTS. WHY? BASIC DESIGN PROVIDES OUR STORABLE LIQUID PROPELLANT MOTORS WITH EXCELLENT PERFORMANCE CHARACTERISTICS—AN EXTREMELY HIGH THEORETICAL SHIFTING EQUILIBRIUM; A TOTAL MOTOR BURNING TIME OF 10 MINUTES AT HIGH PERCENTAGES OF THEORETICAL SPECIFIC IMPULSE. SUPERIOR DESIGN PROVIDES MOTORS THAT ARE SIMPLE, RELIABLE, LIGHT WEIGHT—IDEAL FOR UPPER STAGE APPLICATIONS. THESE ROCKET ENGINES? STATE-OF-THE-ART AT UTC.

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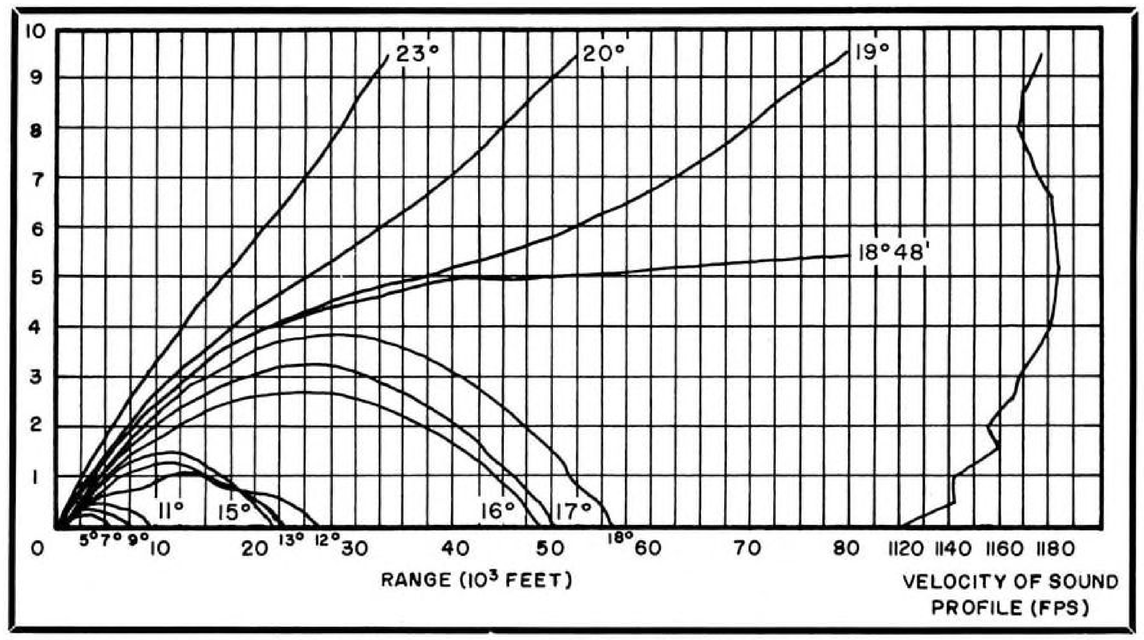


CALCULATED SOUND RAYS for a specific Saturn missile test conducted Dec. 20, 1960. Test produced a high noise level in Huntsville.

the rocket engine goes up, the peak frequency goes down.

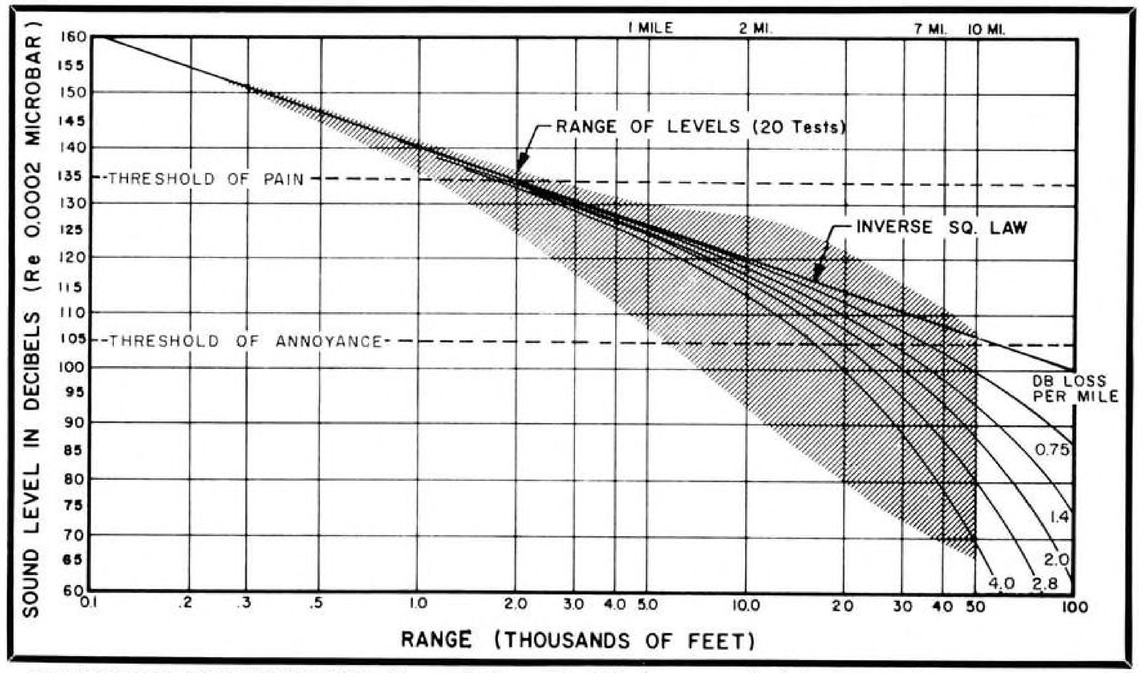
This affects the sound level at long ranges because the lower frequencies do not attenuate as rapidly; thus a larger percentage of the original sonic energy is left to disturb outlying areas. Also, as the energy peak drops in frequency, additional energy is put into the sub-audible range. Since it is these lower frequencies which rattle windows and shake buildings, the "alarm level" is expected to rise with larger boosters.

Another factor affecting the amount of acoustic energy which reaches the surrounding areas is what is known as the "directivity" of the source.

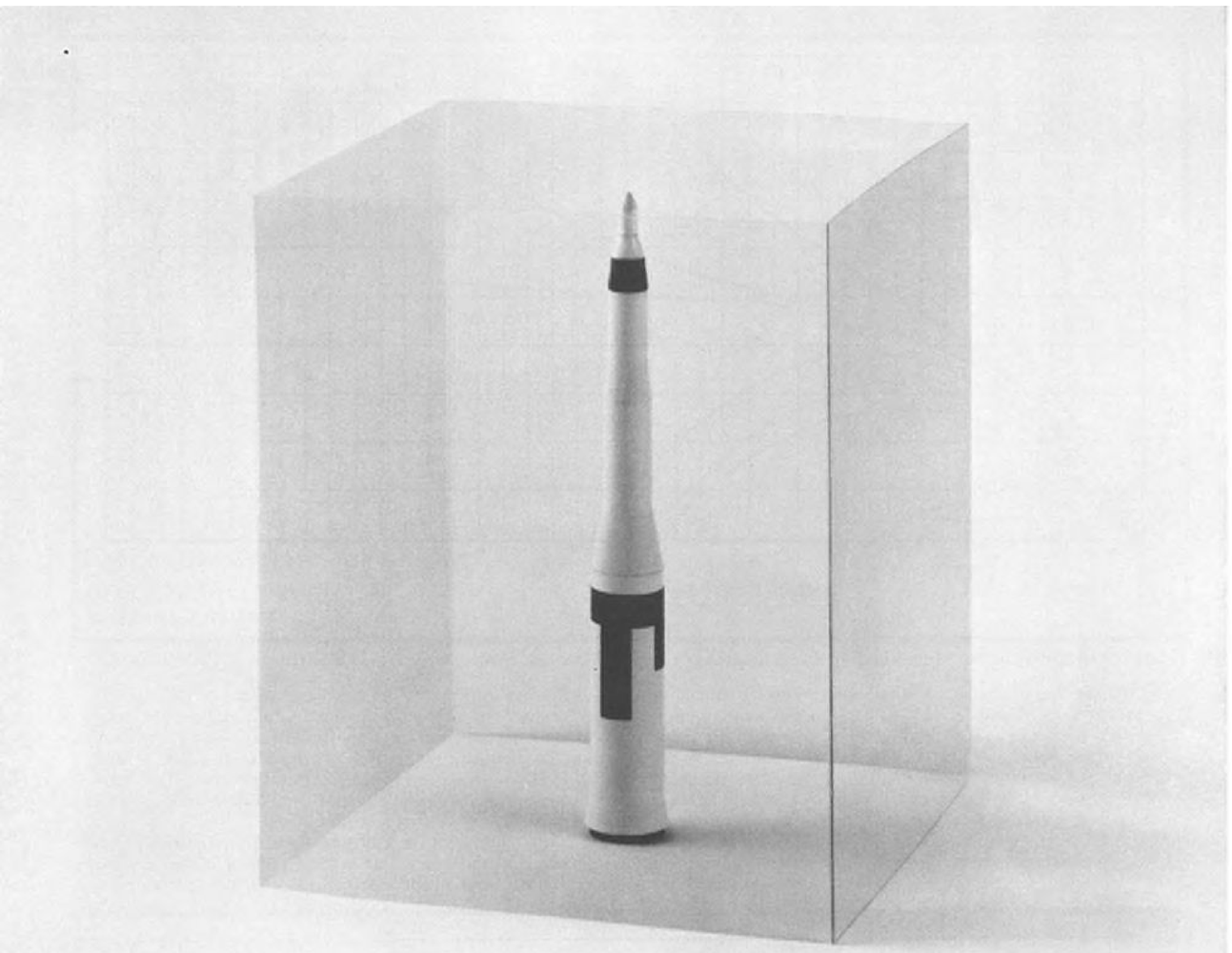
This is simply an index of the relative amounts of energy which are directed by the source itself in each direction.

Contributing to this are not only the rocket engine and exhaust velocity parameters but also the shape and configuration of the flame deflector and test tower. After the sound has been radiated into the atmosphere, several things can happen:

• **The sound can be propagated** normally as in a still room or large stadium where the effects of wind and tempera-



VARIATION OF OVER-ALL SOUND LEVEL with range is shown. Threshold of annoyance value is based on experience with Saturn testing.



AAF Packaged Environment keeps the Minuteman ready for instant retaliation

Deeply buried in isolated launch silos, the Minuteman missiles will strike back instantly, even under direct attack. This is well known. But how can each missile, with its sensitive guidance elements, remain always operational and ready?

Part of the answer is the Minuteman's environmental support system—prime contractor, American Air Filter Company Defense Group.

A system of heating, ventilating, air filtering, refrigeration, and humidity control may seem commonplace. Yet few firms even felt qualified to bid on this Minuteman assignment. The technical problems were staggering. The reliability of hundreds of missiles was at stake. Also the ability of remote control personnel to survive and retaliate.

AAF's capability for such a task had evolved out of four decades of pioneer engineering and large-scale production for military and civilian industry. But even AAF engineers were surprised at the speed with which Minuteman's urgent schedule carried them beyond previous limits of the art of environmental control.

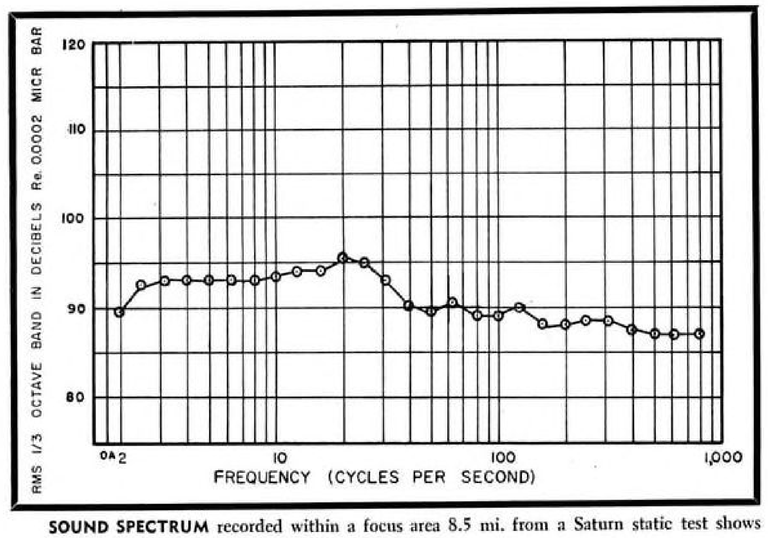
Component after component was redesigned, as AAF moved inevitably away from the idea of equipment *serving* the weapon—to create a necessarily *integral part* of the weapons system itself.

In completing its part of the system on schedule, AAF's Defense Group utilized its own production plants, plus resources of our Air Filter Division, Temper Air Group (Herman Nelson), Fiber Glass Group (Amer-glas), and other AAF divisions and subsidiaries. This corporate team offers scope, flexibility, and effective systems management capability.

If environmental control is important to your project, send for AAF Bulletin D-164. Write Defense Products Group, American Air Filter Company, Inc., 310 Third Street, Rock Island, Illinois.

AAF American Air Filter

BETTER AIR IS OUR BUSINESS



SOUND SPECTRUM recorded within a focus area 8.5 mi. from a Saturn static test shows characteristic flat spectrum of a focus.

ture are negligible (as on a very still and quiet morning).

- **It can be directed into the upper** atmosphere to be dissipated.
- **It can be directed at one or more** locations on the earth's surface.

Until recently these effects have been of only academic interest, but with the advent of the large rocket engine test program, a great amount of effort has gone into trying to understand how and why these things happen. Marshall Space Flight Center scientists have developed methods for forecasting these conditions and for locating the areas which may be adversely affected by returning sound.

By determing the meteorological conditions which exist at test time, it is possible to define the boundaries of the focal areas within the accuracy limits placed upon the problem by the meteorological data acquisition techniques.

If any cities or any other sensitive areas fall within these boundaries, the test can be postponed until such time as those conditions no longer exist. By use of long-range weather forecasting techniques, the number of times static tests need to be postponed can be greatly reduced.

MA-8 Ditty Bag Contents Displayed

Ditty bag carried on Mercury Atlas-8 orbital flight contained (1) camera with view finder, (2) extinction photometer and stand light source, (3) color film magazine, (4) Weather Bureau film magazine and filter, (5) two containers of cube food, two tubes of food and 45 deg. food tube nozzle, (6) dosimeters, (7) motion sickness container, (8) exposure meter and (9) camera shoulder strap.

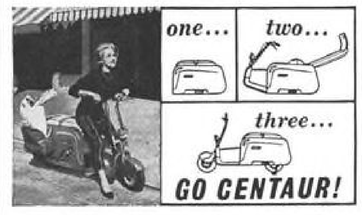
How I save flying time ...after landing

"Man, did I ever waste time trying to get transportation after landing! Sometimes I missed appointments, too. But all that's over, now that I've got a Centaur. Now I can make twice the calls I made before."

"The rugged Centaur is completely portable—precision-engineered to fold away into your plane, car trunk or boat. It takes two people anywhere, yet is light and compact enough to fit into any plane. And here's the pay-off. It's 'instant transportation'. Just set it up—in under 2 minutes—and you're ready to go."

"The whole family just loves it. Here's Jane doing her shopping—Centaur-style. We use it for commuting, camping, hunting—dozens of purposes. Jane finds it a breeze to drive. The Centaur has fully automatic transmission, spring-loaded shock-absorbers, and a husky Clinton motor—American-built throughout. If I ever need spares—no trouble."

"I just couldn't be without my Centaur. It's so convenient and time-saving it pays for itself on business trips alone. Here, hop on and take a ride..."



Easy to find out more. Ask about the Centaur at your local airport, or for further information and details of the Centaur budget payment plan and iron-clad money-back guarantee—mail the coupon below. American Motor Scooter Corporation, 7 Park Avenue, New York 16, New York. Department AVI.

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Please send me absolutely free Centaur's exciting folding brochure.

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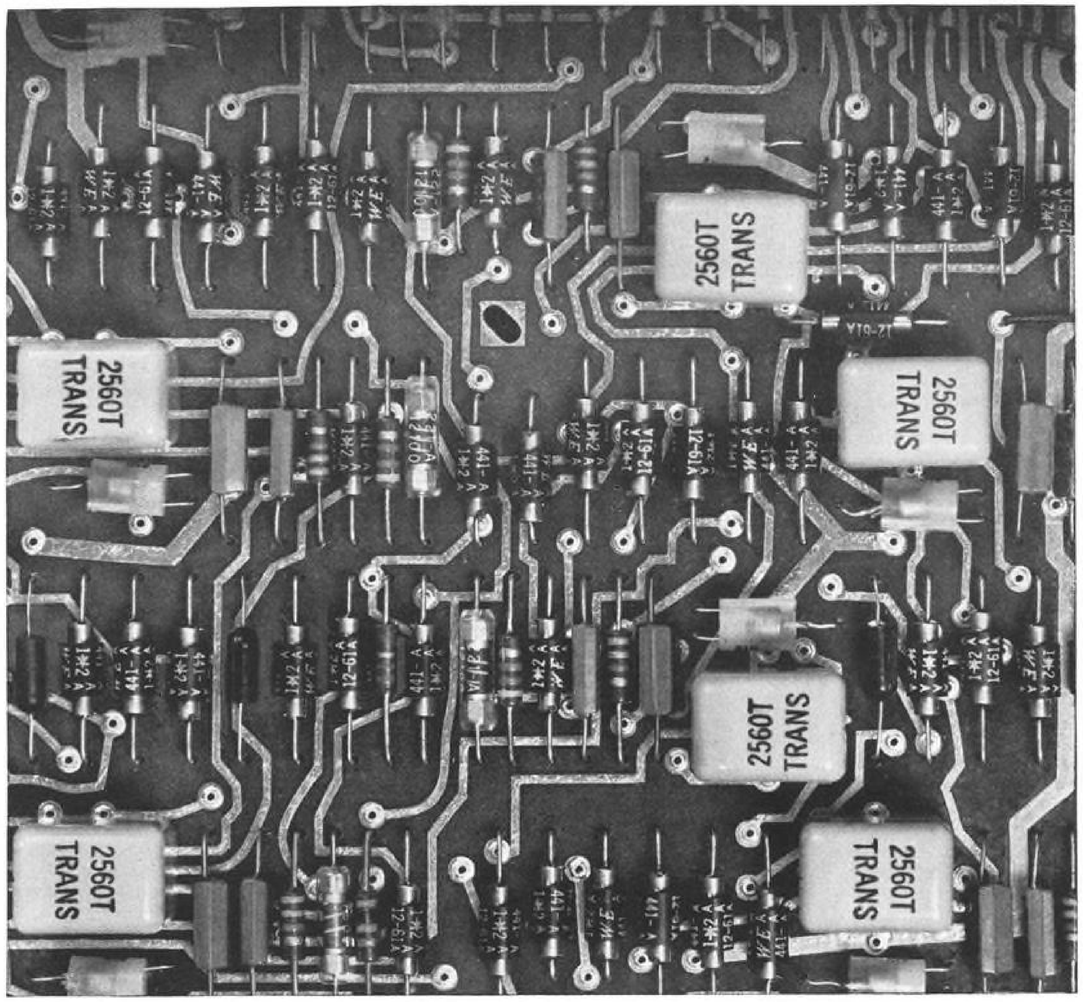


As complexity grows, so must individual component reliability

This is a tiny portion of the miles of complex Bell Telephone circuits used for military and civilian communications.

In order for each circuit to work properly, every component in the circuit must function according to design standards.

And as circuit complexity increases, an almost incredibly high reliability must be engineered into each component.

It is, in the Bell System.

Bell System communications specialists have extended component reliability to new heights of achievement.

In addition, every major communications channel gains support from the vast network that is in being, so that if one channel fails, a "make good" channel maintains continuity.

Communications are the lifelines of our defense system. Nothing is left to chance in the Bell System to assure that these lifelines will always function.

Bell Telephone System

AMERICAN TEL. & TEL. CO. / WESTERN ELECTRIC CO. / BELL TELEPHONE LABORATORIES / 21 OPERATING COMPANIES

Space Vehicle Log

(As of Oct. 20)

1962 Satellites in Orbit	Name	Source	Launch	Inclination (deg.)	Period (min.)	Apogee (mi.)	Perigee (mi.)	Transmitting Freq. (mc)	Weight in Orbit (lb.)
Alpha 1	Ranger 3	NASA	Jan. 26	0.3988	406.4 Days	1.163AU	0.9839AU		727
Beta 1	Tiros 4	NASA	Feb. 8	48.29	100.3	526	439	136.23; 136.92	285
Zeta 1	OSO-1	NASA	Mar. 7	32.83	95.9	365	342	136.744	440
Eta 1		USAF	Mar. 7	90.89	92.4	337	146		
Iota 1	Cosmos 2	USSR	Apr. 6	48.96	98.8	735	121		
Kappa 1		USAF	Apr. 9	86.69	153	2,096	1,753		
Nu 1	Cosmos 3	USSR	Apr. 24	48.95	89.2	177	120		
Omicron 1	Ariel	NASA/UK	Apr. 26	53.85	100.8	744	246	136.408	132
Sigma 1		USAF	May 15	82.33	93.4	368	177		
Upsilon 1	Cosmos 5	USSR	May 28	49.04	99.3	777	130		
Omega 1		USAF	June 18	82.13	92.1	243	224		
Alpha Alpha 1	Tiros 5	NASA	June 19	58.08	100.5	597	374	136.235; 136.922	286
Alpha Epsilon 1	Telstar 1	NASA	July 10	44.81	157.7	3,507	589	136.05	
Alpha Xi 1	Cosmos 8	USSR	Aug. 18	48.97	92.7	349	159		
Alpha Omicron 1		USAF	Aug. 23	99.60	98.6	535	380		
Alpha Rho 1	Mariner 2	NASA	Aug. 27	(Heliocentric Orbital Elements Not Computed)					447
Alpha Upsilon 1		USAF	Sept. 1	82.82	94.3	416	181		
Alpha Tau 1		USSR	Sept. 1	(Unsuccessful Venus Probe—Elements Not Available)					
Alpha Chi 1		USAF	Sept. 17	81.84	92.2	347	125		
Alpha Psi 1	Tiros 6	NASA	Sept. 18	58.28	98.7	445	423	136.235; 136.922	285
Alpha Omega 1	Cosmos 9	USSR	Sept. 27	65	90	220	187		
Beta Alpha 1	Alouette	Canada	Sept. 29	80.53	105.5	639	624	136.979	320
Beta Beta 1		USAF	Sept. 29	65.40	89.1	160	122		
Beta Gamma 1	Explorer 14	NASA	Oct. 2	32.95	2,185	60,897	175	136.44	89
Beta Epsilon 1		USAF	Oct. 9	81.50	90.9	292	103		
Beta Zeta 1	Cosmos 10	USSR	Oct. 16	65.00	90.2	236	138		
Beta Eta 1	Ranger 5	NASA	Oct. 18	(Heliocentric Orbital Elements Not Computed)					755
Beta Theta 1	Cosmos 11	USSR	Oct. 20	49.00	96.1	572	152	20.0048; 90.0216	

(There are 25 spent rocket bodies and otherwise unidentified objects in orbit from 1962 launches)

Pre-1962 Satellites Still Transmitting						
1958 Beta 2	Vanguard 1	USN	Mar. 17, '58	34.24	133.9	
1961 Omicron 1	Transit 4A	USN	June 29, '61	66.82	103.8	
1961 Omicron 2	Injun SR3	USN	June 29, '61	66.81	103.8	

(There are 31 satellites launched prior to 1962 still in orbit but no longer transmitting, and 169 metal objects in orbit from these launches)

1962 Decayed Satellites	Name	Source	Launch	Decay	Remarks
Gamma 1	Friendship 7	NASA	Feb. 20	Feb. 20	Manned
Delta 1		USAF	Feb. 21	Mar. 4	
Epsilon 1	Discoverer 38	USAF	Feb. 27	Mar. 21	
Eta 2		USAF	Mar. 7	Mar. 31	
Theta 1	Cosmos 1	USSR	Mar. 16	May 25	
Iota 1		USAF	Apr. 9	May 4	
Lambda 1		USAF	Apr. 18	Apr. 20	
Mu 1	Ranger 4	NASA	Apr. 23	Aug. 5	
Xi 1	Cosmos 4	USSR	Apr. 26	Apr. 29	
Pi 1		USAF	Apr. 26	May 28	
Rho 1		USAF	Apr. 29	May 26	
Tau 1	Aurora 7	NASA	May 24	May 24	Manned
Phi 1		USAF	May 30	June 11	
Chi 1	Discoverer	USAF	June 2	June 28	
Psi 1	Oscar 2	USAF	June 2	June 21	
Alpha Beta 1		USAF	June 23	July 7	
Alpha Gamma 1		USAF	June 28	Sept. 14	
Alpha Delta 1	Cosmos 6	USSR	June 30	Sept. 8	
Alpha Zeta 1		USAF	July 18	July 25	
Alpha Eta 1		USAF	July 21	Aug. 14	
Alpha Theta 1		USAF	July 28	Aug. 24	
Alpha Iota 1	Cosmos 7	USSR	July 28	Aug. 1	
Alpha Kappa 1		USAF	Aug. 2	Aug. 26	
Alpha Lambda 1		USAF	Aug. 5	Aug. 6	
Alpha Mu 1	Vostok 3	USSR	Aug. 11	Aug. 15	Manned
Alpha Nu 1	Vostok 4	USSR	Aug. 12	Aug. 15	Manned
Alpha Pi 1	Venus Probe	USSR	Aug. 25	Aug. 28	Unsuccessful
Alpha Sigma 1		USAF	Aug. 29	Sept. 10	
Beta Delta 1	Sigma 7	NASA	Oct. 3	Oct. 3	Manned

(There are 38 rocket bodies and metal objects placed in orbit in 1962 which had decayed)

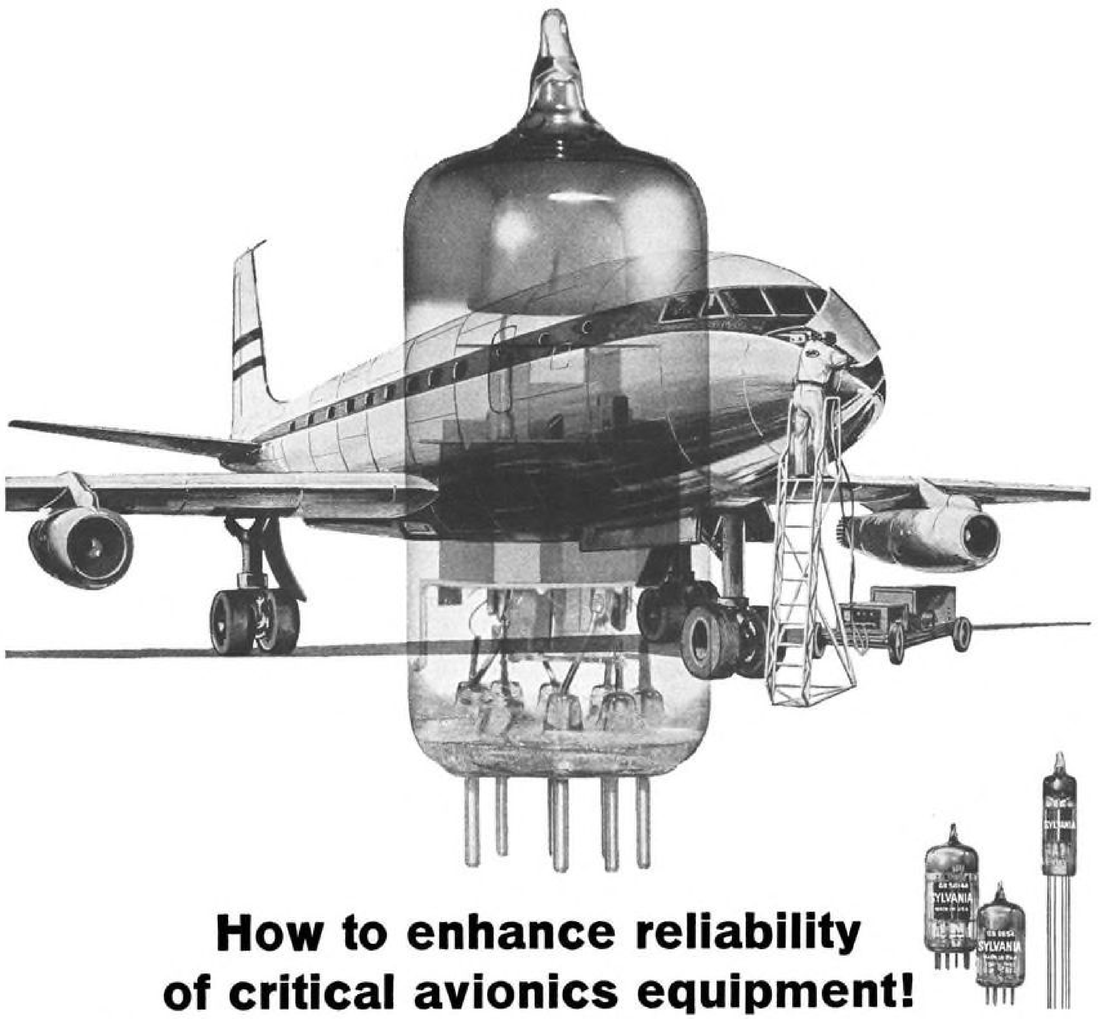
Summary

Launched*		Decay	In Orbit	Transmitting
1957—USSR	2	2	0	0
1958—US	5	3	2	1
—USSR	1	1	0	0
1959—US	11	7	4	0
—USSR	3	2	1	0
1960—US	17	7	10	0
—USSR	3	3	0	0
1961—US	30	16	14	2
—USSR	5	5	0	0
1962—US†	43	23	20	9
—USSR	13	7	6	0
Total—US	106	56	50	12
—USSR	27	20	7	0

(* Includes lunar, planetary probes)
(† Includes cooperative programs)

Notes: Satellites launched by USAF are Discoverer, Midas, Samos and Saint test vehicles. Previous Log was published July 16, p. 63.

Sources: Aviation Week & Space Technology; National Aeronautics and Space Administration Operations Control Center; North American Air Defense Command, and Smithsonian Astrophysical Observatory.



How to enhance reliability of critical avionics equipment!

A good equipment design, proven under laboratory conditions, may sometimes perform erratically during field life. Why? Consider the type of components used. Are they field proven? Do they offer documented reliability?

Take the case for electronic vacuum tubes. Tests by ARINC Research Corp.* illustrate the dramatic improvements in tube reliability since 1954. The results of tests conducted aboard naval vessels, for example, show a combined tube removal rate of 15% per 1000 hours in 1954. By 1960 this figure dropped to 1.2% for miniature tubes and a remarkable 0.19% for subminiature tubes. All the controlled subminiature types in this test were Sylvania tubes.**

Electronic tubes are virtually unaffected by extremes in environment. Example: Sylvania GB Gold Brand Tubes, specifically designed for business-commercial aviation, maintain rated performance even after shocks of 500g, fatigue tests of 2.5g for 96 hours, bulb temperatures of 165°C. They are unrivaled in electrical stability, uniformity and ease of interchangeability.

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

*Courtesy ARINC Research Corp., as published in publication #101-28-166, #101-26-160.

**Tubes were use-tested in eight SRR-13A receivers. Contributing factors to improved reliability included: applied receiver line voltage reduced to 92% of its nominal value; continuous operation of receivers. Sylvania subminiature types included—5636, 5644, 5647, 5718, 5719, 5840, 5899, 5902.

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NASA Contracts

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

HEADQUARTERS, WASHINGTON, D. C.

Northrop Corp., Hawthorne, Calif.—$150,000 to investigate structural approaches for prevention or control of meteoroid damage to space vehicles.

Martin-Marietta Corp., Baltimore, Md.—$99,000 for theoretical studies of control of physical systems.

Stanford Research Institute, Menlo Park, Calif.—$63,000 for studies, analyses and investigations directed toward determination of meteorological value and usefulness of data that could be provided by various weather radar systems.

Stanford Research Institute, Menlo Park, Calif.—$96,000 for investigation of selected problems associated with communications satellites.

Southwest Research Institute, San Antonio, Tex.—$55,000, to survey potential of selected colleges and universities in Texas and Louisiana for participating in space program.

Aerospace Medical Center, Brooks AFB, Tex.—$200,000 to study radiation instrumentation, shielding, and biological effects and determine design criteria of shielding required on manned space vehicle.

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

American Academy of Arts & Sciences, Boston, Mass.—$181,000 for study of long-range national problems in NASA program.

University of California, Berkeley, Calif.—$336,000 for design and provision of IR spectroscope for observations of Mars and Venus, and to supply necessary data storage equipment aloft and interpret results.

Texas A & M Research Foundation, College Station, Tex.—$85,000 for investigation of feasibility of computer coupled activation analysis of the surface of the moon.

Georgia Institute of Technology, Atlanta, Ga.—$104,000 for development and evaluation of submillimeter interference spectrometer.

University of Michigan, Ann Arbor, Mich.—$177,000 for training of graduate students in space-related science and technology.

Her Majesty's Government, Ministry of Aviation, London, England.—$59,000 for Skylark rockets and associated equipment.

Solid State Radiation, Inc., Los Angeles, Calif.—$80,000 for radiation detector for "in vivo" measurements and associated electronics.

Soviet Vostok Report

Moscow—Soviet Russia announced that Vostoks 3 and 4 were launched from the same pad at Baykonur within 24 hr., and that refined data shows the closest the two manned spacecraft came to each other was 4.04 mi.

These are the highlights of a lengthy report in a recent issue of Pravda on the long-duration group flight of Maj. Andrian Nikolayev and Lt. Col. Pavel Popovich in August (AW Aug. 20, p. 26; Aug. 27, p. 36). The article said that Nikolayev floated in his cabin unrestrained a total of 3.5 hr., and that Popovich floated about 3 hr.

The two Soviet pilots reported in a news conference Aug. 21, five days after they landed, that their mission was designed to perfect rendezvous techniques, and they said at that time that their closest approach was 3.1 mi.

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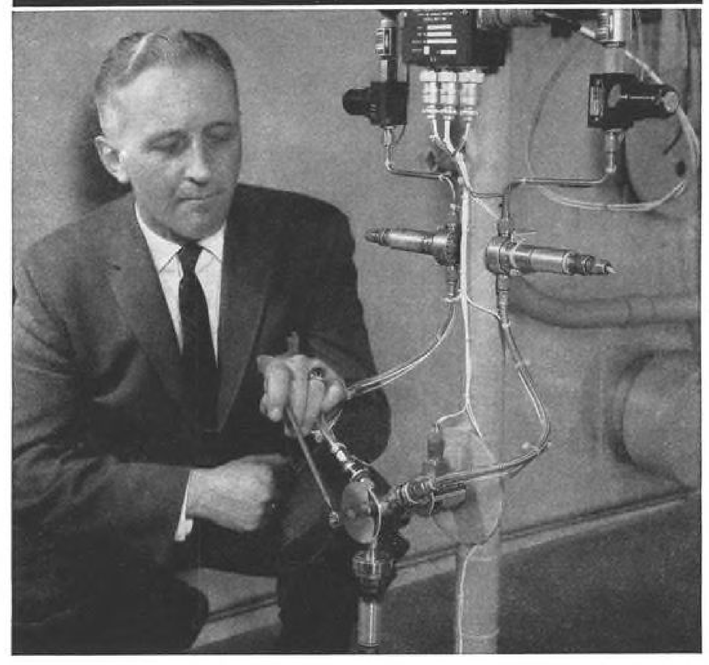

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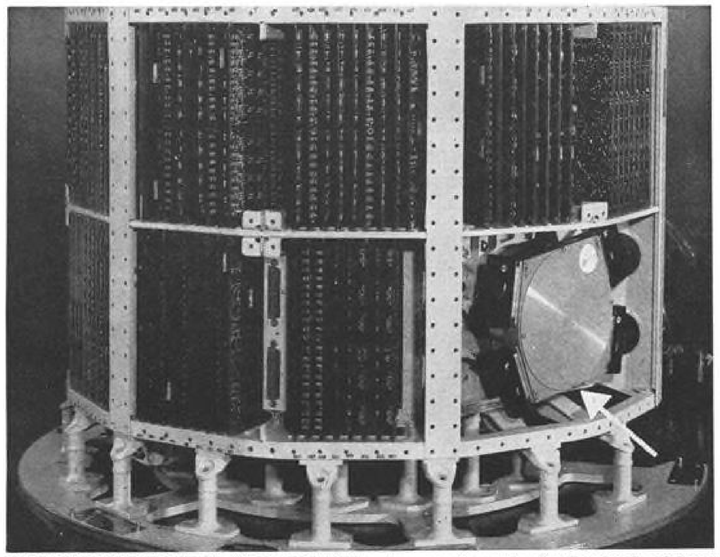
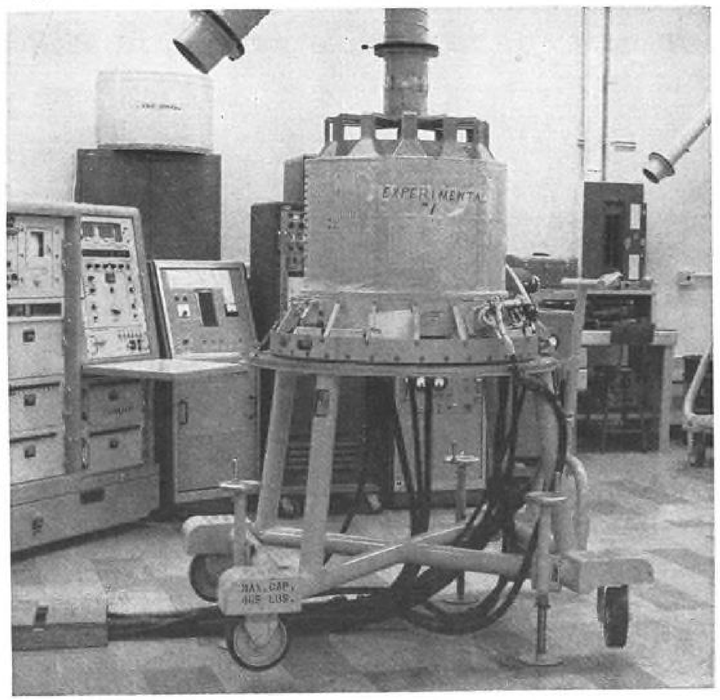
Minuteman Guidance and Control—Part 2:

Minuteman Guidance Built for Long Life

By Philip J. Klass



MINUTEMAN GUIDANCE AND CONTROL system must operate for thousands of hours while in underground silo, yet still withstand rigors of high acceleration missile launch. Above, computer plug-in boards are shown with skin removed. Magnetic disk computer memory is at right (arrow). Computer provides missile check out, flight control and guidance functions. Guidance package (below) is shown with external container removed and computer circuit boards enclosed in a thin toroid skin.



Anaheim, Calif.—Minuteman concept of an ICBM continuously on alert status for several years in an unattended underground silo and capable of launch less than a minute after authorization has sharply altered the traditional difference between inertial systems designed for ballistic missile use and cruise-type systems intended for aircraft and submarine navigation.

Previously, an inertial system for an ICBM was designed principally for operation during a 3-min. powered boost phase, plus occasional checkout periods, where the total usage time amounted to only a few hours at most.

On the other hand, the inertial system for aircraft or submarine applications had to use components designed to provide required accuracy over a mission time ranging from many hours to many days, with a total operational lifetime of at least several thousands hours.

Continuous alert requirement for the Minuteman means that many of its inertial system components must be designed for an operational lifetime measured in thousands of hours. For example, the Minuteman gyros must operate continuously without significant wear or loss of performance. The missile-borne digital guidance computer also must be designed for long operational life because it is used to check out the over-all guidance and control system continuously during the silo life of the missile. (AW Oct. 29, p. 57).

An associate contractor for Minuteman guidance and control, North American Aviation's Autonetics Division provides practically all of the avionics in the missile, except for the warhead and associated arming circuits. This includes:

- **Gyro-stabilized platform.**
- **Digital guidance computer,** also used for flight control and pre-launch checkout, and to control arming of the warhead.
- **Nozzle control units,** one for each of the three missile stages, containing nozzle actuators and autopilot amplifiers.
- **Electric and hydraulic power** supplies for each of the three stage flight control units as well as the basic guidance package.
- **Angular accelerometers,** which provide pitch and yaw attitude signals for first and second-stage flight control.
- **Structure and enclosure** which houses the guidance package.
- **Electric wiring and cables** used to interconnect all missile subsystems.

Additionally Autonetics is responsible for supplying several subsystems installed at the missile silo. These include the optical subsystem used to keep the missile stabilized platform continuously aligned in azimuth and the monitor used to check performance of the missile computer. Autonetics also provides a truck-mounted missile targeting console which is driven to each silo to fill the computer memory with specific target guidance constants.

Each of the three Minuteman stages has four rocket nozzles, two of which are swiveled to provide pitch axis maneuvers while the other two are swiveled at right angles to provide yaw maneuvers. Roll control is obtained by moving one pair of nozzles in a differential fashion. Each nozzle is moved by its own hydraulic actuator, of which there are four on each control unit.

Nozzle Control

Nozzle control units for the three stages are similar except for the size of hydraulic actuator and associated power supply, which becomes progressively smaller in the upper stages. The first-stage nozzle can swivel up to 8 deg. either side of neutral, while the second and third stage nozzles can swivel 6 and 4 deg. respectively.

Nozzle control unit is built in an X-shaped configuration which serves as a structural member for the lower part of each stage, with an actuator attached to each of the four legs of the "X". The structure also houses an electric motor-driven hydraulic demand pump and a small accumulator to power the actuators. Electric batteries also are provided in each nozzle control unit to drive the hydraulic pump. The hub of the structure contains servo amplifiers whose output controls solenoid valves built integrally with the actuators.

Command for nozzle displacement generated by the guidance computer is first converted to analog format, then supplied to the servo amplifier of the active stage, which, in turn, operates the solenoid valve admitting hydraulic fluid to the appropriate pair of actuators to displace the nozzles by the desired amount.

Because the servo amplifier is in such close proximity to the rocket blast, it must be protected from the heat by means of a thermal insulating cover which encloses the hub of the structure.

At the time the Minuteman design was started, it was decided to use swivel nozzles instead of jetavators, which are used for control on Polaris. The actuator forces required to operate the nozzles were calculated on the basis of preliminary data which subsequently proved to be far short of the force required. On the first stage, for example, the current design figure for actuator forces is more than ten times the original estimate.

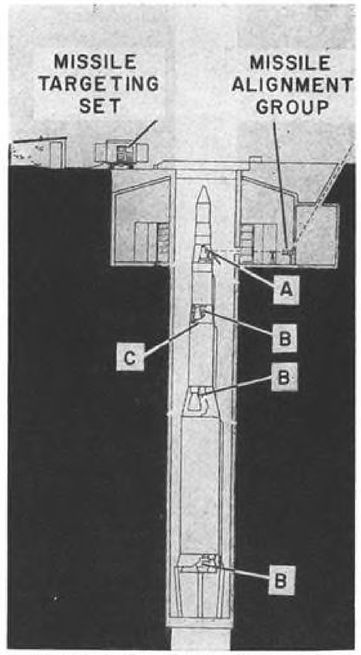
Estimated nozzle actuator forces increased four times before the first Minuteman flight, with the last jump of 25% becoming necessary only three months before the first flight.

One reason for the increases was a change in the Minuteman propellant, involving new additives which accumulated at the nozzle coupling and greatly increased the breakaway friction of the nozzle.

Originally, it was planned to use electric actuators for the third stage to reduce weight and complexity, but after several upward revisions of force required it became necessary to switch to the present hydraulic actuators.

On several occasions, Autonetics had to switch to larger actuators, and in some cases this required the use of a larger hydraulic supply. But in other instances it was possible to trade off actuator response time for the increased force.

Minuteman inertial platform uses an inside-out gimbal configuration. The platform is stabilized by two dual-axis free-rotor gyroscopes whose rotors are supported by self-pumping helium-gas bearings. One gyro serves as the pitch and roll axis reference; the other provides heading reference with one of its axes unused. The platform has ±90 deg. of freedom in pitch, 70 deg. in roll and 20 deg. in yaw.



MAJOR ELEMENTS of Minuteman guidance and control system include guidance package containing inertial platform and computer (A), three nozzle control units (B), and angular accelerometers (C). Autonetics also provides missile alignment set in each silo and mobile targeting set which feeds missile data on its target.

Autonetics selected the gas-bearing dual-axis gyro because of its extremely good dynamic stability over extended operating periods and its ability to withstand high-g loads, according to Robert Knox, chief scientist of the Minuteman Division.

Gyro Reliability

One gyro of this type operated continuously for five years at Autonetics without failure or appreciable performance loss, according to Knox. A similar unit tested at Space Technology Laboratories operated for 14,000 hr. without failure before it was finally shut down, he says.

Minuteman gyros do not require the extremely low-drift characteristics needed for aircraft or submarine cruise-type navigation systems. Its drift rate, measured in "hundredths of a degree per hour" is more than adequate for Minuteman, Knox says.

More important attribute is the extremely low shift of dynamic balance during long periods of operation and the resultant low drift under high accelerations experienced during launch.

Use of self-generated gas bearings does mean that there will be some wear on the gyro sphere whenever it is shut down and re-started. However, during start-up, a much higher than normal voltage is applied to accelerate the sphere quickly and generate the required gas cushion. As a result, Knox says, several hundred stop-start operations are possible before significant wear occurs.

Capacitance-type pickoffs are employed to detect displacement of the gyro case relative to the spinning sphere. Eddy current torquers are used to shift the gyro spin axis.

Guidance Platform

Platform contains four dual-axis level detectors, one of which is used to maintain the pitch and roll axis gyros continuously aligned to the local vertical. The other three level detectors are used to check the operation of the platform's integrating accelerometers and to perform periodic calibrations. The heading gyro is kept continuously aligned to an external azimuth reference in the silo by an automatic optical collimator. Once the missile is launched, the gyros need maintain their position accurately only for a matter of several minutes.

To measure missile velocity along each of its three axes, the stable platform carries three integrating accelerometers. Each contains a pendulous mass which is floated in liquid to minimize bearing load and friction. Vehicle acceleration along the sensitive axis of any accelerom-

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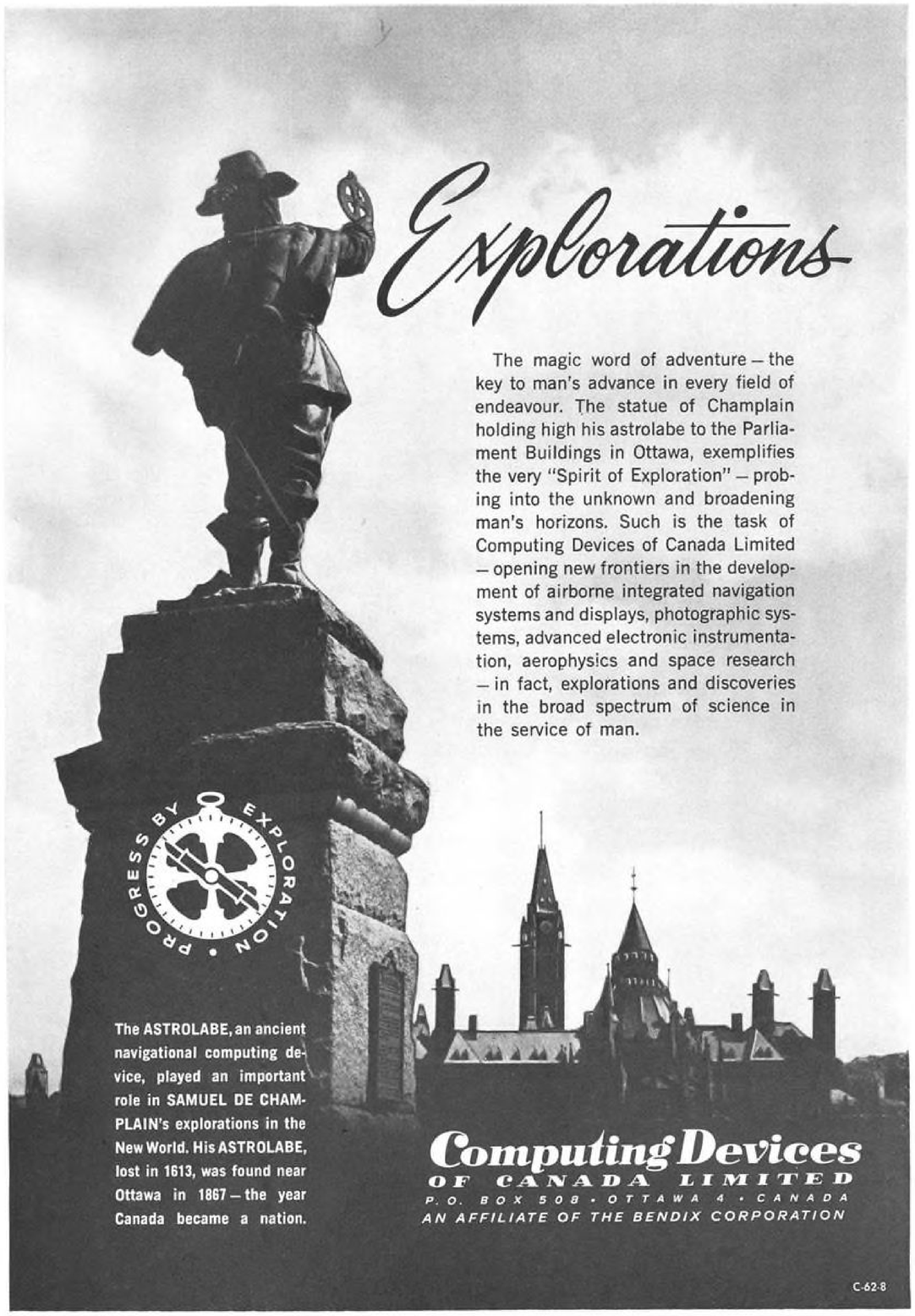


cter displaces its mass. This generates a signal which is amplified and applied to a motor-driven eddy current drag cup which applies a torque to restore the mass to its original position. The number of revolutions made by the drag-cup motor in a given increment of time to restore the mass to neutral position is proportional to the first integral of vehicle acceleration, or its velocity. A thermostatically controlled electric heater is provided to maintain a moderately constant temperature, since the magnetic drag of the cup on the mass otherwise would vary with temperature and change instrument calibration.

Computer Functions

However, Knox emphasizes that this electric power is required only during pre-launch and launch conditions and is not needed during shipping or pre-installation handling.

Minuteman missile-borne digital computer performs a number of functions. Working from vehicle attitude and velocity signals obtained from gyros and accelerometers, it solves the basic guidance-to-target equations, generates missile steering commands and also solves flight control equations which take into account the aerodynamic characteristics of the vehicle.

Additionally, the computer controls staging and thrust termination for each of the three stages and determines when it is safe to provide prearm signals to the warhead. In earlier ICBMs, this arming function has been performed by a separate computer. In the silo, the missile computer is used for the continuous routine checkout of the over-all missile and periodically to perform detailed performance and calibration tests. It also serves to countdown the missile prior to launch.

Computer occupies about one-half of the outer shell of the guidance section structure, whose diameter is 45 in., while the other half contains the servo amplifiers and controls for the gyro stabilized platform. The platform itself is housed in the center of the structure, which has an inner diameter of 32 in.

Computer is a general purpose serial machine using a 27-bit word format, of which 24 bits are used for computation. The machine operates at a clock rate of 345.6 kc. which provides addition time of about 78 microseconds and multiplication time of about one millisecond.

Computer memory unit is a rotating magnetic disk, operating at 6,000 rpm., which is supported radially through a thin metal diaphragm by a ball journal bearing rotor, according to Dr. W. L. Morris, project engineer. The memory unit used in the first Minuteman wings has a capacity of 2,985 words.

Computer supplies three pairs of digital outputs which are used to control

INTERCONNECTION of individual computer and platform amplifier circuits, mounted in circular shell, requires thousands of soldered joints. Operation is performed on special fixture which allows shell to be easily rotated for operator access.

external equipment such as gyros and three analog voltage outputs which serve to command movement of the nozzles to provide pitch, roll and yaw changes.

Additionally, the computer is designed to supply an output for operating a paper tape punch or electric typewriter for printing out results of checkout tests, and another for generating telemetry data.

External Equipment

Computer also accepts 43 on-off type inputs from external equipment. For example, an input from one of the gyros indicating that it is malfunctioning will block the computer from issuing the necessary commands to arm the warhead.

Computer has two basic computation cycles. One is used to solve the basic guidance equation—where is the missile at this instant with respect to where it should be to hit its intended target. The other, performed at more frequent intervals, is used to generate steering signals for the flight control system.

Autonetics has departed from the conventional practice of using a separate set of gyros in the booster to provide vehicle attitude signals for flight control purposes. Instead it uses two angular accelerometers located in the second stage for the initial portion of the powered flight.

When the second stage is dropped, the stabilized platform takes over as the attitude reference.

One reason for using accelerometers is that they are less complex than gyros. Another is that they provide rate derivatives directly which are needed for satisfactory vehicle stabilization.

Stabilized platform can not be used as a flight control reference for the first two stages, except in the roll axis. The reason is that flexure and bending of the missile during early stages of flight would produce erroneous pitch and yaw axis attitude indications at the stabilized platform location.

Once the first and second stages have been dropped, the remaining portion of the vehicle is sufficiently rigid to permit the platform to serve as an attitude reference for the remainder of the guided part of the flight.

Autonetics guidance and control system contains about 26,000 components. Of this total, about 19,000 are in the guidance package and 7,000 are in the three engine nozzle control units. Of the 19,000 in the guidance package, about 15,000 are in the computer, while the remainder function with the stable platform.

Minuteman computer is designed so that it can be completely reprogramed, if desired, by changing the information stored in the magnetic disk memory. After the missile is in the silo, a truck-mounted programmer is moved up to insert specific data on the missile's assigned target location.

Autonetics officials point out that with Minuteman, it is not necessary to modify the guidance instructions for each missile to compensate for the characteristics of the particular accelerometers and gyros installed in that missile, an added complexity required for some earlier ICBMs.

Complete guidance package, consisting of stabilized platform, associated avionics and the computer is housed in a sealed gold-anodized container filled with helium. Electric power for the guidance package is supplied by silver-zinc batteries housed in a skirt slung around the lower portion of the base.

Helium Coolant

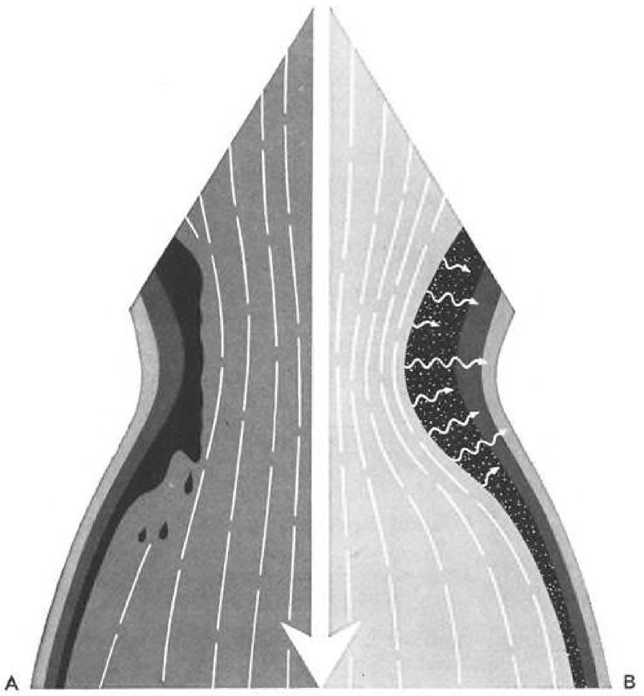
To provide cooling for the avionics equipment, the sealed container is filled with helium. It also contains a circulating fan and a liquid-type heat exchanger in its base. While the missile is in the silo, liquid coolant is pumped into the heat exchanger and heat is transferred to it by means of the circulating helium gas. At launch, the coolant is disconnected and the guidance package utilizes the residual coolant in the exchanger, experiencing a temperature rise which remains within allowable limits for the duration of the guidance function.

Entire guidance package is insulated with glass fiber and placed in a specially coated aluminum monocoque enclosure built by North American's Space and Information Systems Division.

The complete package is then shipped for assembly onto the third stage by Boeing.

Several minor component and subsystem improvements were introduced into the guidance and control system

AEROPHYSICS



New knowledge of fluid dynamics and heat transfer gradually is forcing a revision in our thinking about solid rocket-nozzle cooling problems. For example, we now know that use of the "two-metal" principle in the design of nozzles permits us to expose metals to temperatures well above their normal boiling points. In the two-metal system, one metal is allowed to boil within another. As boiling occurs, the boiling products of the first metal pass through the pores of the second, thus cooling it by convection, mass transfer, and heat absorption in the phase changes. The above drawings show how hot gases passing through a nozzle (A) erode "pure" metal such as tungsten at the throat. In (B), mass-transfer cooling protects the metal from erosion. This and other cooling techniques permit our design engineers to overcome inherent limitations of materials now available for nozzle applications.

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production for Wing 2. A more significant design improvement is planned for introduction with a later wing. These changes, intended to reduce system weight and improve reliability are:

- **Microminiature circuitry,** using discrete micro-components and inked-on resistors with ceramic printed circuit substrates, will be substituted for present conventional miniature construction circuits (AW May 14, p. 95).
- **New circuit designs** employ interstage coupling techniques intended to minimize the use of capacitors. This also has a longer-range objective of easing the way to use of semiconductor microcircuitry at a later date. Such microcircuitry does not lend itself to fabrication of large coupling capacitors.
- **New switching transistors** will be used to provide a.c. power to minimize the number of power transformers needed.

Beyond the improved Minuteman design, Autonetics is doing preliminary work on what is termed the "advanced Minuteman," although production is expected to be several years away. For this design, Autonetics hopes to switch almost completely to semiconductor microcircuitry, at least for low-power circuits. Its studies indicate that 17 basic types of circuits can handle the bulk of the circuit needs, AVIATION WEEK was told.

Autonetics has surveyed about a dozen semiconductor microcircuit manufacturers and plans to select a few to provide sample quantities for rigorous and extensive performance and life tests.

(This is the concluding article in a two-part series. The first article appeared in AVIATION WEEK, Oct. 29, p. 57).

Thermionic Generator

Cascade thermionic-thermoelectric generator delivers 15 watts at over-all efficiency of 7.3%, which is expected to rise to 10-12% in improved design. Thermionic generator core (shown in hand), made by Thermo Electron Engineering Corp., operates at temperature of 1,440C.

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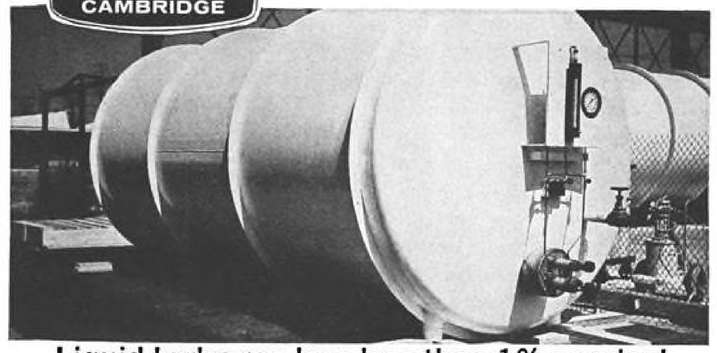

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PROBLEMATICAL RECREATIONS 143

Three hares are standing in a triangular field which is exactly 100 yards on each side. One hare stands at each corner; and simultaneously all three set off running. Each hare runs after the hare in the adjacent corner on his left, thus following a curved course which terminates in the middle of the field, all three hares arriving there together. The hares obviously ran at the same speed, but just how far did they run? *—Contributed*

Length: 13 inches. Diameter: ⅞ of an inch. Weight: 22 ounces. Name: the L-3769. It's a new high gain, broadband CW traveling wave amplifier from our San Carlos group. The conduction-cooled TWT provides a minimum CW power output of one watt with 60 db minimum small signal gain over the frequency range, 5,400-11,000 Mc, and two watts CW, with 65 db minimum small signal gain, over the 7,000-10,000 Mc range. Learn more from the Marketing Department, Electron Tube Division, 960 Industrial Rd., San Carlos.

ANSWER TO LAST WEEK'S PROBLEM: $1001! + 2$; $1001! + 3, \ldots\ldots,$ $1001! + 1001$. $n! + A$ is divisible by A as long as $A > 1$ and $< (n + 1)$.

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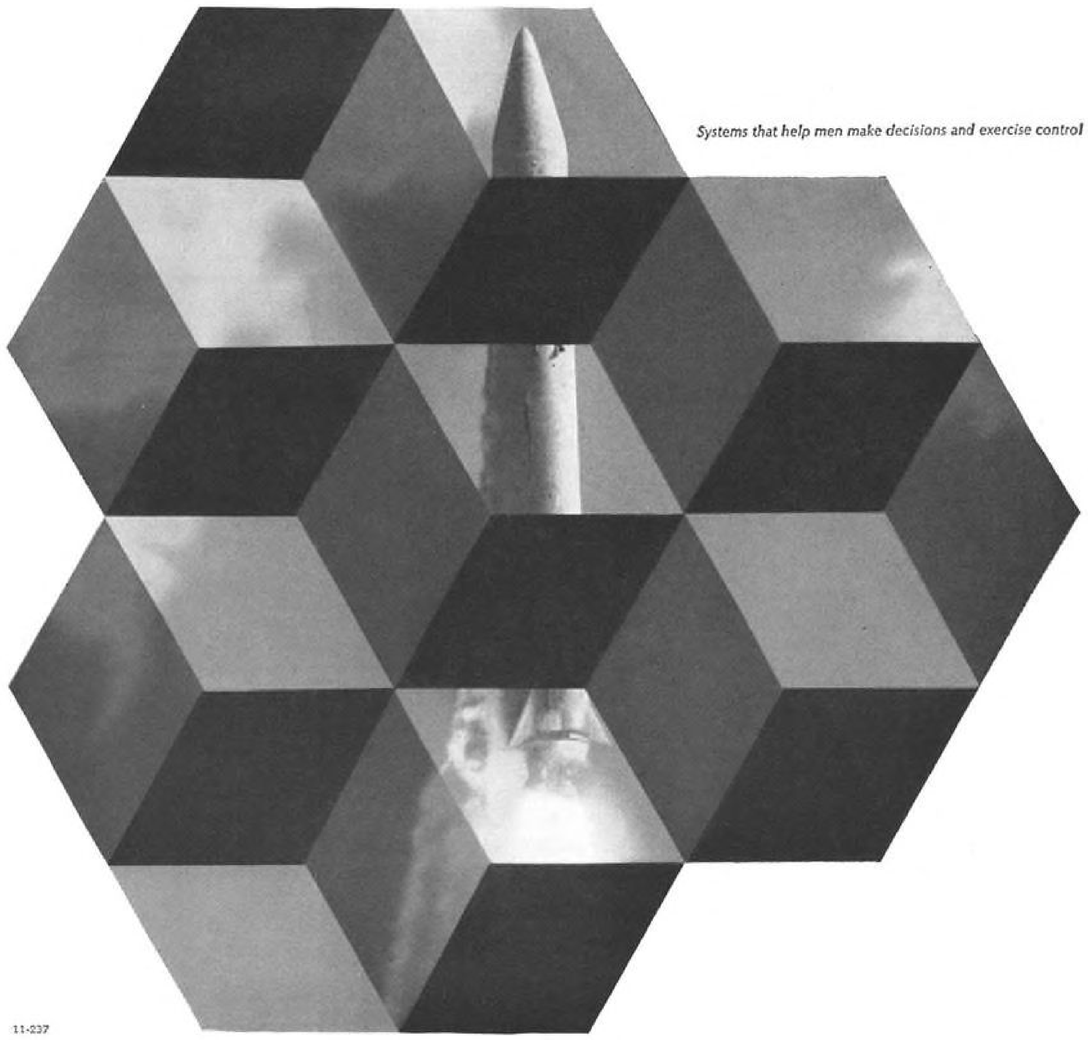


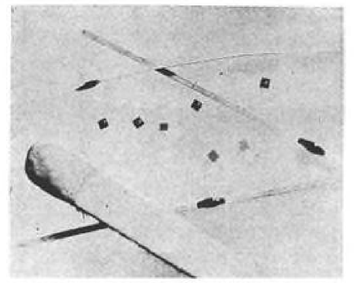
Systems that help men make decisions and exercise control

11-237

NEW AVIONIC PRODUCTS

• **Low-cost control computer,** completely solid-state, stored program digital type which sells for approximately $20,000, has a basic memory of 2,048 words,

24 bits in length including sign. Add-subtract time is 78 microseconds. Computer is designed for industrial environment and does not require air conditioned location, according to the manufacturer. Diginamics Corporation, Dept. DM-4, 2525 E. Franklin Ave., Minneapolis 6, Minn.

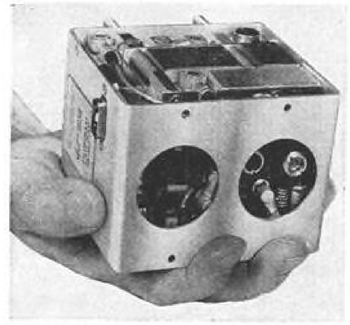


• **Silicon micro-diodes,** with front-to-back resistance ratio greater than 10 billion to one with conductances greater than 400 mils at 1 volt, and with peak inverse voltage ranges of 1,000 v. Standard units dissipate 300 mw., while specials can handle 750 mw. or more. Units are designed to meet MIL-S-19500B and operate above 150C temperature, the manufacturer reports. Micro-Semiconductor Corp., 11250 Playa Court, Culver City, Calif.

• **Digital logic modules,** called Digicube, new line of 12 circuits allow use of AND/OR or NOR logic directly, either in clocked or asynchronous systems. Basic logic fan-out is six unit loads. Drive modules are available to handle fan-outs up to 18 unit loads. Frequency range is dc. to 100 kc. with clock rates to 200 kc. All logic circuit Digicubes measure approximately 0.6 x 0.6 x 0.65 in. and are potted in epoxy. Sanders Associates, Inc., 95 Canal St., Nashua, N. H.

• **Two-axis rate gyro,** Type G-14, has gyro rotor which is centered in structural rotor by two pairs of orthogonally positioned rods. Movement of gyro case causes change of tension in rods which is sensed by piezoelectric cartridges to provide output signal, a composite two-axis voltage which is resolved in a narrow-band amplifier and two demodulators. Design is adaptable for rate sensitivities ranging from 0.02-1,000 deg. per second. Gyro measures 2 in. dia. x 4 in. long, weighs about 2½ lb. American Bosch Arma Corp., Garden City, L. I., N. Y.

• **Solid-state 3-watt VHF-FM transmitter,** Model 503A, covers 215-260 mc. band, weighs 36 oz. and measures



3 x 4 x 4½ in. Device can operate continuously at ambient temperature of 85C, withstand 100g acceleration and impact, according to manufacturer, Electronic Communications, Inc., Box 12248, St. Petersburg 33, Fla.

• **Transistor-sized thermostat,** snap-action type, for use as temperature limiter or monitor weighs only 0.4 gr. and responds five times faster than comparable units, manufacturer says. Device is available either with threaded plug or pin terminals, rated up to ½ amp at 115 v.a.c. or 30 v.d.c. with temperature setting range of 0 to 350F. Technical bulletin DD-PRET-12 gives application data. Metal & Controls Inc., 34 Forest St., Attleboro, Mass.

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See October 22nd Aviation Week article on this equipment, Page 70.

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- **Makes a schematic function like the real equipment so that troubleshooting can be solved with understanding**
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FILTER CENTER

► **Picosecond Diode Developed**—New type diode, using junctions made of different types of semiconductors (hetero-junction), may provide switching speeds of a few picoseconds (trillionths of a second) according to scientists at the International Business Machines research center who developed it. The new type diode also may be suitable for use as a highly efficient microwave detector at frequencies above 100 gc. (kmc.). The new hetero-junction diode, consisting of an N-type germanium junction grown on an N-type gallium arsenide junction, has a theoretical recovery time of about one picosecond, but this has not yet been confirmed by measurement for lack of suitable test equipment, IBM says. Device was described by Dr. F. F. Fang and Dr. W. E. Howard at the Electron Devices Meeting in Washington.

► **Diode Infrared Emission Source**—New information on the basic source of infrared radiation emitted by gallium arsenide diodes, first discovered by Lincoln Laboratories, was reported by IBM scientists at the Electron Devices Meeting. IBM experiments indicate that the emission comes from the P-side of the junction and results from recombination involving an acceptor center.

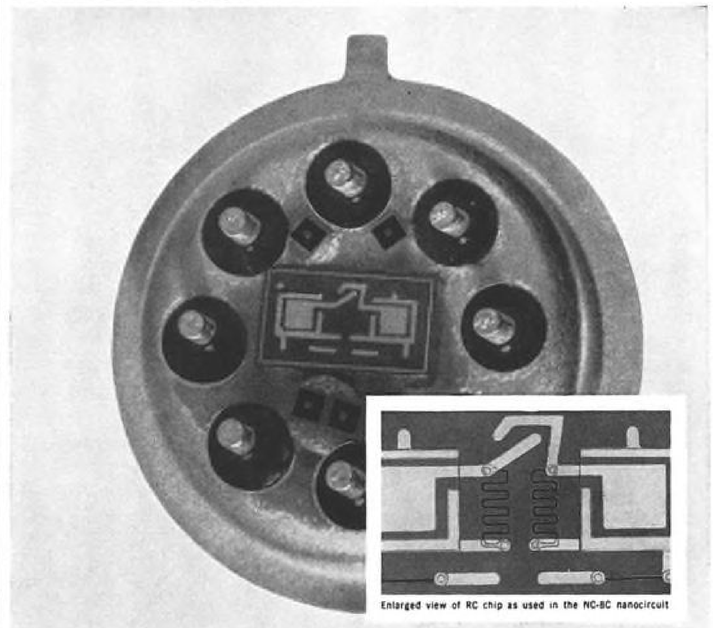
► **Neglected Sunspot Cycle**—Seeking explanation for recently discovered 26-month cycle in direction of zonal winds in the equatorial stratosphere, which shift from east to west and back, Air Force Cambridge Research Laboratories scientists have discovered a previously undetected 25-month sunspot periodicity in addition to the well-known 11-year cycle. However, AFCRL is not certain that there is a causal relationship between the two despite the apparent correlation, since the 11-year cycle does not produce any yet-detected cyclic effects on zonal winds.

► **Laser List Grows**—New output wavelength for neodymium-doped glass laser has been achieved by scientists at Corning Glass Works. Laser action has been obtained at 9,180 angstroms where other lasers using same material had outputs at 10,600 angstroms. Energy threshold for the 9,180 angstrom laser is 700 joules at temperature of 80K. At energies 50% above threshold, the stimulated emission spreads over a band of about 80 angstroms, centered at 9,180 angstroms. Program is sponsored by Office of Naval Research.

► **Super-Power Tubes Coming**—Eitel-McCullough will develop an X-band klystron capable of delivering one megawatt continuous (average) power at 8 gc. (kmc.), 20 times the power available today at this frequency, according to the company. Rome Air Development Center is sponsoring development under a $1.3-million contract.

► **Wideband Laser Modulator**—Modulator for lasers, which has demonstrated a bandwidth of more than 1 gc. (kmc.) and requires only 10 watts of power for operation, has been developed by the Applied Research Laboratory, Sylvania Electric, a subsidiary of General Telephone & Electronics. Company says it represents a 50:1 increase in bandwidth and a 100:1 reduction in power over previously demonstrated laser modulators. Device consists of two brass rods with an electro-optical crystal material sandwiched between. Phase modulation is accomplished by varying voltage applied to crystal, with brass rods serving as transmission line to apply voltage and to achieve the wide band operation. Modulator has been tested over frequency range from 30 kc. to more than 1 gc.

Nanocircuit of the Month



Enlarged view of RC chip as used in the NC-BC nanocircuit

Flip-Flop for Airborne Computers

Performance to 20 MC. Operable over the full MIL range from −55° to +125° C.

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SOFTWARE

The hardware for space travel is coming along nicely. The software for space travel is people, about whom a great many issues are clear and some are not. Clear: a man can survive a few hours out there. (Nikolayev, 96½ hours, no known after-effects.) To be determined: can a man survive in space for weeks, or months? (On a round-trip to the moon, for example. Or in an orbiting space station.)

The most versatile and valuable component of any space system is man. His welfare out there is going to depend (in part) on the environment inside his vehicle. And the composition and pressure of that environment will depend on engineering requirements: weight, power, reliability. Suppose a pure oxygen, low-pressure environment were selected. How would our Astronauts function during a two-week mission?

NASA needs to know. They assigned us to find out. We're doing it right now.

The theory is simple enough. The procedure is not. It starts with our Environmental Test Chamber, a steel cylinder 30′ x 18′ in which we can produce various combinations of temperature, pressure, humidity, vibration and atmospheric composition. Inside, in groups of 6, go healthy young men to breathe pure oxygen for two weeks. For each group the pressure is changed. Pure oxygen at 5 psi for the first group, 7.4 psi for

the second and 3.8 psi for the third. A fourth group, breathing air at 14.7 psi, serves as control.

Outside the chamber are specialists in aerospace medicine, physiology, psychology, microbiology, biochemistry and environmental testing. During each two-week period this team performs 683 specific tests on each man (mental, sensory, motor, pulmonary, hematological and microbiological.) The group is assisted by instruments (polygraphs, oscillographs and the like) that automatically monitor and record each subject's reactions.

Probably the most significant oxygen pressure in the test program is 5 psi. That's the environment currently used for Project Mercury. It is also under consideration for Project Gemini, a planned two-week orbit for two Astronauts. Long before they go up, the "unknowns" of living in an oxygen environment will have become knowns. And the hazards thereof, if any, will have been pinned down, studied and eliminated.

This research, supported by NASA, is being carried on in our Space Environment and Life Sciences Laboratory, to determine the effects of space travel upon the software as well as the hardware.

REPUBLIC AVIATION CORPORATION

REPUBLIC AVIATION CORPORATION, FARMINGDALE, LONG ISLAND, NEW YORK

GRUMMAN A2F INTRUDER, all-weather strike and close support aircraft, is now in final phase of acceptance testing. Deliveries to Navy and Marine Corps units is expected to begin early next year, and Air Force also plans to purchase the plane in Fiscal 1964.

Extensive Electronics Aid A2F Capability

By C. M. Plattner

Bethpage, N. Y.—Grumman A2F-1 Intruder, all-weather strike and close support aircraft, met Navy's Oct. 1 Board of Inspection and Survey delivery date on schedule and first delivery to Navy and Marine Corps units is expected early next year.

Board of Inspection and Survey trials at Patuxent River Naval Air Test Center, Md., which will continue through mid-winter, are the final phase in acceptance by the Navy before aircraft are delivered to Replacement Air Groups (RAGs).

Fiscal 1962 A2F appropriation for 24 aircraft was $150.3 million. For Fiscal 1963, $159.3 million was appropriated for 43 aircraft, and an additional $56.2 million was allotted for procurement of 12 A2F-1Qs (EA-6A).

New Department of Defense designation for the ECM version is EA-6A. The new A2F-1 designation is A-6A.

To date, 18 A2F-1s have been built and flown by Grumman under what was originally described as Navy's first cost-plus-incentive contract. Penalties and incentive payments so far in the program have just about averaged out, according to Grumman spokesmen, but incentive funding will not be completely determined until after acceptance trials.

An Electronics Counter Measures (ECM) version of the Intruder has also been ordered by Navy. Termed by company officials as the first growth version of the A2F, it will be undergoing developmental flights during the coming year. It is assumed that both active as well as passive ECM capabilities will be built into the aircraft.

STOL effect from tilting the tailpipes of the plane's twin-jet engines downward 23 deg. during takeoff and landing built into early models will not be incorporated into production models. Navy has abandoned the idea, which reduced stall speed 6 kt., as an economy measure in view of the already slow 90 kt. takeoff and landing speed. Tailpipes in the production models will be angled downward 7 deg. from the mean aerodynamic chord.

Extensive employment of electronic equipment is responsible for the A2F's unique day or night mission capability under all weather conditions. Marine Corps A2F missions will be primarily all-weather/night close air support for ground troops, using the airplane's long endurance capabilities for loitering. Aircraft has short field landing and takeoff capability to fit Marine Corps' requirements for a front line aircraft.

USAF Purchase Plans

Air Force has requested funds for purchase of A2Fs in its Fiscal 1964 budget as a result of Defense Dept. policy calling for full utilization of new aircraft by all services.

Continued interest in A2F development has been shown by Air Force but high initial unit cost has been a deterring factor. Representatives of Tactical Air Command, which would receive the aircraft, have taken rides in the A2F and have followed the program closely during Grumman's flight evaluation.

Carrier-based Navy A2Fs designed for nose-tow catapult launch will also be used for close air support in addition to long-range, low-altitude, all-weather strike missions, including nuclear weapons delivery.

In its low-altitude, all-weather weapons delivery role, the A2F can:

- **Fly at speeds near Mach .9** close to the ground.
- **Fly to and from the target area,** and release its stores, all under control of the automatic flight control system.
- **Pull up automatically** to avoid mountainous terrain using terrain avoidance equipment. Terrain-following equipment is now being considered by Navy and may be installed in future models.
- **Remain airborne for long periods** of time, approaching propeller-driven Douglas AD series endurance limits.

Ability to fly at relatively high speeds at low altitude is intended to provide protection from ground fire and radar detection. Since the A2F is not a high-speed aircraft, compared with supersonic fighters even at altitude, and carries no machine guns or cannons, defense against enemy aircraft is primarily limited to defensive maneuvers.

The electronic flight control system is a Digital Integrated Attack System (DIANE). It is basically a three-part system, consisting of sensors, computers and read-out displays.

Sensors, such as position and navigation radars, an inertial platform and pitot tube, acquire information on environmental conditions, position of the plane relative to the earth, fuel consumption and target information. Sensor outputs go to the computers which, in

turn, pass the information to the pilot and bombardier/navigator via the read-out scopes in the cockpit. The computers may in addition give command signals to the automatic flight control system to conform to a programed flight envelope.

The sensors also send information directly to a full complement of standard flight instruments, now referred to as standby flight instruments. Instrument flying in the A2F will be done with reference only to a single integrated instrument display scope incorporating all necessary flight information.

Pilot's role during an all-weather mission when the plane is controlled by the central computer and automatic flight control system, is mainly one of making tactical decisions and monitoring the flight, according to Grumman. He can at any time, however, take control or feed into the computer different mission information or corrections.

Primary components of the Digital Integrated Attack System (see drawing) include:

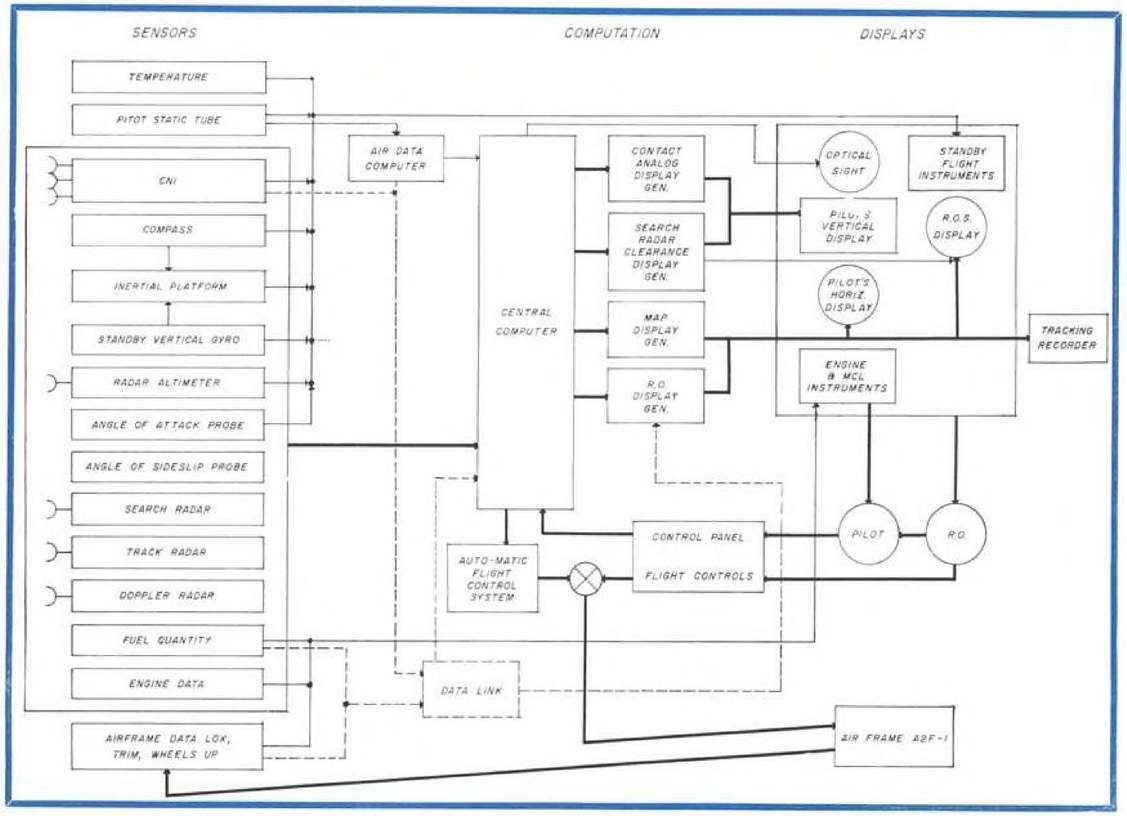
• **Track radar, AN/APQ-88,** maps terrain in front of the aircraft and is capable of tracking or locking-on moving targets. Airborne targets such as missiles released from the aircraft or ground targets can be tracked depending on which mode is selected. Information is read out in the cockpit by the pilot on a horizontal display scope located directly below the pilot's vertical display television scope, and by the bombardier navigator on a repeater scope located on his front console. Horizontal display is a view of the ground from above. Vertical display is a straight-ahead view of the horizon. Pilot and bombardier/navigator sit side-by-side. Track radar is built by Naval Avionic Facility (NAFI) located at Indianapolis, Ind.

• **Search radar, AN/APQ-92,** built by Norden Laboratories, division of United Aircraft, Norwalk, Conn., searches out moving targets and also maps terrain in front of aircraft. Terrain avoidance radar operates in conjunction with the search radar, yielding information on terrain obstacles in front of the aircraft which is relayed to the vertical television display scope. Both pilot and bombardier navigator are able to select multiple modes of track, search and terrain avoidance radars for cockpit readout on a centrally located control panel.

• **Air data computer, CP-582/a,** is a computer link between environment sensing instruments and the central digital computer. It receives information on temperature and static and dynamic pressure, applying necessary instrument corrections and computes Mach number and pressure altitude. This information is fed directly into the central digital computer. Giannini Controls Corp. furnishes the air data computer.

• **Inertial platform subsystem,** AN/ASN-31, measures all aircraft acceleration relative to the earth about all three axis, including air mass (wind) acceleration. The two-gyro stabilized platform sends sensed accelerations to a computer which integrates the information to obtain ground speed and wind. This information is fed into the central digital computer along with similar information from the Doppler radar. The AN/ASN-31 is built by Litton Systems, Inc., division of Litton Industries, Inc.

• **Doppler radar, AN/APN-122,** built by Ryan Electronics, is a multiple beam system used to obtain ground speed and wind information. The central digital computer can use ground speed and wind information from either or both the Doppler radar and the iner-



DIGITAL INTEGRATED ATTACK SYSTEM on A2F is basically a three-part system, composed of sensors, computers and read-out displays. Read-out displays for the pilot and the bombardier/navigator are located in the cockpit, and pilot can take control at any time.

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60 db Isolation

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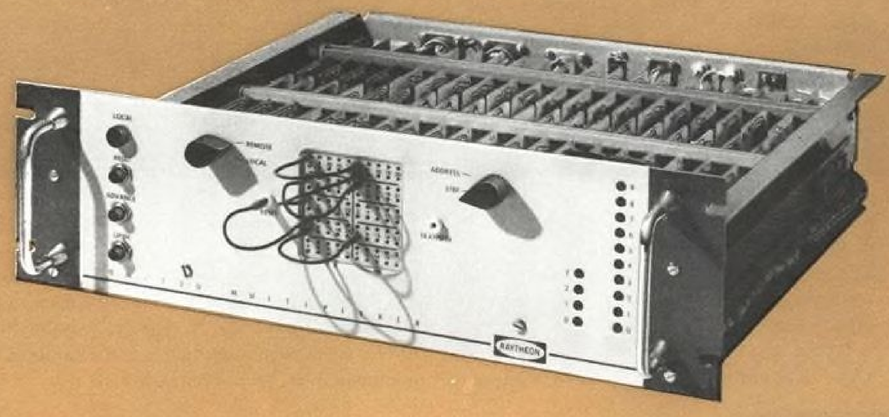
For detailed technical literature write: Raytheon Company, Dept. 60, 1415 Providence Turnpike, Norwood, Massachusetts.

RAYTHEON

Raytheon DM-120
Multiplexer



The DM-120 Multiplexer is another product of DATA-DESIGN,
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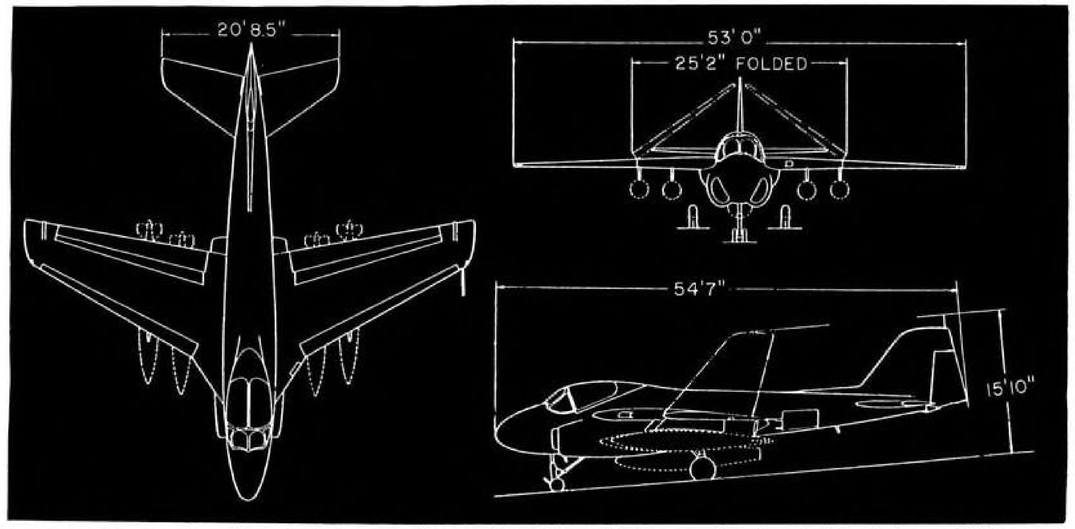

THREE-VIEW SHOWS dimensions of the Grumman A2F Intruder. It is a mid-wing, two-place aircraft with a single set of flight controls. Powerplants are two Pratt & Whitney J52-P-6 jet engines producing 8,500 lb. thrust each at sea level.

tial platform, which provide redundant information.

• **Central digital computer,** AN/ASW-16, gathers information on the plane's position, attitude, fuel state and altitude from the sensors. With this information on what the plane is doing it makes a comparison with the programed flight mission stored in its memory system and sends the information, along with necessary correction notations, to the cockpit displays. If the plane is in automatic flight control mode, the computer sends correction commands to it to conform to programed mission. The miniaturized central computer also remembers such things as ballistics of different weapons carried, position of home base, what type of ordnance has been dropped and what remains, and fuel consumption. It can assume control of missiles such as the Bullpup, guiding them on the way to programed targets. Litton Systems builds the central digital computer.

• **Automatic flight control system,** AN/ASW-16, can accomplish all basic mission maneuvers for the pilot except takeoff and landing. The system can automatically perform all conventional weapons delivery maneuvers with any of the weapons presently used by the Navy, including nuclear devices. Sperry Gyroscope Co. builds the automatic flight control system.

In the cockpit, the pilot monitors flight progress using the automatic flight control system or flies the aircraft in the conventional manner with reference to the vertical television display scope (also called contact analog display). The vertical television display (AN/AVA-1) presents a standard picture of ground texture which expands or contracts to simulate altitude above the ground. The ground texture presentation also moves downward off the scope to indicate a sense of forward motion to the pilot. Top half of the TV display gives the pilot the impression he is looking at the sky by showing a simulated cloud display. Superimposed on the scope are pitch and roll marks so the pilot can keep wings level and maintain altitude. Heading is maintained by correcting to a superimposed simulated flight path in the middle of the scope which moves either left or right of a selected course to indicate drift.

Terrain avoidance signals and fuel control information are also indicated on the vertical TV scope, which is built by Kaiser Electronics, division of Kaiser Industries, Inc.

The AN/AVA-2 horizontal radar scope is a primary instrument for weapons delivery. It is normally monitored by the pilot and operated by the bombardier/navigator. A tracking recorder unit consisting of a remote repeater scope and a camera records the entire radar presentation during flight. The filmed record of the mission can be used for training purposes or combat strike evaluation.

The A2F is a mid-wing, two-place aircraft with a single set of flight controls. The bombardier/navigator sits on the right side, slightly aft of the pilot and can lower his seat to provide the pilot with better starboard visibility. Marine Corps and Navy are emphasizing the teamwork involved in the A2F's mission accomplishments and consider the bombardier/navigator's role of running radar equipment, navigating and target acquisition as essential to mission accomplishment.

Powered by two Pratt & Whitney J52-P-6 engines developing 8,500 lb. thrust each at sea level, the A2F-1 has already demonstrated ability to deliver a 15,000-lb. bomb load. Normal mission gross weight will probably be 43,-

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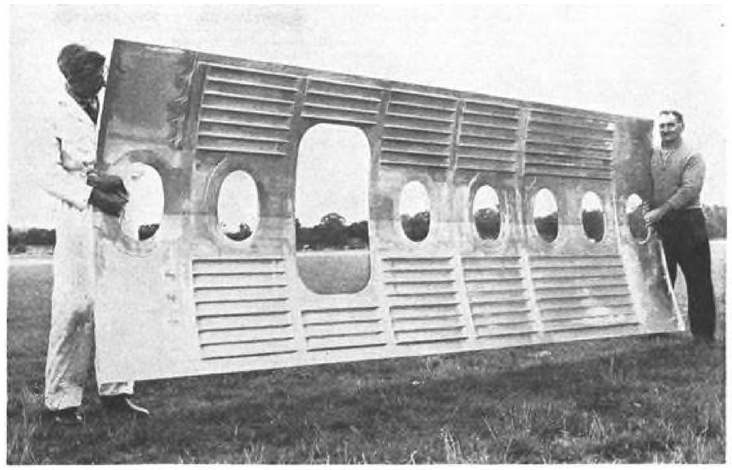


BAC 111 Fuselage Panel Machined From Aluminum

Fuselage side skin panel for British Aircraft Corp.'s BAC 111 twin-jet transport incorporates stringers and stiffeners adjacent to fuselage frames and cutouts as integral parts of the panel. Section was machined from solid light alloy aluminum fillet.

000 lb. and maximum mission gross weight will be 50,000 lb.

With no external stores, takeoff weight is 30,000 lb.

Leading edge wing slats and wing flaps are both hydraulically actuated to the down position with movement of the flap handle bringing the A2F's stall speed down as low as 90 kt. in light configuration, A2F Program Manager Bruce Tuttle told AVIATION WEEK. Grumman pilots fly landing pattern at 105-110 kt. with gear and flaps down, and report very stable handling characteristics at these speeds.

Aerodynamic control about the roll axes is obtained with flaperons on the top side of each wing adjacent to and forward of the flaps. Control stick movement to the left raises left flaperon creating drag and a decrease in wing lift. The over-all torque imbalance of the aircraft from the right wing then tends to roll the aircraft to the left. Control surfaces about pitch and yaw axes are a solid slab flying tail and conventional rudder surfaces. Rudder surface has been increased to improve spin recovery characteristics by extending lower portion 16 in. and top portion 2 in. Improved directional control on takeoff has resulted.

Standard liquid oxygen system (Lox) and Martin-Baker ejection seats are used in the A2F. Air-to-air refueling will be possible with the probe located directly in front of the cockpit on top of the nose section, angled upward and forward.

Maximum endurance with a full load of internal fuel, including wet wings, is over 5 hr.

The Intruder is equipped with anti-skid brakes and large 36 in. by 11 in. tires on the main gear and dual 20 in. by 5.5 in. nose wheels. The aircraft has nose-wheel steering. Large tires were necessary for unimproved field capability and heavy maximum takeoff loads.

Navy says the A2F will replace the Douglas propeller-driven AD aircraft currently being used for close air support and strike missions as are A4D type aircraft in the fleet.

French Aircraft

Paris—French aviation industry officials are urging the French government to undertake development of three new aircraft to offset an anticipated slump in aircraft export orders during the mid-1960s.

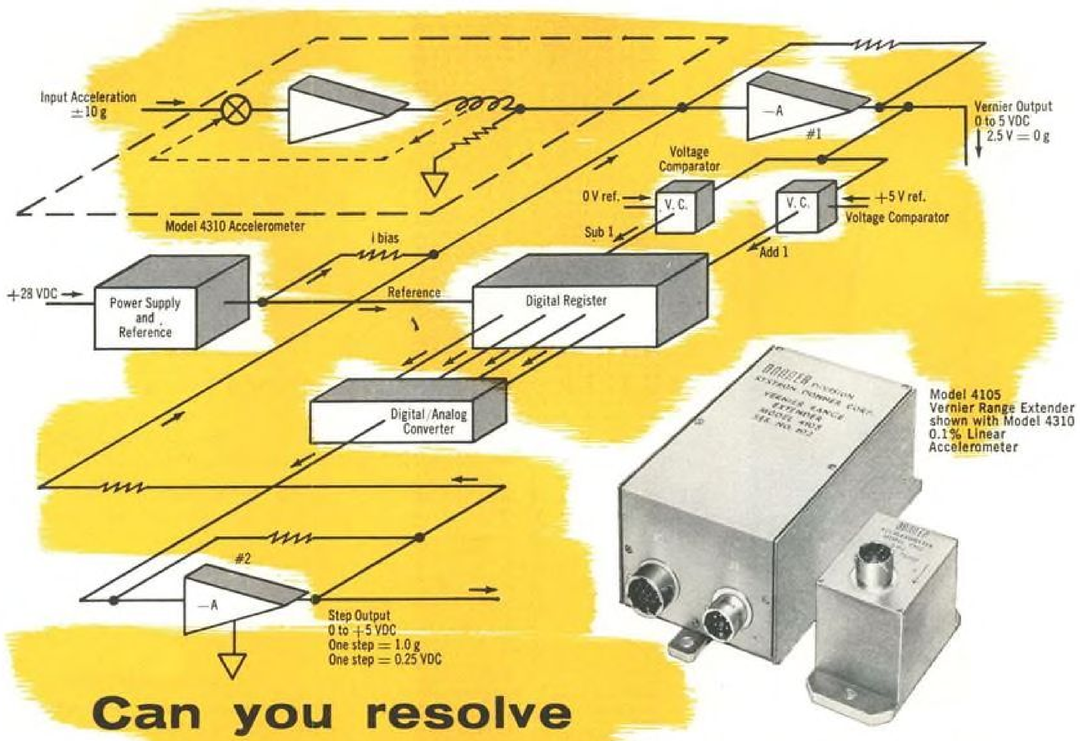
Proposed projects include:

- **Sud Alouette 4 helicopter, a 12-passenger, turbine-powered machine designed to fill the gap between the present seven-passenger Alouette 3 and Sud's 11.5-ton, three-engine heavy helicopter prototype. Helicopter presently is a paper project.**
- **Simplified version of the Dassault Mirage 3 fighter for sale to countries with limited defense budgets. Present versions of the Mirage recently lost competition to the less expensive Soviet MiG fighter aircraft in India.**
- **Small, twin-turbine transport powered with Turbomeca Astazou engines.**

All three aircraft are being proposed for 1964 marketing by the National Committee for Expansion of the Aircraft Industry.

French aircraft, engine and missile exports in 1961 totaled approximately $306 million and have already passed the $200 million mark this year. Export orders next year are expected to hold at about the $200-million level, but are expected to decline to $160 million in 1964 and to $100 million in 1965.

After 1965, the Anglo-French supersonic transport and the Dassault VTOL fighter are expected to cause the dollar value of French exports to rise again.

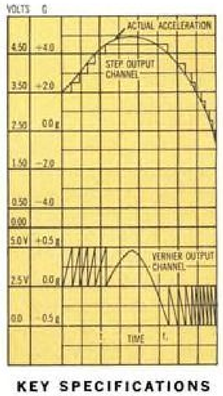


Can you resolve ±12 g's acceleration to 0.04 g over a 2% telemetry system?

Yes, if you use the new Donner 4105 Vernier Range Extender. Coupled to the Donner 4310 linear force balance accelerometer, this remarkable device yields up to a 12-fold increase in resolution compared to methods currently used in today's telemetry systems.

In operation, the Model 4105 provides two distinct 0-5 vdc outputs for transmission over two telemetry channels. One output generates ±1.0 g steps of measured acceleration, the other resolves the difference between steps to 0.04 g. For example, over a 2% telemetry link, the resolution possible with a ±12 g Model 4105 is 2% of ±1 g or 0.04 g. Using an ordinary ±12 g accelerometer over the same telemetry link, the best possible resolution is 2% of ±12 g or 0.48 g—or 12 times worse.

The Model 4105 also offers fast response which allows tracking a 1 g/0.0004 second rate of acceleration change without loss of step on the step output channel.



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OUTPUT Two 0-5 vdc channels
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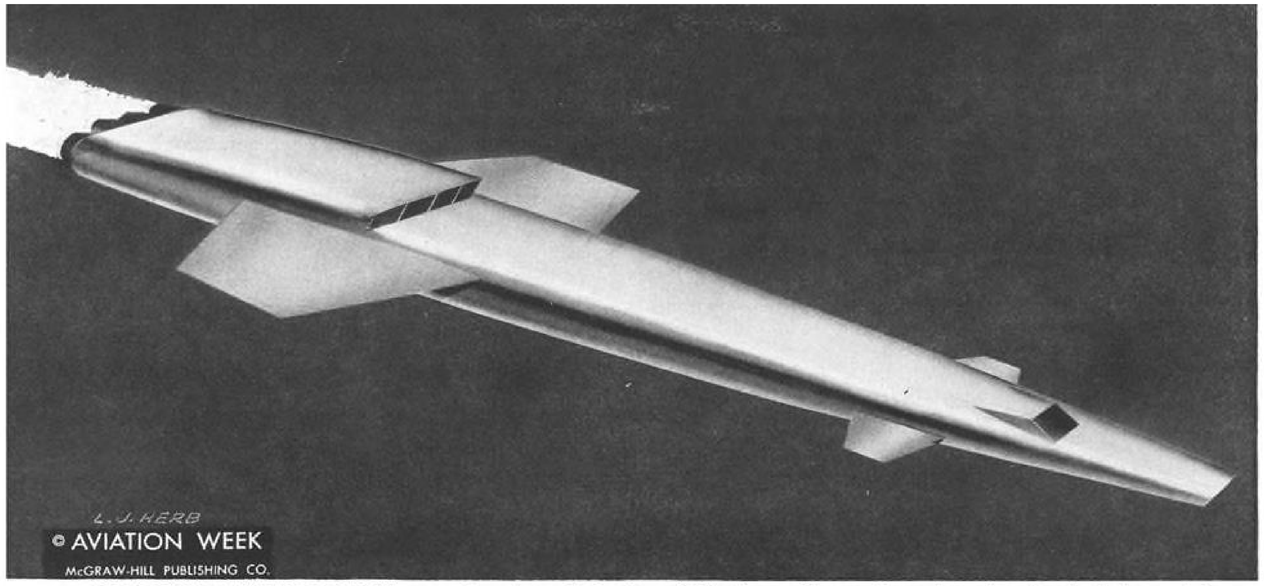


HYPERSONIC TRANSPORT DESIGN, presently under study by General Electric, would use turbo-ramjet engines burning hydrogen fuel. Aircraft would be designed to operate over Mach number range up to 10, according to the company.

Hypersonic Transport Technology Studied

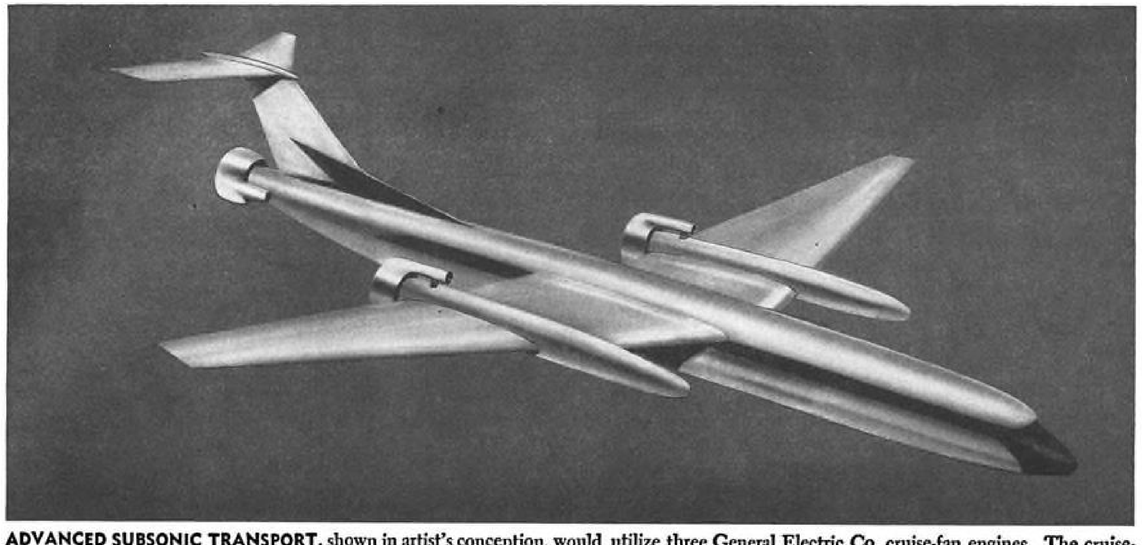
Toronto—Design of a hypersonic transport with cruise speeds above Mach 5 will be one of the major technical trends by the end of this decade.

Future engineering effort forecast was made by R. H. Miller of Massachusetts Institute of Technology at a joint meeting here sponsored by the Institute of the Aerospace Sciences and the Canadian Aeronautics and Space Institute, and aimed at giving rough dimensions to aerospace technology in 1972.

Miller said the efficiency of a hypersonic transport based on present technology, and using hydrocarbon fuel, is comparable to that of the supersonic transport on a theoretical basis. Calculations of direct operating cost using the standard Air Transport Assn. method showed that figures for the hypersonic transport from Mach 4 to 7 were almost the same as those for current subsonic jets.

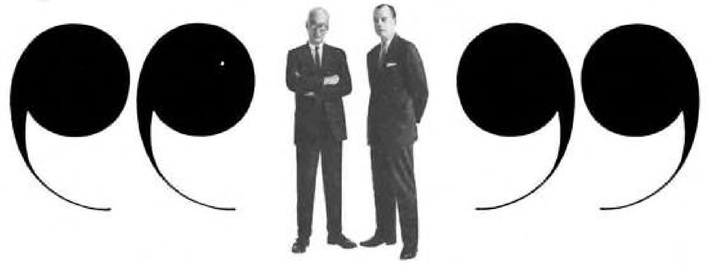
If hydrogen costs were to be reduced to a point where they would be competitive with hydrocarbon fuels, then direct operating cost calculations show that costs would be less than half of those associated with contemporary subsonic transports, Miller said. But the tremendous performance gain obtained by burning hydrogen is not likely to be obtained at low cost. Today, liquid hydrogen costs about $1.50 per pound. If that figure were to be reduced to about 1/15th its value, hydrogen would still be prohibitively expensive. Miller concluded that hydrogen-fueled engines were not likely to give economic flight.

Miller said the Mach 2 or Mach 3 supersonic transport would be operational by the end of this decade but two later speakers, Ian Gray and John Gillies of Canadian Pacific Airlines, said they personally hoped that the super-



ADVANCED SUBSONIC TRANSPORT, shown in artist's conception, would utilize three General Electric Co. cruise-fan engines. The cruise-fan engines are arranged to ingest boundary-layer air and reduce drag.

OTHER COMPUTERS WERE DESIGNED FOR BUSINESS MEN!



THE LGP-30 WAS CREATED FOR ENGINEERS AND SCIENTISTS.

What does an engineer or a scientist respect most? Answer—sheer brainpower. The LGP-30 packs more brainpower than any computer in its class. 4096 word memory—2000 more than its nearest competitor. And alphanumerical input-output via keyboard or punched paper tape. □ Then comes—independence. The LGP-30 is the easiest computer to program and operate. If you know algebra—you can achieve programming competence in hours or days. Even non-technical personnel can master it. You'll never have to be dependent upon computer programming specialists. And you can set it up right in your own office or any other point of use. No expensive installation—just plug it into conventional outlet. □ Right now—scientists and engineers, in addition to businessmen, in hundreds of universities and corporations are using the LGP-30. Therefore, the LGP-30 is able to offer you the use of the most extensive Program Library in its class. No doubt, the program you'll need is ready now—and that's a big saving in time and money. You also benefit from membership in the computer industry's largest, most active information-swapping (POOL) of users. □ Cost? Well, let the businessmen in your organization worry about that. And there's mighty little worrying to do, for a computer with comparable capacity would cost twice as much. The LGP-30—a complete system—rents for only $1100 per month. For more information about the LGP-30, write Commercial Computer Division.

GENERAL PRECISION

COMMERCIAL COMPUTER DIVISION/ GENERAL PRECISION, INC./ BURBANK, CALIFORNIA

Soviets Modify MiG-19 Fighter

Changes in the Russian MiG-19 Farmer indicate an all-weather version of the twin-engine supersonic fighter may be in service. Nose radome has been added at the top of the engine intake, and the probe extending from the intake bottom on other versions has been moved to the right wingtip. Fairing at the side of the intake may be actuator for a variable geometry intake system that was required because of airflow changes resulting from the radome modification. Missiles on underwing pylons are about 8 ft. long, including aerodynamic fairing covering the nozzle. Besides the small delta-shaped forward fins, there are also similar small fins located between the large delta-planform fins at the rear. Missiles most resemble ones carried by a new-type Russian delta wing Mach 2-plus fighter at the Tushino Air Show last year (AW July 24, 1961, p. 29). Missile nose appears to have a homing device. Fairings in the tailpipe area may cover actuators for variable tailpipe geometry system. Stub antennas on the horizontal stabilizer, a frequently used Russian device, are visible. MiG-19 has both ventral and dorsal fins.

sonic transport could be held off until 1982 in order to give airline operators an opportunity to write off their current fleets to residual values.

Air-breathing engines planned for either supersonic or hypersonic applications by the end of this decade will be built around today's components, W. R. Collier of General Electric Co.'s Flight Propulsion Laboratory said.

He predicted these specific improvements in major components of turbojet engines:

- **Turbine inlet temperatures** now approximating 2,000F should increase to nearly double that value by 1972.
- **Compressor stage pressure** ratio now pegged near 1.3 for both subsonic and transonic compressor designs should increase somewhat to 1.4 for transonic compressors.
- **Heat release** in the combustor should be doubled by 1972, making for shorter and lighter combustion chambers.
- **Thrust-weight ratios** now running between 5 and 10 should increase to 14 by the end of the decade.

These improvements were correlated to an engine in the 7,000-lb. thrust category, which represents a medium-sized engine now. Collier emphasized that there is current GE interest in the lift-fan powerplant now being installed in the Ryan-built VZ-11A test aircraft (AW Aug. 20, p. 32), and in a derivative of that system which GE calls a cruise-fan.

Essentially, this is a lift-fan in a vertical plane producing thrust instead of lift. Studies of aircraft made by GE indicate that the cruise-fan system could be used to power a short-haul transport weighing 54,000 lb. at a design-point speed of 400 kt. and an altitude of 25,000 ft. Such a design could have specific fuel consumptions much lower than turboprop values. Typical sfc. points: takeoff, 0.37 lb./lb./hr.; climb,

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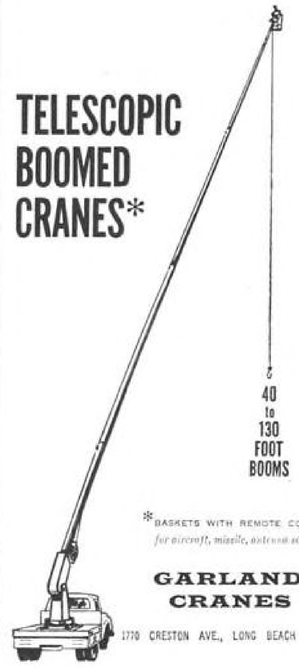

*BASKETS WITH REMOTE CONTROLS
for aircraft, missile, antenna service, etc.

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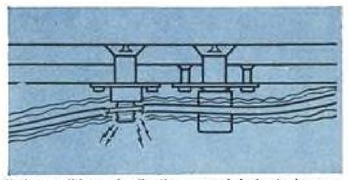
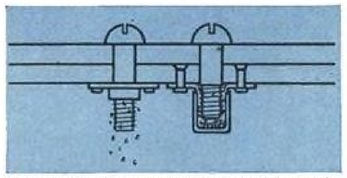
BOOTS CAPPED LOCKNUTS

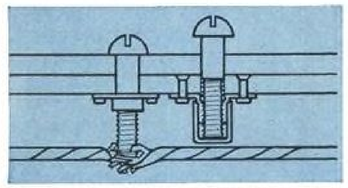
Protect Vital Assemblies, Assure Safe, Trouble-Free Operation



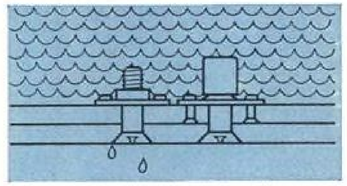
Under conditions of vibration, capped locknuts increase assembly reliability by preventing the abrasive removal of insulation from wires near protruding bolt threads.



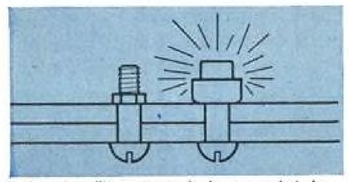
Increased reliability and protection for delicate exposed circuits—cap effectively traps metallic flakes or other fallout resulting from assembly of screw and nut.



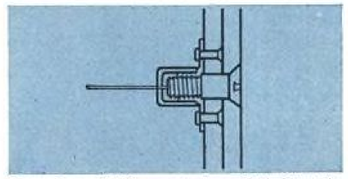
Automatic quality control—capped locknut prevents damage to internal and hidden assembly from screw that is too long. Important wire bundle circuits are safe.



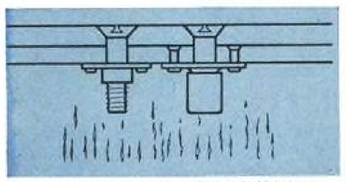
Used in conjunction with liquid sealing "gunk," capped locknuts provide one of the lightest weight integral seals possible for fastening integral tanks or other liquid reservoirs.



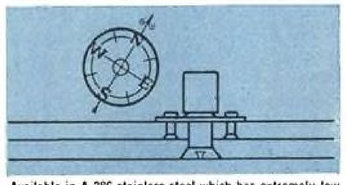
Neat, workmanlike appearance is always a product plus—capped locknuts show extra care in design and manufacturing—experienced buyers look for these extras.



For maximum reliability, caps can be provided with a probe hole so inspectors can check penetration of screw in nut locking element.

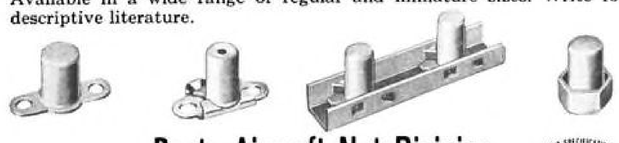


Protection from galling of screw threads in high temperature and corrosive atmospheres. Capped nut protects threads and permits easy subsequent removal of screw—fast replacement of sub-assemblies.



Available in A-286 stainless steel which has extremely low magnetic permeability—ideal for navigation instrument applications, ASW devices, as well as certain corrosive atmospheres.

Boots all-metal, one piece self-locking nuts are simple in design, compact, lightweight and exceed government specifications for tensile strength. Torque and loading is uniform. Re-usability factor is high. Available in a wide range of regular and miniature sizes. Write for descriptive literature.



Boots Aircraft Nut Division

Norwalk, Conn.

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0.61, cruise, 0.67, loiter or descent, 0.67.

Automatic engine control was forecast for the 1972 period by Arnold Guetta of Computing Devices of Canada, Ltd. He expects that the control system will be of analog form and interdependent with other analog systems in the aircraft for autopilot and automatic navigation.

These analog functions would be supplemented by an airborne digital computer.

Function of the automatic engine control would be to vary fuel flow and those portions of the propulsion system that feature variable geometry for optimum performance. The system would provide optimum power settings for cruise modes for maximum endurance range or speed.

PRODUCTION BRIEFING

American Bosch Arma Corp.'s Arma Division has received a contract from Avco Corp.'s Lycoming Division for sonic height-measuring units which will be part of the automatic pilot system on Marine hydrofoil landing vehicles under development by Lycoming. Units consist of two sonic horns and can measure height within accuracies of inches by detecting phase shift between sound waves transmitted down from one horn and the echo received by the other. Applications on helicopters and VTOL aircraft are being studied.

General Electric has been awarded a $400,000 contract from Air Force's Special Weapons Center to measure the effects of lightning strokes on missile sites. GE will check its instrumentation at the company's High Voltage Laboratory, Pittsfield, Mass., before testing it at missile sites during thunderstorms.

North American Aviation, Inc.'s Autonetics Division will build 163 radar terrain clearance computers and accessory equipment under a $3.5-million follow-on contract from General Motors' AC Spark Plug Division. Computers are the heart of a terrain-avoidance system designed to give low-level flight capability to Air Force's B-52 bombers.

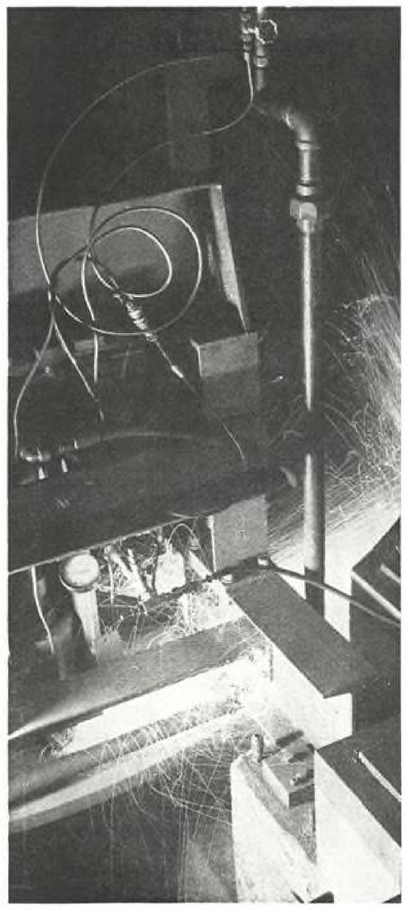
Specialties, Inc., Charlottesville, Va., has received a $1.5-million contract from Ling-Temco-Vought for the production of approach power control systems for Navy's F8U jet.

Avco Corp.'s Lycoming Division, Stratford, Conn., has received a $1,799,860 contract from Air Force's Aeronautical Systems Division for the production of additional T53-L-9 helicopter engines for Army's new Bell HU-1D helicopter.

Astro-Science Corp., Culver City, Calif., has received a $1,585,000 contract from Lockheed Aircraft Corp. for mobile, diesel-electric ground power units for Navy's P3V anti-submarine warfare program.

Titan silo launch test facility at Vandenberg AFB, Calif., used in 1961 for the first silo launch of a heavy ICBM, has been converted to a Titan 2 training facility by Martin Co. and turned over to Air Force for use as a Strategic Air Command missile crew trainer.

General Telephone and Electronics Corp.'s Sylvania Electrical Products Division will build electronic security systems for Atlas-Titan ICBM sites in the continental U. S. under a $2-million Air Force contract.



X-20 Skid Simulated

Horizontal dynamometer is used to simulate landing conditions in testing wire brush skids which have been developed by Goodyear's Aviation Products Division for the Air Force's X-20 (Dyna-Soar) space glider.

ACTION MEMO

FROM: Value Analysis Manager

TO: J.M.H. Dept 77-31

These Cherrylock features mean lower installation cost. We should save money in purchasing and manufacturing—fewer rivets to buy and stock—less chance of installing the wrong grip. We authorize an immediate evaluation.

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- ★ *Positive Mechanically Locked Stem*
- ★ *Flush Fracture (No Stem Trimming)*
- ★ *Strong Clinch*
- ★ *Wide Grip Range*
- ★ *Positive Hole Fill*

United States Patent No. 2931532. Qualifies under NAS Specification 1400 and meets Standard Pages NAS 1398 and 1399. For technical data on the Cherrylock "2000" Series rivets, write Townsend Company, Cherry Rivet Division, Box 2157-N, Santa Ana, California.

Cherry Rivet Division

Santa Ana, Calif.

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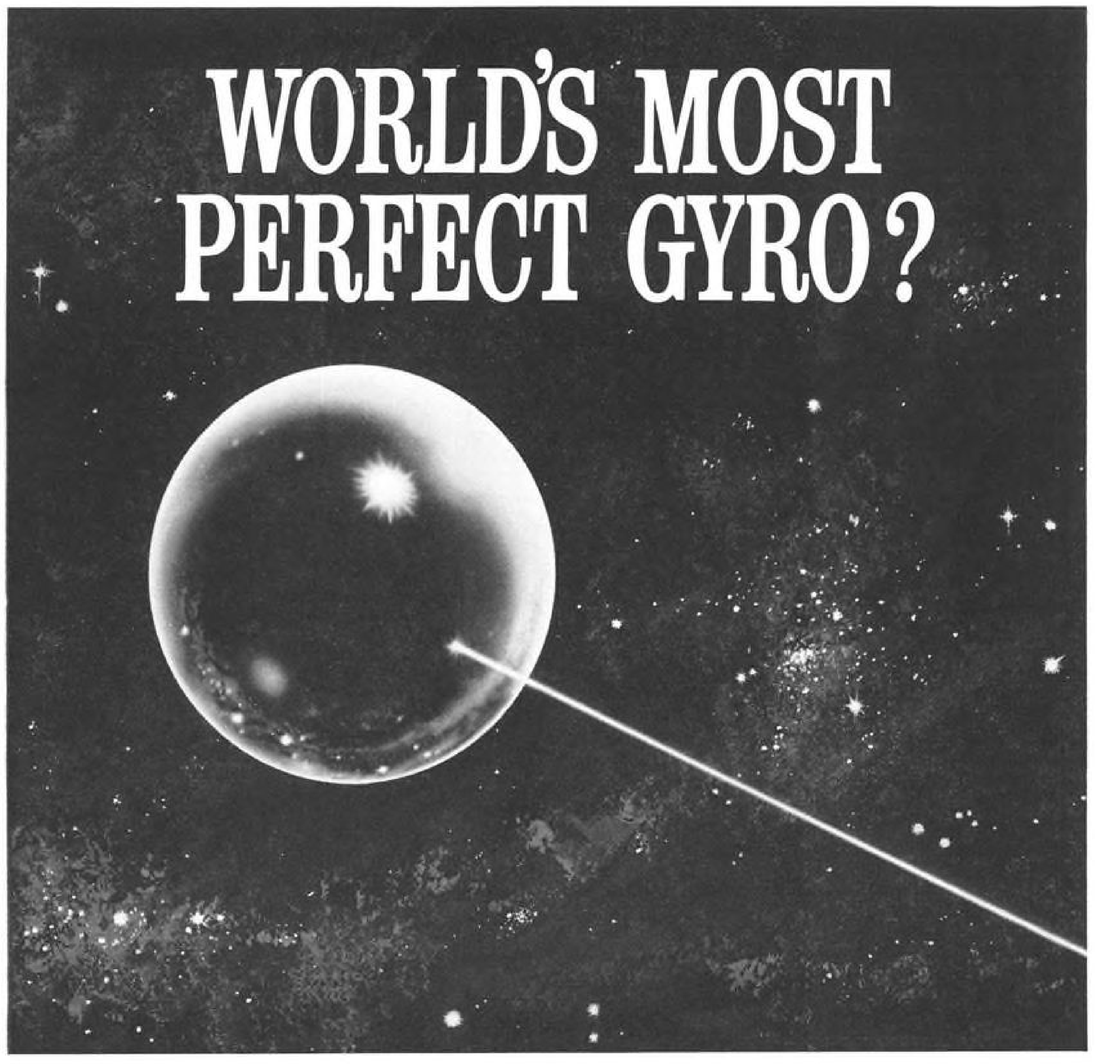
WORLD'S MOST PERFECT GYRO?



Because of the virtually frictionless environment of its rotating element, the Honeywell ESG (Electrically Suspended Gyro) offers very low drift rate, long life and high reliability. Eliminating conventional mechanical suspension, it operates in a coasting condition for long periods of time with optical pickoffs sensing its orientation. Like the stars, this gyro will serve as a precise reference for long range navigation.

The Honeywell ESG was originally developed with funding by the Navy Special Projects Office and Wright Air Development Division. Further developments, including the MEG (Miniature Electrostatic Gyro), are being made with the technical support and funding of the USAF Aeronautical Systems Division, as well as company sponsorship. The MEG demonstrates Honeywell's advanced technology in the field of inertial systems and sensors.

The ESG and MEG are based upon Honeywell's experience in developing and producing more than 35,000 inertial gyros and accelerometers. These inertial devices have been used on 62 of America's successful orbital shots and on such missile programs as Sergeant and Polaris.

For further information on Honeywell's inertial sensor capabilities, from research through manufacturing, write Dept. AW-11-88, Minneapolis-Honeywell, Minneapolis 40, Minnesota.

Honeywell

H Military Products Group

Aerospace Orders—First Quarter 1962

Value of backlog of orders, net new orders, and net sales reported by manufacturers of complete aircraft, space vehicles, missiles, and selected parts: First quarter 1962

(Millions of dollars)

Type of product or service	Backlog Dec. 31, 1961*	First quarter 1962			Backlog Mar. 31, 1962
		Net new orders[1]		Net sales receipts or billings	
		Prime contract	Sub-contract		
TOTAL	13,965	2,868	331	3,875	13,289
United States government	11,043	2,552	xxx	3,037	10,658
Other customers[2]	2,922	316	331	838	2,731
Complete aircraft and parts, total	5,646	642	45	1,119	5,214
United States government	3,968	496	xxx	744	3,720
Other customers	1,678	146	45	375	1,494
Aircraft engines and parts, total	1,546	334	6	382	1,504
United States government	1,088	262	xxx	267	1,083
Other customers	458	72	6	115	421
Missile and space vehicle systems, engines, propulsion units and parts, total	3,829	1,247	95	1,423	3,748
Missiles and space vehicle systems and parts:					
Missile systems	2,866	689	16	966	2,605
Space vehicle systems, United States government, military	368	167	1	155	381
Engines and/or propulsion units for missiles and space vehicles (including parts), United States government, military	367	191	59	205	412
Space vehicle systems and their engines and/or propulsion units, United States government, non-military	228	200	19	97	350
Other aircraft, space vehicle and missile activities, total[3]	1,803	361	139	648	1,655
United States government	1,412	311	xxx	463	1,260
Other customers	391	50	139	185	395
All other products and services, total[4]	1,141	284	46	303	1,168
United States government	953	235	xxx	205	983
Other customers	188	49	46	98	185

* Revised.

[1] New orders received during the quarter less terminations during the quarter.

[2] Includes some reported values, primarily those associated with subcontracts, shown under "Missile and space vehicle systems, engines, propulsion units and parts," even though such values were reported as United States government orders.

[3] Includes all conversions; modifications; site activation; other aerospace products (including drones) and services not included above; and receipts for applied research and development on items such as drones, etc. Receipts for other applied research are included with figures for the respective reporting categories.

[4] Includes all non-aircraft, non-space vehicle, and non-missile products and services and all basic research.

★

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★

Aerospace Ground Systems

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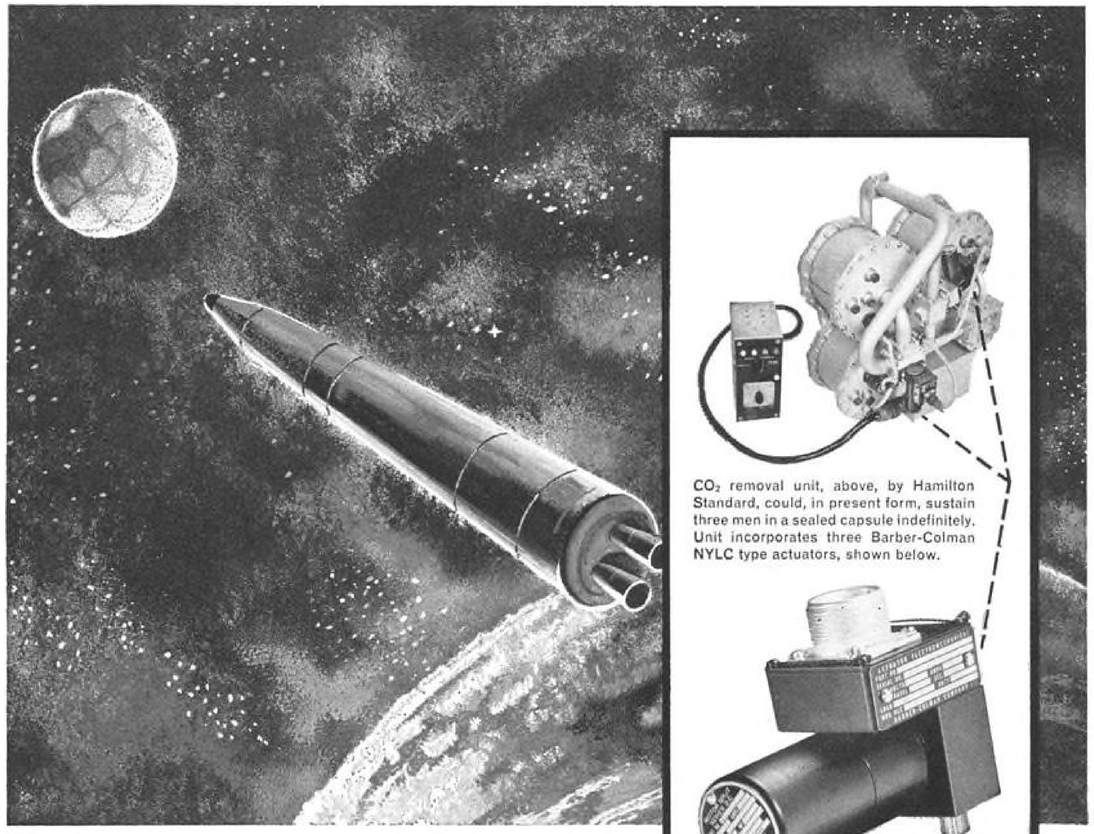
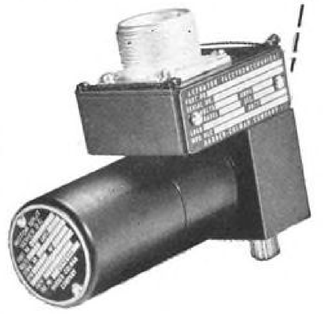


CO_2 removal unit, above, by Hamilton Standard, could, in present form, sustain three men in a sealed capsule indefinitely. Unit incorporates three Barber-Colman NYLC type actuators, shown below.



fresh air for the "ride" all the way out and back

When long-duration manned space flights begin, astronauts will travel in a craft with interior environment provided by a mechanical life-support system.

This environment must be precisely controlled to provide a constant supply of fresh air throughout the entire mission. An important part will be a regenerable CO_2 removal system, such as recently developed by Hamilton Standard Division of United Aircraft Corporation. With it aboard, carbon dioxide exhaled by occupants of the spacecraft is trapped and dumped into space.

Within this CO_2 removal unit, valves are operated by three Barber-Colman NYLC electromechanical actuators, which, along with the entire system, have undergone hundreds of hours of successful testing with a three-man load in Hamilton Standard's "Moon Room." Further tests are also scheduled by NASA.

The NYLC series of actuators has helped reduce weight and size in many other critical applications. Write for bulletins describing this dependable actuator or consult the Barber-Colman engineering sales office nearest you: Atlanta, Baltimore, Boston, Dayton, Fort Worth, Los Angeles, Montreal, New York, Rockford, San Diego, Seattle.

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USAF Planning Advanced ICBM Studies

By Barry Miller

Los Angeles—Comprehensive review of ballistic missile concepts which might make new types of ICBMs available for deployment in the 1968-74 period—or at least advance present strategic missile thinking—will begin early next year with a USAF Ballistic Systems Division multi-million-dollar study effort (AW Oct. 15, p. 29).

Approximately 250 industry representatives from about 88 aerospace companies attended briefings at Norton AFB, Calif., recently to hear Air Force representatives outline requirements for what is believed to be a minimum of 15 funded studies and advanced development contracts embracing 10 tasks.

Industry proposals for these fixed-price contracts are due on a staggered schedule starting late last month.

Aerospace companies attending the briefings included Aeronutronic, Aerojet, Boeing, Douglas, General Dynamics/Astronautics, General Electric, General Precision, Hughes, International Business Machines, International Telephone & Telegraph, Ling-Temco-Vought, Lockheed, Magnavox, McDonnell, Minneapolis-Honeywell, Nortronics, Radio Corp. of America, Raytheon and Sperry Rand.

Essentially, the studies and development efforts cover several missile concepts and various associated technical areas applicable to one or more of these missiles. These efforts are widely interpreted in industry as another Air Force attempt to explore and review the entire field of long-range ballistic missile technology, possibly applicable to its future, earth-atmospheric weapons role.

Some of the ideas appear to be a review of what has already been investigated in many of the funded and unfunded Air Force study requirements of the past several years.

Among ideas to be explored are:

• **Coordinated use** of the nation's early-warning systems to increase survivability of missile sites. The possibility will be explored of coordinating data on prediction of impact points for enemy missiles with launch of U.S. weapons. This would permit launching of U.S. weapons located in the predicted impact zones before hostile missiles impact.

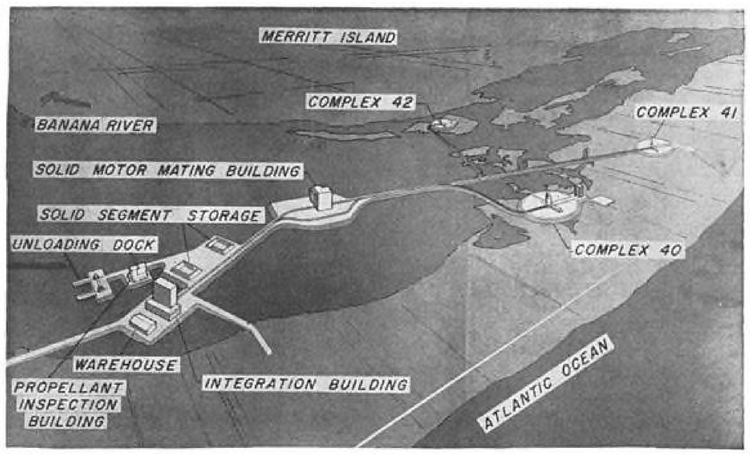
• **Hardened mobility.** Attention in this study will focus on the cost-effectiveness of vastly increasing the number of hardened ICBM sites and periodically shifting the missile complement among a large number of sites, thus leaving many sites always vacant. This would boost a potential enemy's cost of zeroing in on a larger number of hardened sites.

• **Dormant storable missiles.** Stemming from intensive in-house efforts of General Dynamics/Astronautics in its "Orca" concept (AW July 9, p. 16; Oct. 15, p. 29), the dormant concept envisages a missile, protected in some type of cocoon, left unattended at remote sites, such as in water or Arctic wastes, and standing by for rapid activation on command. The missile would be dormant—completely inactive—except, perhaps, for an alert radio command receiver which, on signal, would energize the missile's guidance and control components. Within a 15-min. alert period, it might respond to proper triggering impulses. These missiles would have to be extremely reliable over long lifetimes and subject to minimum, or no maintenance. Air Force is understood to feel that even a dormant missile deposited on the ocean floor for long periods would be experiencing a less hostile environment that a similar weapon in space.

• **Global ranging.** Under this task, an unusually long-range ballistic missile, possibly able to orbit the earth partly or completely and then hit any spot in the world, even by traveling a long way around the globe, would be studied. Some thought may be given to a vehicle circling more than once, a throwback to the earlier positive control bombardment system, or recallable ICBM (AW

Nuclear Stage Shown on GAM-83B Bullpup

First photo of Martin/USAF GAM-83B Bullpup air-to-surface missile (AW May 7, p. 86) shows slightly bulged second stage carrying nuclear warhead. Third stage contains warhead detonation system ordered by Air Force. Missile is mounted under wing of North American F-100 jet fighter. GAM-83B incorporates offset-firing guidance system which enables pilot to control the missile from parallel course, thus increasing distance between the launch aircraft and point of nuclear detonation.



Standard Space Launch System Shown

Artist's concept of Air Force 624A Standardized Space Launch System planned for Cape Canaveral (AW May 21, p. 98) shows flow from receiving docks to three launch pads. Designed for use with Titan 3 space booster, system provides for inspection, storage and mating of solid motors with liquid booster.

Dec. 5, 1960, p. 26), investigated by industry under Air Force study requirements in the 199 series. The global-range missiles would be launched on early notice of a possible attack. Thus, they would be on their way toward targets pending verification of an enemy attack. Should attack warning prove false, the warheads would be dropped harmlessly into the sea.

• **Maneuverable re-entry vehicle.** How much attention will be focused in these studies on maneuverable re-entry vehicles as distinct from the global-ranging concept is not clear, particularly because the BSD re-entry vehicles directorate is expected to have a later, separate study on this subject. BSD reportedly is urgently seeking new ideas in this area. Several companies, including McDonnell and General Electric, have proposed maneuverable re-entry vehicle concepts. Air Force might prefer a vehicle which could maneuver after re-entry to force an enemy to commit his defenses to a given cone of defense before the vehicle switches to a safe course. GE has promoted a re-entry vehicle system called Lapdog which employs hardened gyros that can operate through extremely high acceleration forces of re-entry.

Specific items in the ballistic missile studies are divided among three separate proposal requests. In one, "Study of Advanced Packaging Concepts for Ballistic Missiles," RFP 04-(694)-63-117, there are expected to be 11 studies in six task categories, as follows:

• **Packaging.** This is to cover encapsulation of the dormant missile. Proposals are due Nov. 2; two contractors may be selected by Feb. 1 for 10-month studies. Contracts are expected to be $225,000.

• **Large payloads.** Parallel $150,000 studies will be concerned with exceptionally large payloads for knocking out enemy hardened ballistic missile sites. Proposal deadline is Nov. 9, with the contractor selection scheduled by Feb. 1. These studies will both be for 10 months' duration.

• **Early warning.** A pair of dual $100,000 six-month studies to explore the use of early warning systems to improve survivability will be awarded on Mar 1 on the basis of evaluation of proposals to be submitted on Nov. 19.

• **Hardened mobility.** Possibly only a single $300,000 study of 11 months' duration will be awarded at the first of the year after evaluation of proposals due for submission Nov. 26.

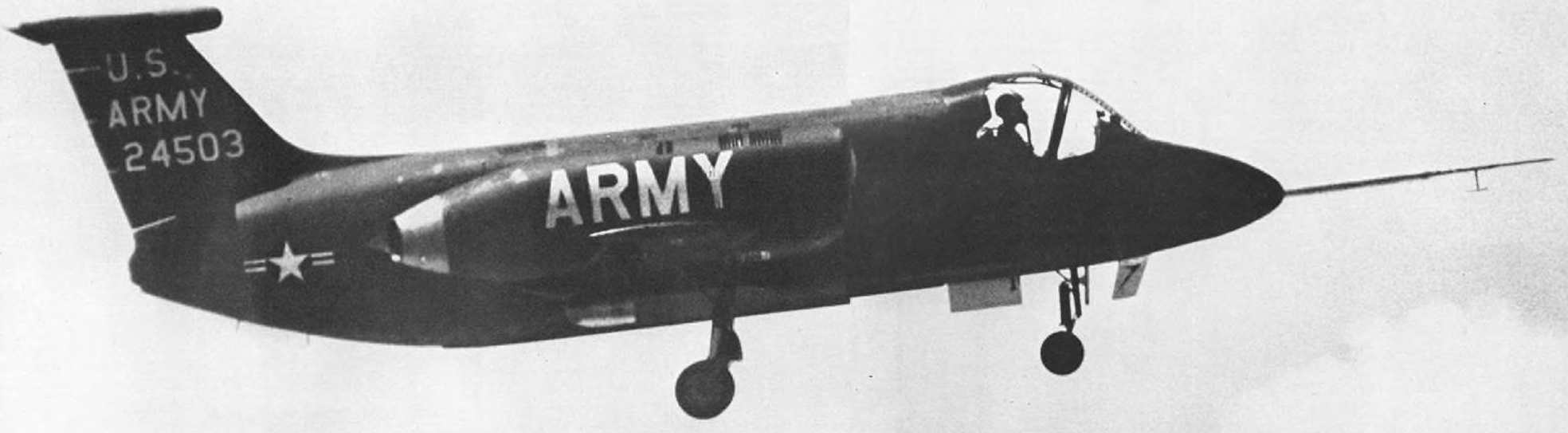
• **Global ranging.** Dual eight-month contracts for global ranging studies, including command and control investigations, will be awarded Apr. 1. Proposals are due Dec. 3. Contract value will be about $300,000.

• **Extended deployment.** These 10-month contracts scheduled for award Apr. 1 will explore missile deployment. Proposals are to be submitted by Dec. 10.

Potential contractors are being asked to submit proposals for both a single $2-million, or shortened $1-million, advanced development contract covering command and control systems for dormant, storable missiles. One $2-million or two less-comprehensive $1-million contracts will be awarded. Proposals

Coal-Tar Coating Protects Missile Complex

Coal-tar coatings 70-B enamel and Bitumastic No. 50, produced by Koppers Co., Inc., protect a 68,000-gal. tank and associated cable ducts and walkways which will be buried 30 ft. underground at a California missile base. Tank also will be wrapped in tar-saturated felt. Tanks which will contain potable water are coated inside and out with the 70-B enamel which imparts no taste to water.



THE FLIGHT OF THE HUMMINGBIRD

In the air for the Army a year from go-ahead

This is the new XV-4A (formerly the VZ-10) Hummingbird now being developed for the U.S. Army Materiel Command by Lockheed-Georgia. It has been flying since July 7, and is progressing successfully in its flight-test program.

The Hummingbird, as the name suggests, will take off straight up, land straight down, hover, then dart away at speeds up to 500 mph. It combines — with simplicity — the characteristics of a helicopter and a high-speed jet. Mission: to work directly with the troops in performing surveillance and other missions.

The principle of the Hummingbird is a system of ejector mixing chambers in the fuselage, fed by high-velocity exhaust from twin jet engines. In vertical flight, gases are directed downward through bomb-bay-type doors. In conventional flight, these doors are closed and forward thrust is provided in the normal manner.

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there's a ship on the way to the moon

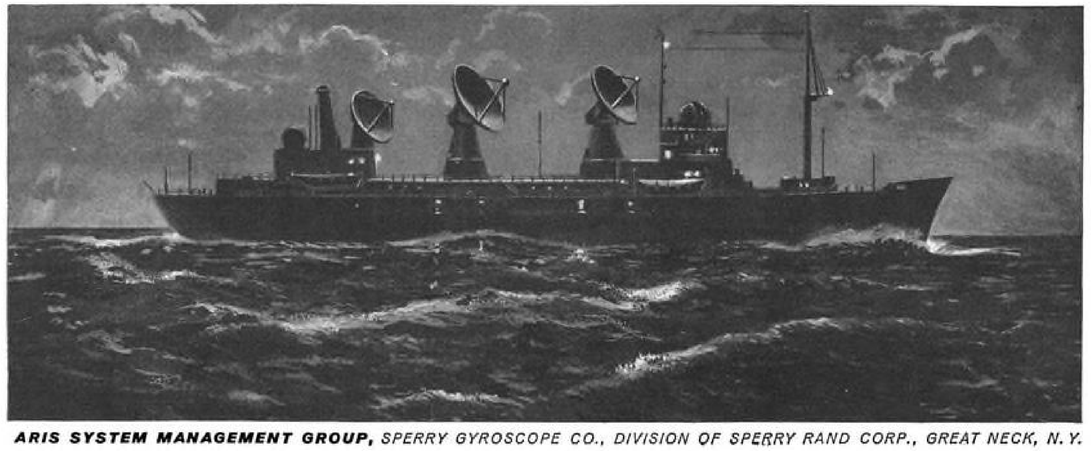
There will be many interim steps, but every shot on the Atlantic Missile Range puts the U.S. closer to its goal of a lunar landing in this decade.

Soon our capabilities on the range will be sharply increased as Advanced Range Instrumentation Ships (ARIS)—large transports converted to seagoing range stations under direction of the Sperry System Management Group—go into service. The highly accurate terminal trajectory and re-entry data the ships collect will greatly advance the system support capability of AMR.

Sponsored by the Air Force Missile Test Center, AFSC, the ARIS ships will incorporate every advanced technique of data acquisition and handling, integrated instrumentation radar, telemetry, inertial navigation, weather forecasting. With mobility and precision they will move to any aim-point in thousands of miles of ocean and take measurements with all the precision of a land-based station. They will provide refined study of space vehicles during the critical terminal phase of flight. Sperry's job is to obtain the finest instrumentation available and integrate it to do the job . . . on schedule and at minimum cost.

The ARIS ships will help fulfill AMR's responsibility with NASA for range instrumentation supporting our exploration of space. The capabilities developed will be steadily advanced in pace with the program. Team members with Sperry include Bethlehem Shipbuilding, Ford Instrument, Gibbs and Cox, IT&T and UNIVAC Division of Sperry Rand.

SPERRY



ARIS SYSTEM MANAGEMENT GROUP, *SPERRY GYROSCOPE CO., DIVISION OF SPERRY RAND CORP., GREAT NECK, N.Y.*

for 15-month contracts, to be completed May 30, 1964, are due Jan. 3.

Heavy emphasis will be placed on a mobile command center for dormant missiles, with the likelihood that command will be exercised from airborne platforms or the ground.

Need for reliable missile activation and the related question of how to transfer information to a missile under water will be scrutinized closely. Space-based command center is only a remote possibility. Command and control contracts will be issued in response to RFP 04-(694)-63-118.

There will be three advanced technology development efforts in the guidance field. As in the command and control area, contractors will be expected to identify items requiring development and cite status of development of these components throughout industry so that immediate implementation can follow, if necessary.

Desire to reduce the circular error probability (CEP) for any warhead is forcing the Air Force to concentrate on radio guidance techniques. It is hoped that this latter method may provide greater accuracy, although it is subject to jamming.

Three specific guidance efforts will be:

• **Survivable radio guidance.** This seven-month contract will explore ways of lowering the CEP, ensuring retaliatory capability and safeguarding control. Deadline for proposals is Nov. 16, with awards due Dec. 1.

• **Stellar-inertial guidance** contract or contracts for the dormant missile are due to be awarded Jan. 2 and are expected to extend through September, 1964. One problem will be how a floating dormant missile, subject to continually-changing orientation, can establish its initial orientation prior to firing. Proposals are due Nov. 16.

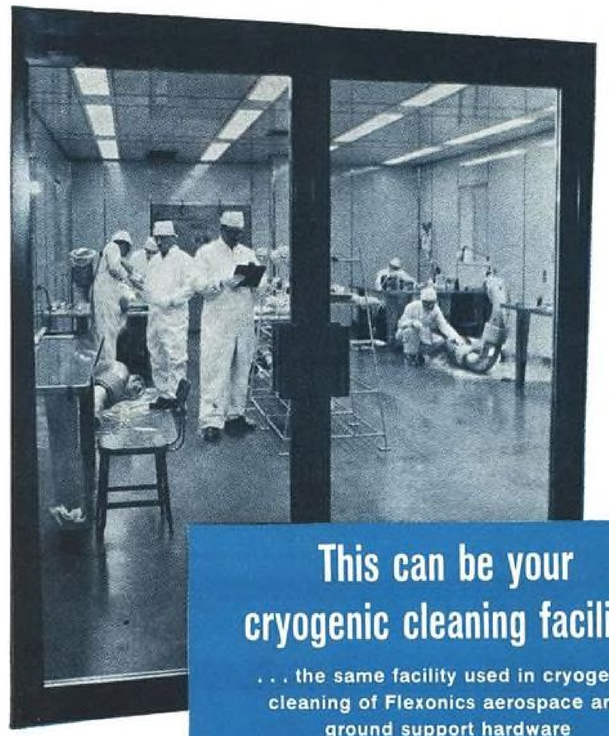
• **Radio command** for the global ranging missile will be an eight-month effort scheduled to start Dec. 1.

There is feeling in industry that these investigations will have no greater future than had earlier Air Force studies conducted in the study requirement era of the past.

This may be particularly true now, with Defense Dept. closely scrutinizing Air Force weapons system development programs.

At the briefing, Air Force is reported to have stressed that items would be judged on the grounds of cost-effectiveness. Nevertheless, there are indications that industry participation in the competitions for these studies and advanced development contracts will be widespread.

Aerospace Corp. is supplying Air Force with technical guidance on these efforts.



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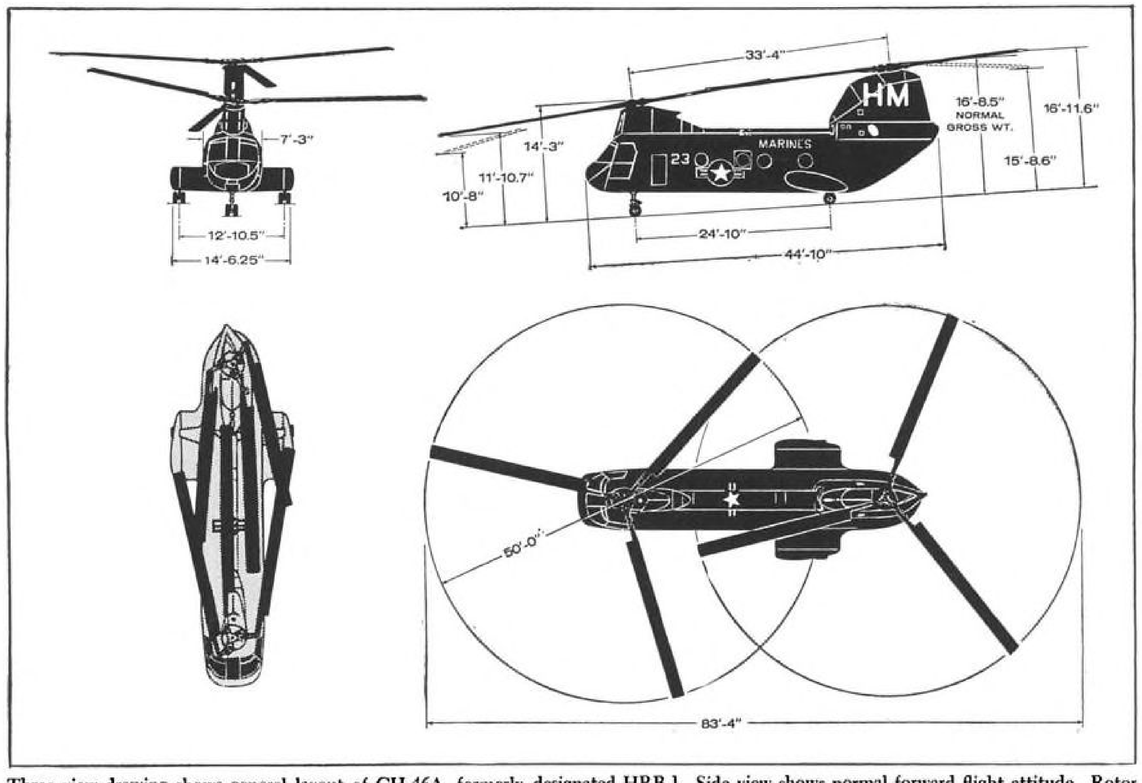
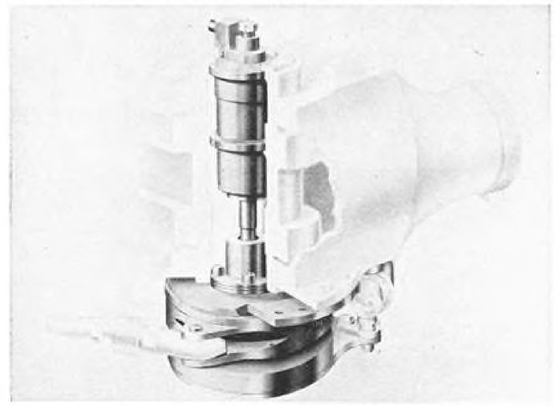
Taxi technique for the Boeing Vertol CH-46A Sea Knight medium assault helicopter for the Marine Corps is to hold off the nose-wheel. Forward speed otherwise can build too much because of rotor inclination in three-point attitude. Auxiliary powerplant is installed aft in the rear pylon, making for a larger fairing than on the Vertol 107, from which the CH-46A is derived.

Marine CH-46A Designed for Ship, Field Operation



Three view drawing shows general layout of CH-46A, formerly designated HRB-1. Side view shows normal forward flight attitude. Rotor folding system folds all blades back along center line (lower left) to permit CH-46A to fit on elevator of LPH-2 or LPH-4 assault ship.

Rear ramp can be extended in flight at all speeds (above, left). Loading ramp, hydraulically actuated, is fitted with both rollers for cargo pallets and treads for wheeled vehicles (above, right).



Blade folding system has actuator and electric motor (right) fitted in hinge near the rotor hub. Hinge and actuator both are visible on blade to the right of the pylon in photo (below, right). Motor stalls out when blade hits stop at the end of its folding travel, eliminating need for cut-off switch.

Accessibility of systems in fore and aft rotor pylons is shown in ground demonstration (below). Engine access is from below, and rear ramp can be used as an adjustable height work platform for engines. Intake configuration differs from the Vertol 107 because of addition of a particle separation system (AW Oct. 22, p. 30).

EQUIPMENT

Mass Production Process Shown For Superalloy Gas Turbine Parts

By Donald E. Fink

Minerva, Ohio—Facility capable of mass producing high-performance gas turbine components by the vacuum-melting process was demonstrated here recently by Kolcast Industries, a division of Thompson Ramo Wooldridge, Inc.

Company officials said the facility will make superalloy components economically feasible through mass production, thereby enabling gas turbine engine manufacturers to realize greater performance from existing engine designs.

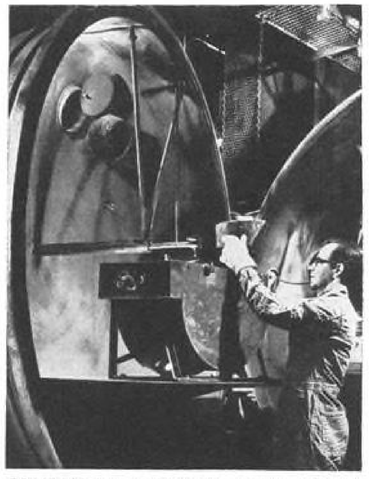
Gas turbine efficiency, dependent to a great degree on the inlet temperature, has not been fully exploited, they said, because exotic alloys capable of withstanding the higher temperatures previously have been manufactured only in melts up to 50 lb. and have therefore been very expensive.

Nelson G. Spoth, Kolcast's general manager, said the company's new vacuum-melting and casting furnace has run 350-lb. melts in semi-continuous operation and is capable of handling 500-lb. loads.

"With the semi-continuous furnace, vacuum-melted components can be made in a quarter of the time previously needed," Spoth said. "And by raising furnace capacity from the average 50-lb. pour to 350 lb., much larger castings can be turned out."

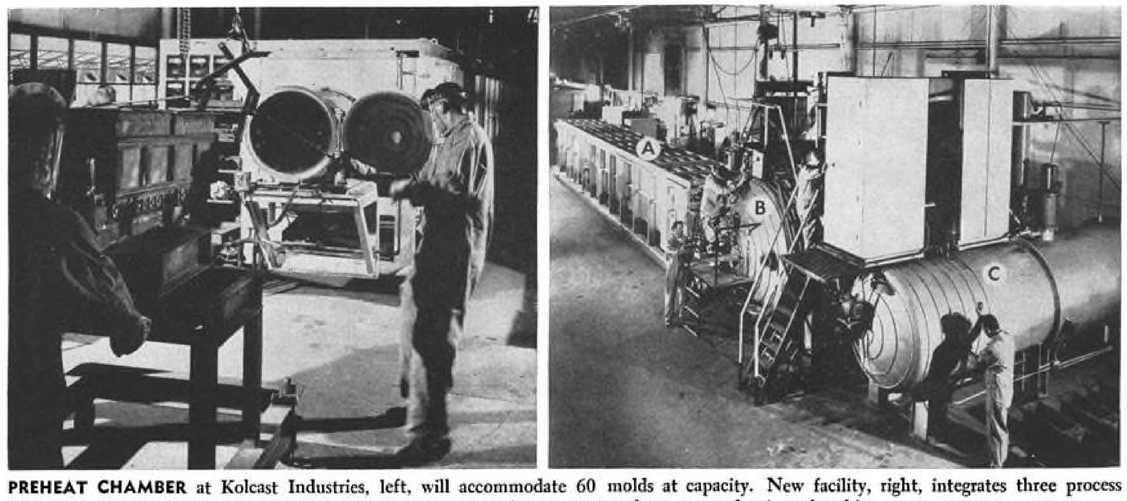
Spoth said the power zones, critical areas where high temperature and quality of metals govern the entire power output, represent about one-third of the complete turbine assembly cost.

"Of this one-third, 50% is represented by the exotic-metal buckets, blades and vanes. This amounts to only 17% of the turbine cost, but it is the 17% in which performance improvements are immediately possible."



COMPONENT CASTINGS up to 350 lb. and 48-in.-dia. can be developed in pour chamber at Kolcast Industries.

In some cases, company officials estimated that capacity of some existing turbine engines could be increased by 200 hp. with a 25F increase in inlet temperature. Superalloys required to withstand the temperature increase, however, are extremely sensitive to impurities and must be worked under vacuum, so metal impurities and oxides will escape in gaseous form. Vacuum working also makes possible a closer control of furnace and atmospheric impurities around the molds.



PREHEAT CHAMBER at Kolcast Industries, left, will accommodate 60 molds at capacity. New facility, right, integrates three process steps: preheat (a), pouring (b) and cooling (c) into continuous-line operation for mass production of turbine components.

As a result of the special handling required, the cost of superalloy turbine components has averaged about 300% higher than the cost of air-melt, air-cast components used in lower performance engines.

In certain space and supersonic aircraft applications, performance requirements relegate cost to a secondary level, but for the majority of gas turbine engine users, selection has to be based on the ratio of dollars per horsepower delivered, Spoth said.

Kolcast undertook a research program five years ago aimed at solving the problem of high cost of superalloy components. The result, after an investment of about $2 million in company funds, is the 350-500-lb. semi-continuous vacuum furnace.

Volume production with the facility will bring about substantial decreases in the cost of superalloy components, Spoth said.

The facility, which occupies about 750 sq. ft. of floor space, consists of

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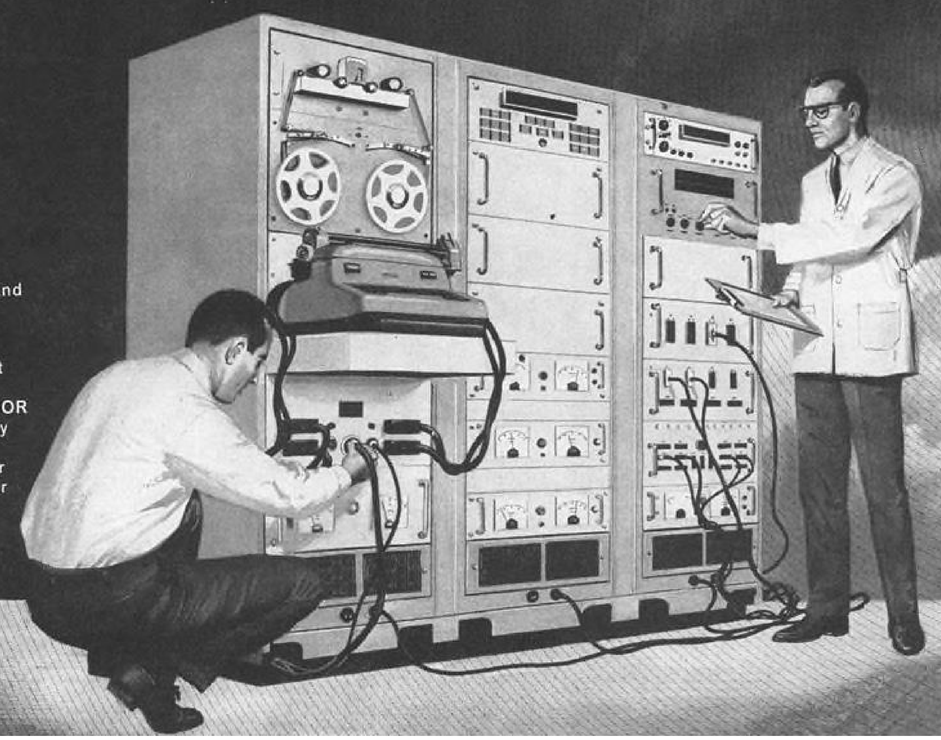

DEMON is the second generation of Curtiss-Wright's programmed comparator automatic checkout equipment. It consists of 4 major sections: Command generator, stimuli generators, system exerciser, and output translator. The equipment combines increased test capacity with simplified NOR logic circuitry. The display unit can be automatic typewriter, punched paper tape, alphanumeric printer or visual indicator.

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There is an intensive program for the development of Demon and related projects (digital computer controlled systems, automatic waveform analyzers, peak reading voltmeters) being carried forward at Curtiss-Wright Electronics Division. These and other advanced activities have created immediate opportunities for systems engineers and circuit designers with specific experience on automatic checkout equipment.

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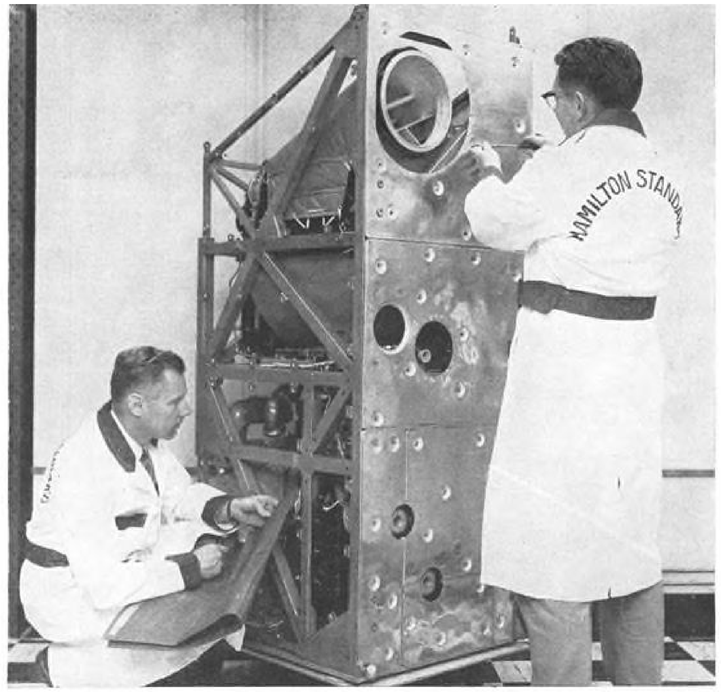
three major stations: preheat chamber, pouring chamber and cooling chamber.

Alloy ingot molds are first heated to temperatures of 1,700F to 1,900F in a series of preheat ovens. The molds are then covered and placed in the facility's 46½-ft. preheat chamber. As the molds move on a chain conveyor to the pouring chamber, electric heat elements maintain the temperature at about 1,250F. Chamber capacity is 60 molds.

When the preheat chamber is filled, it is sealed and evacuated. The vacuum lock between the pour and preheat chamber is opened and the metal composition and crucible temperature are checked by remote control. The component molds are then poured and moved into the cooling chamber on another conveyor. Once the preheat chamber is emptied, vacuum locks are again closed, and the cycle is repeated.

Production run requires a maximum of 4 hr. Operating on a continuous three-shift basis, the facility has an annual capacity of 450,000 to 600,000 lb. of superalloys. Another advantage of the large melt furnace is its ability to handle castings weighing up to 350 lb. and measuring up to 48 in. in diameter. Less testing also is required, since samples are taken from much larger melts, on which the quality control has been constant.



XB-70 Environmental Control System Checked

Refrigeration package for North American XB-70 and electronic equipment environmental control system undergoes final checkout by Hamilton Standard technicians before delivery. System will permit "shirt-sleeve" environment for crew when skin temperature reaches more than 450F. It controls relative humidity, air pressure and ventilation for cabin and electronic compartments, as well as temperature.

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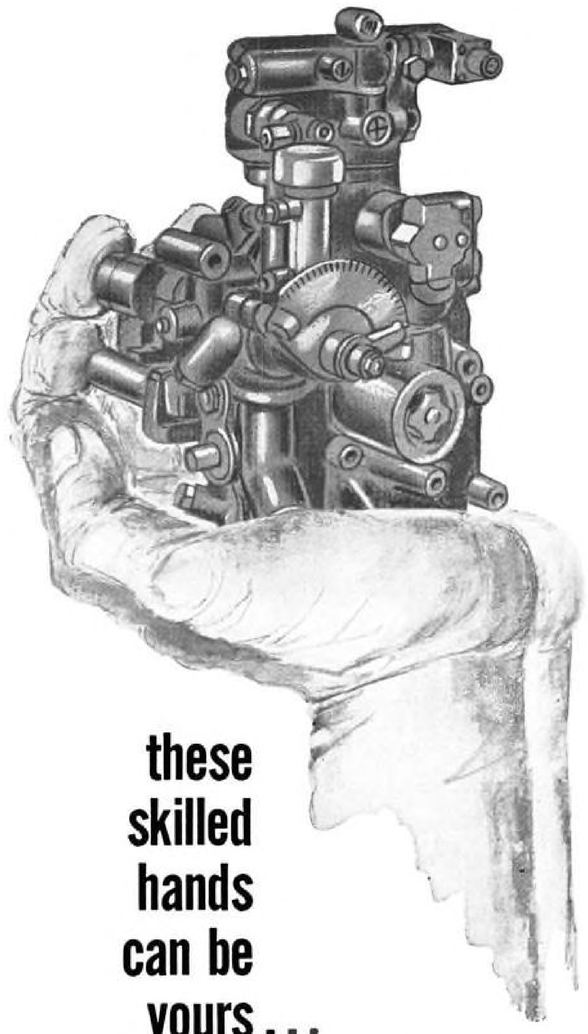

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Ablative Plastics Used For Rocket Cooling

Liquid rocket engine for upper-stage use, incorporating ablative plastics for cooling, has been designed by United Technology Corp.

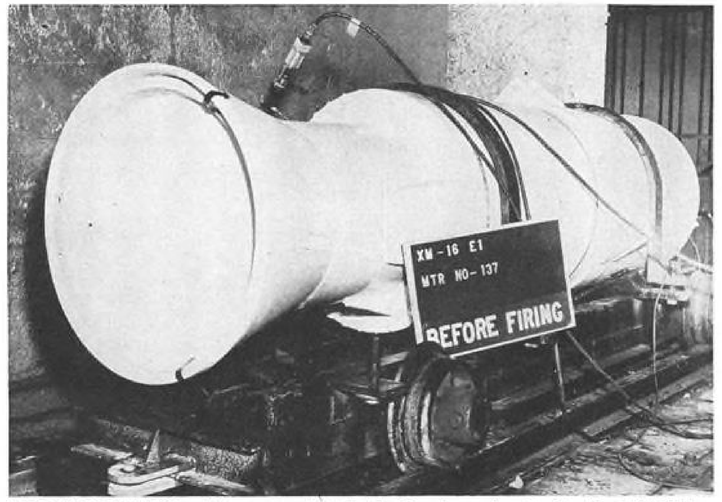
Engine's thrust chamber liners are machined from plastic logs formed by pressing small squares of resin-bound glass cloth together under pressure. Asbestos insulator is placed around liner, and the outer structural shell is composed of glass fiber.

When the engine is fired, heat from its combustion gases is absorbed by the chamber's ablative liner and its epoxy resin slowly melts and vaporizes to provide cooling.

Engine is approximately 45 in. in diameter and about 180 in. long, including ablative chamber. A variable thrust injector can vary rate of propellant flow.

Titan 3 Fluid Pod

Model displayed recently to President Kennedy (AW Sept. 24, p. 32) of USAF Titan 3 boost vehicle shows pod—small cylinder between right-hand solid booster and Titan 2 core—being evaluated to carry fluid for thrust vector control system.



SOLID PROPELLANT rocket motor originally developed as a booster for the USAF Mace missile was stored for five years before recent successful static firing.

Solid Motors Fire After Long Storage

Three Thiokol M16 solid propellant rocket motors have been successfully static fired after protracted storage periods. One of the motors had been in continuous storage for five years, the other two for 56 months.

During the inactive period no special treatment or precautions were taken to preserve the rocket motors which were originally developed by Thiokol as the booster unit for the Air Force TM-61B Matador, which is currently designated Mace.

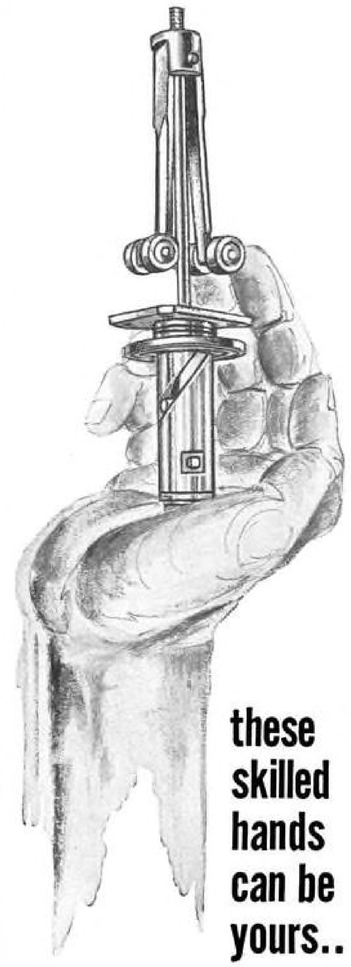
The motors were stored in a reinforced concrete igloo with no thermostat or humidity control. Relative humidity reached as high as 94%. Inside temperature ranged from a high of 80F to a low of 39F.

Five-year-old M16 motor was tested by personnel of the U. S. Army Missile Ordnance Command at Redstone Arsenal. The motor was temperature-conditioned to 77F for slightly over six days before it was fired. There was an elapsed time of 1 hr. 16 min. between removal of the motor from the conditioning chamber to the actual static firing.

According to Thiokol the three motors tested "performed within the tolerance limits established for new motors."

Aging program of the M16s began at Thiokol's Huntsville facility in 1955 after the motor was developed.

M16 is shown after static firing. Motor performed within the parameters established for new units, according to Thiokol. Successful test was conducted at Redstone Arsenal.



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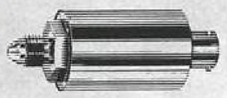

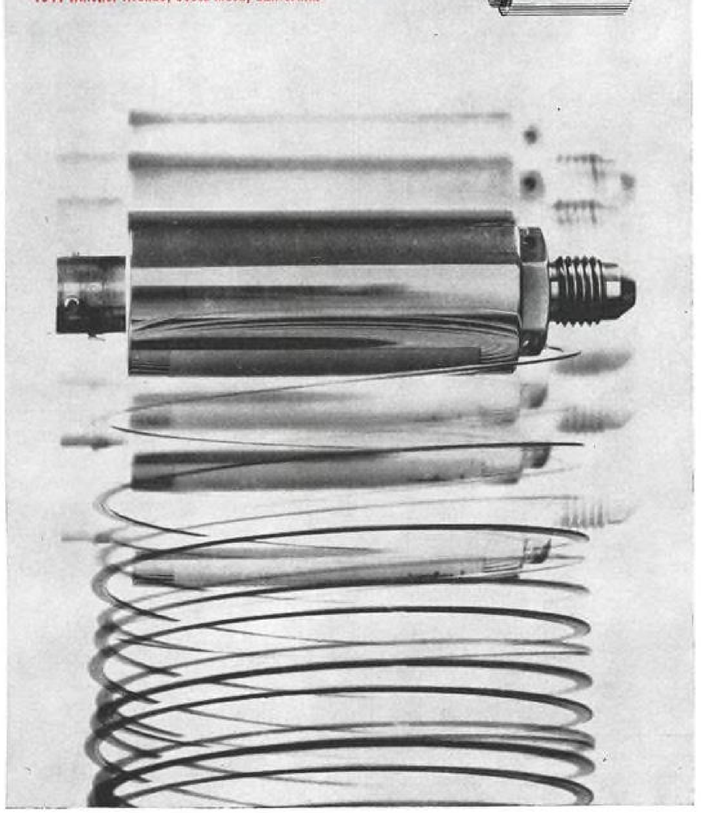

Business Flying

PRIVATE LINES

Backlog exceeding 300 four-place Musketeers, including 50 export orders, currently is being worked on by Beech Aircraft Corp.

Approximately 13,500 business and utility aircraft stopped at Southwest Airmotive Co. at Love Field in Dallas during the first six months of 1962 and were refueled with approximately 2,093,000 gal. of aviation fuel, setting new company records in servicing transients. Airplanes represented 34 states and four foreign countries. Southwest Airmotive estimated that the total value of the airplanes it served in this period was more than $300 million.

Cessna Aircraft Co. has reported total sales of $89,700,000 for Fiscal 1962, which ended Sept. 30. This represented an increase of approximately $2,100,000 over Fiscal 1961. Preliminary reports indicate after-tax earnings were $1.40 per share, compared with $1.58 per share for Fiscal 1961. Largest increase came from commercial aircraft sales, which totaled approximately $52,800,000, a 13% increase over 1961. Military sales declined from $21,094,000 to $14,970,000. Dwayne Wallace, Cessna president, said lower per share earnings were caused by production and engineering costs on the new Model 205 and revisions of Models 182 and 210. Company announced a regular quarterly dividend of 25¢ per share.

Electro-thermal de-icing system for light twin aircraft has been marketed by Goodyear Tire and Rubber Co.'s Aviation Products Division. System, certified on the Beech Queen Air 65 and on propeller systems of the Aero Commander 560F, 680F and 680FP, consists of a knitted wire de-icing element in neoprene which can be bonded to flight surfaces and will withstand heavy vibration.

Brittain single-axis autopilot has received FAA approval of installation on four 1962 model aircraft, the manufacturer says. New approvals cover the Cessna 210B, Piper Comanche 180 and 250 and the Mooney Mark 21.

Alfred Dunhill of London, Inc., New York men's gift shop, has listed Aero Commander aircraft in its current Christmas catalog. Store officials say they hope to persuade corporate chairmen to give the twin-engine aircraft to executives who travel a great deal. Price is listed as "from $72,000."

BEECH "IMAGINUITY" IN *Air Mobility*

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- ☐ AS COMMAND LIAISON TRANSPORT, THE L-23F HAS SEPARATE PILOT COMPARTMENT AND "CONFERENCE ROOM" PASSENGER CABIN.
- ☐ EXCEPTIONAL STABILITY AND EASE OF HANDLING AT EVEN THE SLOWEST SPEEDS MAKE THE L-23F IDEAL FOR INSTRUMENT TRAINING.

The Beechcraft L-23F meets the need for a . . .

Low-cost way to maintain instrument proficiency

Substitute the Beechcraft L-23F for large, expensive to operate multi-engine airplanes frequently used to maintain pilot instrument proficiency. Savings will run into hundreds of thousands of dollars. And necessary realistic regular training schedules can be easily maintained.

The L-23F is fitted-out like a much larger airplane. Yet it costs far less to buy, operate and maintain. Its ample space and weight allowances provide for all electronic navigation and communications equipment normally used for instrument flying on even the largest aircraft.

The Beechcraft reliability built into the L-23F is attested to by thousands upon thousands of civilian and military air hours. Twin 340 hp Lycoming supercharged fuel injection engines allow the L-23F to cruise at 190 knots at 70% power, and provide top speed of over 200 knots.

Already in worldwide use by the U. S. Army, additional L-23F s are quickly and economically available.

Beech *Aerospace Division*

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Beech Aerospace Division projects include R&D on manned aircraft; missile target and reconnaissance systems; complete missile systems; space systems management; programs pertaining to liquid hydrogen propellants and cryogenic tankage systems; environmental testing of missile systems and components; and GSE.

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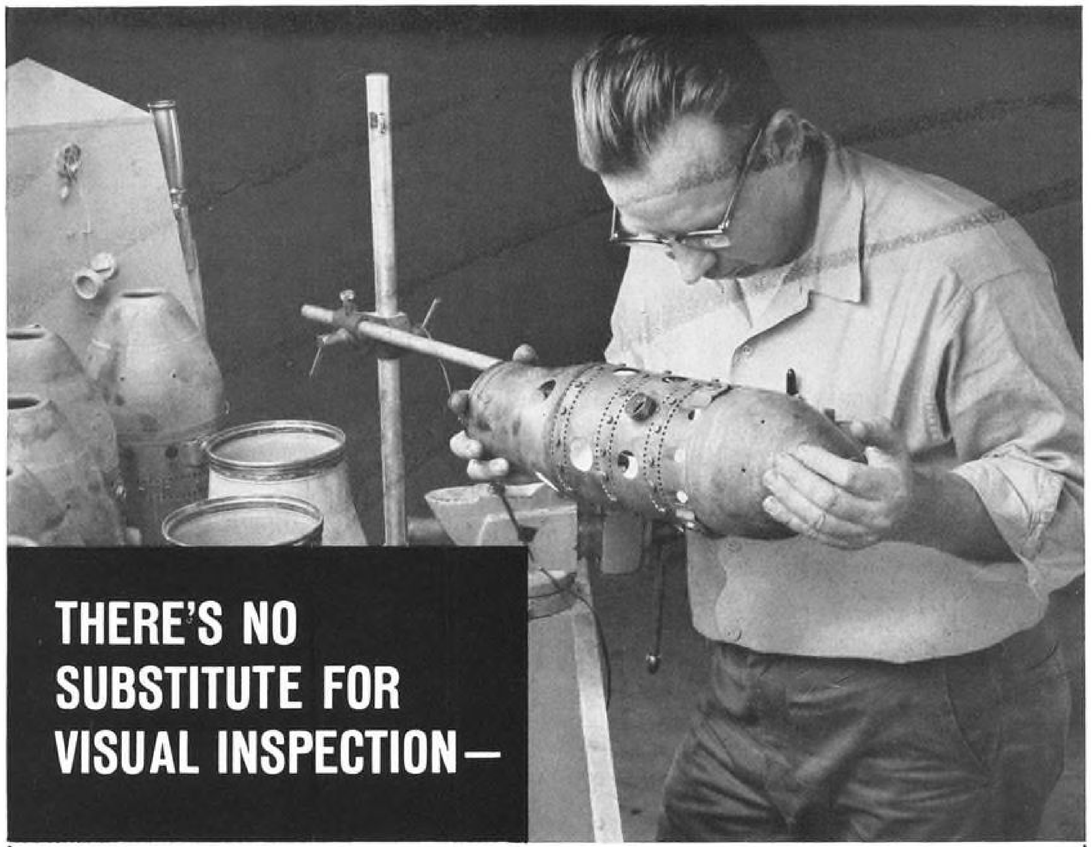

THERE'S NO SUBSTITUTE FOR VISUAL INSPECTION—

EVEN ON TURBINE ENGINES

Detailed, exacting visual inspection of Dart flame tubes is used to find cracked cooling rings, loose rivets and other discrepancies. The inspection is very precise — and very honest, for the flame tube is as vital to turbine engine life as cylinder condition is to piston engines.

Like cylinders, flame tubes are normally good for more than one operating cycle. If they are defective, they are repaired in the Airwork shops, using modern methods for handling high temperature metals.

If necessary, the flame tube is sectioned on a lathe, and a new center section added. Then the tube is rewelded under a blanket of argon gas to prevent oxidation of the sophisticated metal at high temperatures.

The volume of Dart engines handled by the Airwork shops, justifies the best available test and re-work equipment. But, in many cases, the best test equipment available is still the honest craftsmanship of well qualified inspectors; working for a company with a long tradition of quality. We offer you this at Airwork . . . and back it with the trouble-free experience of our many turbine and piston engine customers. Write for our new brochure, "Essential Aviation Services".

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Millville, New Jersey

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Can a Computer Recognize

MOON GEOGRAPHY?

• Cornell Aeronautical Laboratory's engineers and scientists are investigating concepts for computers which can be "taught" to recognize patterns, whether those patterns be airfields, missile sites — or even significant topographic features of the moon. In related areas, CAL is developing special purpose computers surprisingly small in size, yet faster for the task than the speediest general purpose computers in use today. These computers use novel delay line storage techniques to perform computations in real time.

As a research tool in our cognitive systems program, a special input facility for the IBM 704 digital computer has been developed, allowing photographic data to be inserted directly into the computer. This facility allows CAL engineers to implement and evaluate pattern recognition concepts at an early stage in the research program.

Other computer related science activities include analytical and experimental research in data processing techniques, adaptive control systems, and trajectory tracking techniques. Our scientists engaged in this research have education and experience in areas such as information theory, statistics, control systems, advanced programming, theory of automata and intelligent machines.

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FINANCIAL

L-T-V Securities Form HoldingCompanyBasis

Dallas, Tex.—Alpha-Omega Corp., a new holding company equally owned by Ling-Temco-Vought board vice chairman and executive committee chairman James J. Ling and Dallas businessman D. Harold Byrd has been formed to provide a base for further expansion of business ventures by the partners. Ling-Temco-Vought securities will be the principal asset of the new company.

Byrd, chairman of the board of Alpha-Omega, and Ling, president and chief executive officer, declined to elaborate on the holding company's future plans until Securities and Exchange Commission completes its study of the new organization.

Ling, who had been disposing of a large quantity of his Ling-Temco-Vought holdings in recent months, stated he still maintained effective control of the company through holdings by his Ling Investment Co. and ownership of shares and debentures by parties friendly to his interests. Ling had disposed of more than 22,000 shares of the firm's common stock, reducing his personal holdings of common to 11 shares, also 54,000 common shares held by Ling Investment, leaving it with some 13,000 shares, in addition to divesting himself of considerable warrants and debentures.

Contract Formalized For 35 Atlas Vehicles

Washington—Air Force has formalized the contract to General Dynamics/Astronautics to supply 35 standard Atlas space launch vehicles, to be called SLV 3, which will contain standard guidance, electrical system, autopilot tracking and telemetry kits (AW Oct. 8, p. 41).

SLV 3 engines will be rated at 390,000 lb. thrust. Mission and launch site will dictate which of the interchangeable component kits will be used. General Electric Mod. 3G guidance unit will be specified for Atlantic Missile Range launches, and the GE Mark 2 kit will be used for Pacific Missile Range firings.

Each booster will be identified as to mission and launch site eight months prior to delivery date.

Incremental funding to date on the contract is $3 million, with total funding expected to amount to approximately $70 million.

SLV 3 with Agena B upper stage will be able to orbit payloads up to 6,000 lb. at altitudes under 1,000 mi.

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Do you fit these qualifications? We want a man to be responsible for overall reliability and quality assurance aspects of development space projects. He will help in the indoctrinating engineering personnel in reliability design and test requirements and methods. Should have a degree in engineering or physics, and three to five years experience in an engineering program from proposal stage through design, testing, manufacturing and field use. Must be familiar with Military Specification requirements.

Among the attractions here are forward looking people, modern plant, a liberal relocation allowance, company paid graduate study program, excellent living conditions in picturesque New England towns, and fine schools for your children at any age.

As a first step to getting your ideas off the ground, we suggest you submit your resume, with salary requirements, to Mr. M. R. Wakeman, Personnel Department. We will be in touch soon after.

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Financial Briefs

National Aeronautical Corp. and subsidiaries earned $694,194 on sales of over $7.8 million for the nine months ended Aug. 31. The figures were 17% and 85% increases, respectively, over earnings and sales for the comparable period last year.

Aerojet-General Corp. had consolidated sales of nearly $431.6 million with earnings of over $8.8 million for the nine months ended Aug. 31. The figures were 24% and .4% increases, respectively, above sales and earnings for the same period last year.

Dynamics Corp. of America has moved its listings from the American Stock Exchange to the New York Stock Exchange. The firm is listing 4,116,560 shares of common stock, of which 3,049,160 are outstanding, in addition to 443,100 shares of convertible preference stock which was previously traded over the counter.

Dallas Airmotive, Inc., reports $5.45 million gross revenues—$3 million of which was derived from commercial sales—and $302,259 net income for the six months ended Aug. 31. Same period last year showed sales of $5.1 million with earnings of $345,308.

General Electric had net earnings of nearly $179.5 million on sales of nearly $3.5 billion for the first nine months

Apollo Radiation Pattern

Apollo spacecraft antenna radiation pattern is shown undergoing measurement by Collins Radio, using a scale model at the company's Dallas facility. At the apex of the capsule is a discone-type antenna which Collins is evaluating for possible use.

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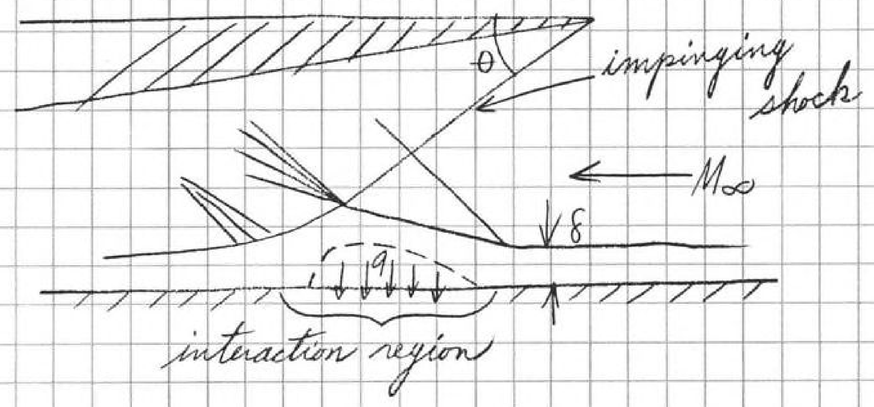

AERO-THERMODYNAMICS

...among the more than 500 R & D programs under way at Douglas

Extensive research in advanced aero-thermodynamics relating to missiles and space vehicles is now being performed in Douglas laboratories.

Among current areas are dissociation nonequilibrium in supersonic flows; separated supersonic boundary layer phenomena; experimental boundary layer studies; heat transfer; turbulent mass transfer; and base flow.

Support of this program is provided through a multi-million dollar laboratory complex. Included is the Douglas Aerophysics Laboratory, one of the finest fluid dynamic research facilities in the aerospace industry.

outstanding career opportunities at Douglas.

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of 1962. The figures were 19% and 11% increases, respectively, over the same period last year. All four major segments of GE's business—including the aerospace and defense segment—shared in the increased sales and earnings.

Continental Aviation and Engineering Corp., of Detroit, had more than $12.6 million in sales with net earnings of $170,895 for the nine months ended July 31. However, $3.6 million in sales for the three months ended July 31 were accompanied by a net loss which totaled $1,918.

Sanders Associates, Inc., of Nashua, N. H., expected nearly $42 million in sales and other income for the fiscal year ended July 31. Sanders says the figure would be a 95% increase over last year's sales and income. Net earnings are expected to total about $2 million. Sanders also predicts that Fiscal 1963 sales will total more than $60 million.

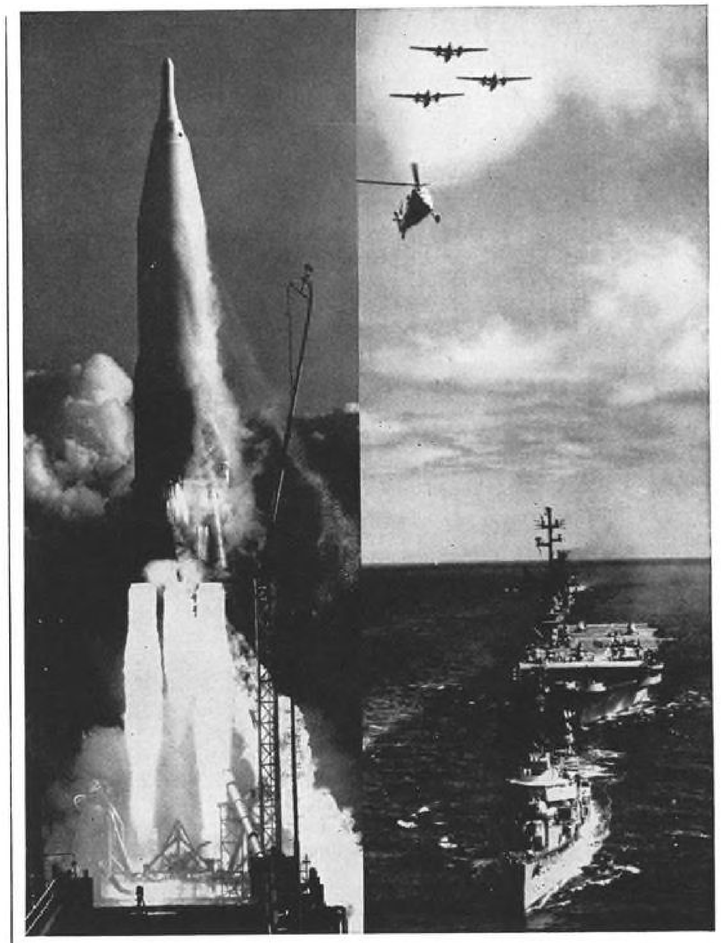
Mergers and Acquisitions

Hupp Corp. of Cleveland, has sold 80% of its capital stock to a group of three Gemco, Inc., officers. Gemco is a Hupp subsidiary now making jettisonable pylon and bomb racks for Republic F-105s and other aerospace components. The three Gemco officers have until 1967 to buy the remaining 20% of the Hupp Corp. stock.

Solartron, Inc., of Anaheim, Calif., has been recently acquired by Electro-Mechanical Research, Inc., of Sarasota, Fla. Solartron was U.S. subsidiary of Solartron, Ltd., of England, and is a manufacturer of transfer function analyzers used in laboratory and field checkout of servo systems.

California Airmotive Corp., of North Hollywood, has purchased Aircraft and Metals Corp., of Long Beach, for about $2 million. Sale involves nearly 1,600 Wright and Pratt & Whitney engines, variety of engine, airframe and propeller parts, tools and also various other equipment.

Computer Instrumentation Corp., a Philadelphia computer test equipment manufacturer, has been acquired by General Kinetics, Inc., of Arlington, Va. GKI acquired Computer Instrumentation by exchanging common voting stock for all the outstanding shares of the corporation. GKI manufactures a line of specialized production and preventive maintenance equipment for magnetic tapes.



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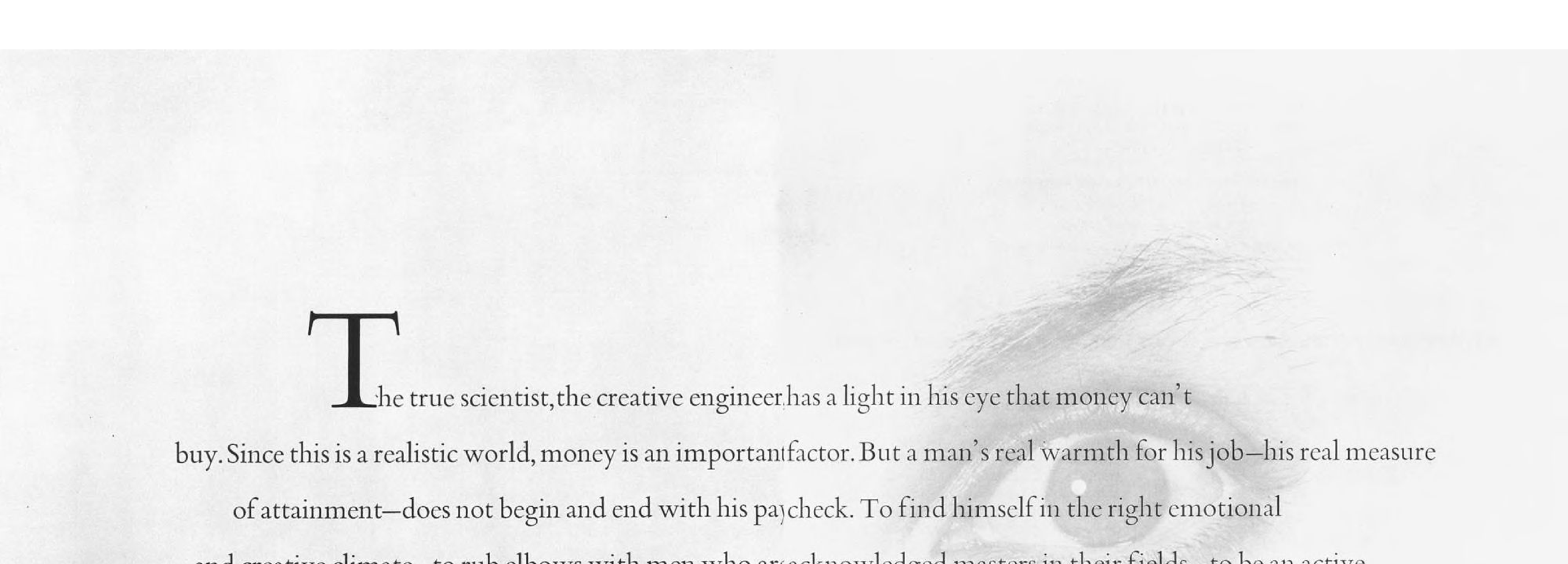

The true scientist, the creative engineer, has a light in his eye that money can't buy. Since this is a realistic world, money is an important factor. But a man's real warmth for his job—his real measure of attainment—does not begin and end with his paycheck. To find himself in the right emotional and creative climate—to rub elbows with men who are acknowledged masters in their fields—to be an active participant in the Great Adventure of Tomorrow—these are the satisfying, the lasting, rewards. And these rewards-within-rewards impel men of outstanding talent to come to Lockheed Missiles & Space Company.

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Are you on the high bridge?
Are you a robot or a martian geologist?
Have you defined your requirements for professional growth?
Can you tell us what you want?
Do you work in fields of the future?"

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We have work to do here. We have the facilities to do the work and the contracts, both prime and sub, to stimulate your production. Our location, St. Louis, suits us fine and we think you'd like it here too. The work is interesting and the pay is good. So Let's Swap Resumes. You send us yours, we'll send you ours.

Please complete this form and forward to: D. F. Waters. Professional Placement, Dept. 62J, McDonnell Aircraft, St. Louis 66, Missouri. *This is not an application for employment.* Your qualifications will be reviewed by our placement staff and you will be advised of positions at McDonnell for which you qualify. You may then make application if you wish. All replies confidential.

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City & State_____ Phone_____ Age_____
Present Position _____
Primary Experience Area_____ Number of Years_____
Secondary Experience_____ Number of Years_____
Additional Comments_____

Education: AE____ ME____ Math____ Physics____ Chemistry____ EE____ Astronomy____ Other_____
Degree: BS_____ (Date) MS_____ (Date) PHD_____ (Date) I would like to receive application form ☐

Openings now exist in the following areas:

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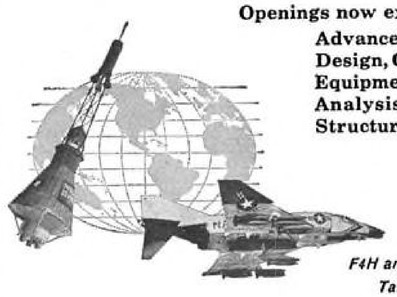

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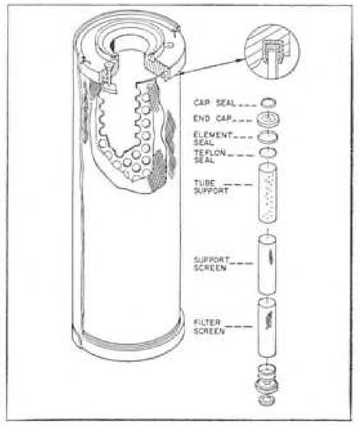
NEW AEROSPACE PRODUCTS

Take-apart Filter

Filter cartridge that can be completely taken apart and cleaned is designed for filtration of fluid in aircraft hydraulic systems, and liquid oxygen and hydrogen fuels in missiles, the manufacturer says.

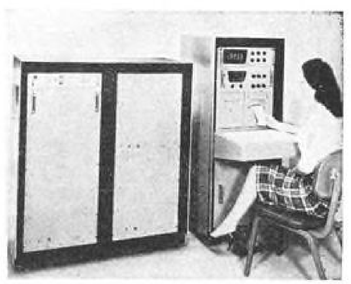


According to the manufacturer, the "dutch weave" stainless steel filter element has "absolute and uniform" particle retention. Because it can be readily disassembled and cleaned ultrasonically, the filter cartridge is expected to have application in critical areas where absolute particle removal standards are necessary.

Filter can operate in the −200F to +400F range. CFC Dutch Weave filters are available to meet 5, 10, and 40 nominal micron removal specifications at 25 gpm. flow with 1.2 to 2.7 lb. pressure loss.

Cartridges are made of stainless steel with Teflon end caps.

Commercial Filters Corp., 2 Main St., Melrose 76, Mass.



Thermocouple Data Logger

High-accuracy, remote-control thermocouple data logger automatically scans, digitizes, and records the outputs of as many as 300-chromel-alumel and iron constantan thermocouples, the manufacturer says.

The logger, Model 24271, prints the temperature measurements on paper and displays them on a four-digit readout from +00.01 to ±55.00 millivolts, covering the useful range of chromel-alumel thermocouples up to 2,500F. System speed is about two seconds per thermocouple. Absolute accuracy is ±25 microvolts and usable sensitivity is ±10 microvolts.

The data logger is contained in two consoles: one contains thermocouple reference junctions, crossbar scanner switch and differential preamplifier; the other console contains control, measuring and recording equipment. These can be located as much as 150 ft. apart. Uses include piston and turbine engine design, heat transfer studies and guided missile and aircraft testing, according to the manufacturer.

Non-Linear Systems, Inc., Box 728, Del Mar, Calif.

Lightweight Life Jacket

Life jacket designed for use on civil aircraft weighs 4 to 8 oz. less than comparable units, the manufacturer says.

Jacket has self-righting features and is designed to allow unconscious wearers to maintain the best flotation angle for survival.

The jacket, Model JLA-1, weighs 20 oz. and can save airline operators 50 to 60 lb. of payload on an average over-water flight carrying 120 passengers, the manufacturer says.

Standard model has CO_2 inflation actuated by wearer. Water-contact inflators are also available.

Sales Dept., Jay-El Products, Inc., 1845 W. 169th St., Gardena, Calif.

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Our engineers work in our very successful Project Group System. A project group or team, consisting of specialists in research, design, administration and production, is assigned to each major requirement for hardware or research. All members are "in" on their projects from conception through prototype testing to production. This logical, practical way gets things done, and permits each man to broaden his own capabilities.

If you would like to be considered for a position in one of these exciting project groups, send your resume (including salary requirements) to Mr. A. W. Wakeman, Personnel Department.

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At ITT Federal Laboratories engineers and scientists participate not only in advancing communications theory and technology but also in the applications of these new techniques to systems of large scope and major importance. To cite a few instances: **ACE HIGH** — the command communication network of tropospheric and line-of-sight radio stations linking NATO countries ☐ **465-L** — the vast-scale Command and Control system for SAC, for which Federal Labs is doing basic R&D work in cooperation with other ITT Divisions ☐ **UNICOM** — for which ITTFL is designing the store and forward portion of a comprehensive world-wide digital communication system for the U.S. Army Signal Corps ☐ **OTHERS** — include complete development of the ground equipment for the Courier communication satellite, participation as a ground terminal for the NASA Relay satellite program ☐ Current assignments open at Federal Laboratories in Nutley, N. J., reach across the spectrum of research, development, design and test engineering; they also include systems development and program management. An unusual array of R&D facilities includes a 40-foot radio telescope used for probing space, moon-relay links and other communications tests ... and a 90-mile tropo scatter link from the Laboratories in Nutley to Southampton, Long Island ☐ **IMMEDIATE OPENINGS: Project Engineers** — project leadership, proposal preparation in the 2-, 5-, and 8-KMC bands on microwave communication equipment, solid state transmitters, receivers and modulators ☐ **Tropo Scatter Communications** — design and development engineers skilled in radio or wire line communication equipment for voice and data transmission equipment. Design experience in microwave antennas, transmission lines, filters, IF amplifiers, multipliers, parametric amplifiers and varactors. Versed in telephone transmission standards and tropospheric scatter propagation ☐ **Computer Engineers** — development of digital data recording equipment. Competence in logic designs, circuit designs, packaging and testing of A/D converters, servomechanisms, magnetic and optical recording ☐ **Space Communications** — studies and development of space craft telemetry and control equipment, RF circuits for transmitters and receivers, systems integration and instrumentation ☐ **In the broad view,** communications programs represent only a part of ITTFL activities. The entire R&D Capability is functionally organized into 17 laboratories engaged in missile and space systems, avionics, communications, electronic defense, and research in the physical sciences. At the Nutley facility, many programs are carried from R&D through design, to manufacture and installation ☐ To apply, or gain more information, forward your resume in full confidence to Mr. T. Allen, Box 19-WM, ITT Federal Laboratories, 500 Washington Avenue, Nutley, N. J. (An Equal Opportunity Employer)

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Disabled Lights Cited in Alaska DC-6 Crash

An Alaska Airlines, Inc., Douglas DC-6A, N 6118C, Flight CKA 779 of July 20, 1961, was a contract cargo flight from Travis AFB, Calif., to Tachikawa, Japan.

At 0211, Bering Standard Time, on July 21, 1961, during the approach to a landing at Shemya, Alaska, an en route refueling stop, after descending through minimum weather conditions under the guidance of GCA,[1] the aircraft crashed and burned approximately 200 ft. short of the runway threshold on a course aligned with the runway. All six persons aboard the aircraft were crew members and all received fatal injuries.

The red runway approach lights, the first four pairs of runway lights and two of four green threshold lights were inoperative. This lighting deficiency was not observed or reported to the aircraft by those in charge of field lighting or by the GCA controller. The single strobe light, 152 ft. short of the threshold, two of the green threshold lights, and the remainder of the runway lights were operating.

The Board determines that the probable cause of this accident was the absence of approach and runway lights, and the failure of the GCA controller to give more positive guidance to the pilot during the last stages of his approach.

The Board has recommended to the Administrator that he take action to assure that personnel and equipment used in GCA approaches meet pertinent standards for such operations.

Investigation

At 0211[2] on July 21, 1961, a Douglas DC-6A, N 6118C, operated by Alaska Airlines, Inc., as Flight CKA 779, crashed and burned while on approach to landing on runway 10 at Shemya Airport, Shemya, Alaska. All six persons aboard the aircraft were crew members and all received fatal injuries.

Flight 779 was being conducted pursuant to a contract between the carrier and the Military Air Transport Service to transport military freight from Travis AFB, Calif., to Tachikawa, Japan. The flight had originated at Paine Field, Everett, Wash., on July 20, 1961, and proceeded to Travis AFB, California, where it was to load military cargo. At Travis AFB, 25,999 lb. of cargo was loaded by military personnel under the supervision of the Alaska Airlines' flight engineer. The flight then departed Travis AFB and flew nonstop to Anchorage, Alaska, where it landed to refuel and take a navigator aboard.

At Anchorage, the crew received weather and NOTAM information for the flight to Shemya, which did not include the approach or field lighting deficiencies. The stop at Shemya was for the purpose of servicing the aircraft before proceeding to Tachikawa. The flight was being conducted in accordance with the operational provisions of Part 42 of the Civil Air Regulations under an amendment to the carrier's Part 41 Operating Certificate.

The crew filed an instrument flight plan to Shemya, using Adak, Alaska, as its alternate. The estimated time en route was 6 hr. 40 min. Extensive areas of fog and low stratus prevailed in the relatively warm, moist air enveloping an area including Shemya and that part of the Aleutian Islands extending 500 mi. east of Shemya. The flight took off from Anchorage at 1940 and proceeded routinely toward Shemya in accordance with its flight plan.

The flight made contact with Shemya Radio at 0045 and gave its position as 55 deg. 46 min. north and 179 deg. 8 min. east at flight level 100 (10,000 ft. with altimeter set at 29.92, required for international flights) between layers of clouds with 9,560 lb. of fuel remaining. Forty-three minutes later, the flight reported it was 100 mi. east of Shemya estimating Shemya at 0155. At that time Shemya Radio transmitted to the flight as follows: "ATC advises no traffic reported, continue inbound to Shemya Homer, descend to maintain 5,500 ft., GCA standing by 134.1." The flight replied, "Alaska 779, Roger."

At 0145, the flight contacted Shemya GCA and radar contact was made with the aircraft approximately 18 mi. north-northeast of Shemya, at 5,500 ft. Frequency on which contact was made and which was used during entire GCA approach was 134.1 mc.

Radio Transmissions

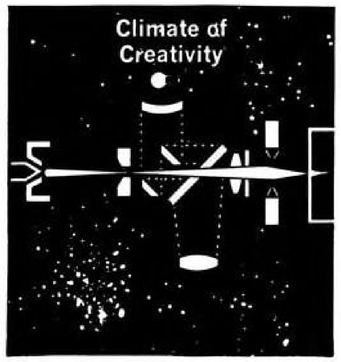
The radio transmissions of neither the flight nor GCA were recorded, which was in direct violation of instructions issued by Northwest Airlines[3] for operation of the GCA; hence the description of how the flight was controlled through the instrument approach is based to a large degree on the controller's testimony. He said that he advised the flight while it was still in the surveillance pattern to expect possible "wind burble" on final approach between one mile and ¼ mi. from touchdown point. He stated that he gave the flight the following Shemya weather information: "Indefinite ceiling 200 ft.; sky obscured, visibility one mile in fog; new altimeter 29.86."

The controller said that the flight intercepted the glidepath properly and maintained a good course during the entire approach. He said that when the flight was two miles out from touchdown, it dropped approximately 10 to 15 ft. below the glidepath and he advised the flight several times

[1] Ground Controlled Approach.
[2] All times herein are Bering Standard based on the 24-hour clock.
[3] Northwest Airlines operates the Shemya GCA as a privately-owned facility.

USAF Tests Limited War Version of T-37

Shown fitted with four Philco Sidewinder missiles on underwing racks is one of two modified Cessna T-37B trainers delivered to USAF's Special Warfare Center, Eglin AFB, Fla., for evaluation of the two-place side-by-side twin-jet's limited war capabilities. Planes can also be armed with podded .50-cal. machine guns, 14 2.75-in. folding fin rockets or two 500-lb. bombs. Auxiliary wingtip fuel tanks, each holding 65 gal., extend the airplane's normal range to more than 900 mi. (AW Oct. 1, p. 13).



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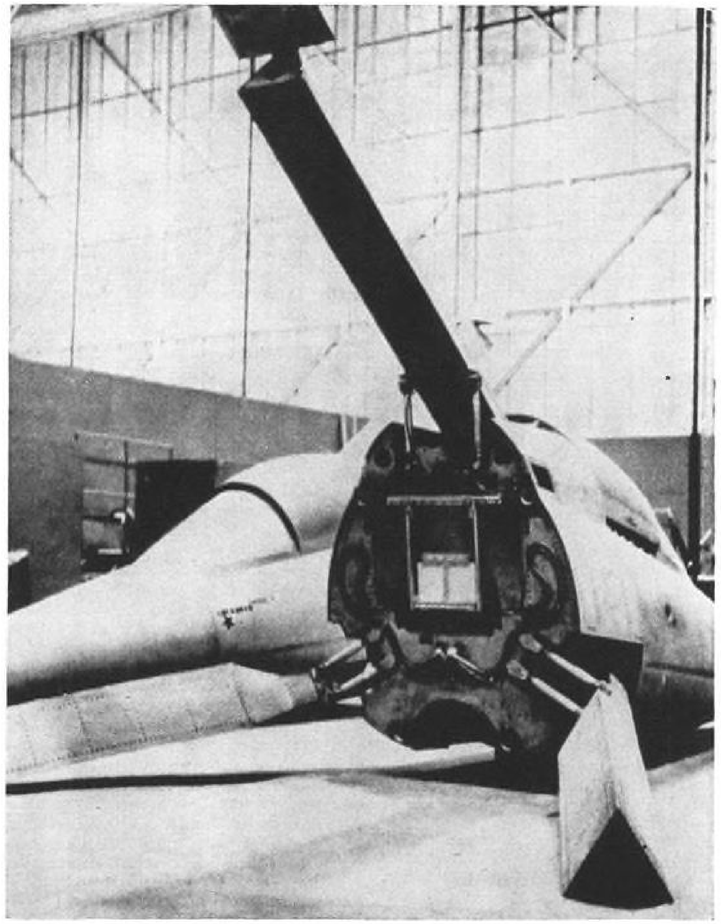


Future Aircraft Escape Capsule Developed

Aircraft escape capsule, developed by Lockheed-California, comprises the cockpit and nose of the plane and features three wedge-shaped fins which tuck into fuselage slots. Mechanism is designed to protect crewmen ejecting at speeds up to 2,500 mph. from aircraft of future design and altitudes up to 100,000 ft. Fins provide arrow-like stability during free-fall of the capsule prior to automatic parachute opening.

to "ease the aircraft up"; however, no apparent correction was made. He said that at approximately one mile from touchdown, the flight went an estimated 30 to 40 ft. below the glidepath, and he advised the flight several times to "bring the aircraft up," yet no apparent correction was made. He advised the flight it was passing GCA minimums at one-half mile out and was still below glidepath. He said that the flight maintained the 30- to 40-ft. below-glidepath condition until it was over the approach lights, which begin 1,460 ft. before the threshold of the runway. He stated that at no time did he consider the flight to be in danger, and that the 30- to 40-ft. below-glidepath condition was still well above the minimum safe altitude for the approach. He said that when the flight was over the approach lights, it started to descend rapidly and he assumed the captain had taken over visually for his landing, intending to "grease it on" at the end of the runway. He therefore did not advise the pilot of his position relative to the glidepath at that point. The controller said that he continued to advise the flight that it was below glidepath (though not stating how far below, or that the safety limits were being exceeded). He stated that he last saw the aircraft on radar at the end of the runway, and also that he knew it had crashed because he did not see the aircraft target move down the runway as he usually is able to do by reference to his radar scope. He also stated that the flight's transmissions indicated to him that the pilot understood all instructions and was familiar with the GCA approach to Shemya's runway 10. The crash took place at 0211. At 0212, in response to notification of the accident, the U. S. Weather Bureau observer made the following weather observation: "Indefinite 200 ft. variable ceiling; visibility ¾ mi. variable, fog; temperature 45 deg.; dewpoint 45 deg., wind south-southeast 8 kt.; altimeter setting 29.84; ceiling 100 ft. variable to 300 ft., visibility ½ mi. variable to one mile."

Published GCA approach weather minimums at Shemya for Alaska Airlines flights are ceiling 200 ft. and visibility one-half mile. The ceiling heights are reported in feet above the runway, and the reported visibility is an average visibility using a visibility reference chart which depicts objects at known distances and directions from the Weather Bureau Office.

The wind at slightly more than 500 ft. above the runway was south at 20 kt., while the surface wind was southeast at 8 kt. The freezing level was at 12,000 M.S.L. Official sunset, July 20, 1961, was at 2137, and civil twilight ended at 2223. Civil twilight began the morning of July 21, at 0443, and official sunrise was 0527. The moon had set at 0046 on July 21.

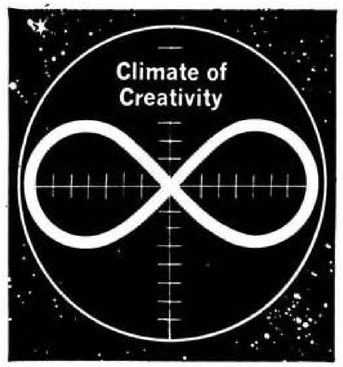
Runway 10 is macadam and is 9,990 ft. in length, 200 ft. wide, and its elevation is 95 ft. M.S.L. There are six pairs of red approach lights extending 1,460 ft. outward from the threshold. They are spaced at 200-ft. intervals and are 200 ft. apart in width. From the edge of the threshold pavement to a point 186 ft. in the direction of an approaching aircraft, the ground slopes downward gradually at an angle of about 1 deg. Then the ground drops suddenly at an angle of approximately 30 deg. to a valley floor 50 to 60 ft. below the level of the runway.

The six pairs of approach lights are mounted on poles of different heights to accommodate the variance in terrain height, but the lights themselves are practically on a level with the runway. A single strobe light[1] is located on the ground, aligned with the runway centerline approximately 152 ft. short of the runway threshold. There are two pairs of green threshold lights, each pair mounted side by side (crosswise to the runway), one pair at each corner of the runway. Thereafter, at 200-ft. intervals, single runway lights extend the full length of the runway along both sides. All lights (except the strobe light) utilize 200-w. bulbs.

The aircraft struck the embankment approximately 200 ft. short of the threshold in a nearly level attitude, the nosewheel touching first about 18 ft. below the crest, very nearly aligned with the centerline of the runway. The aircraft slid up the embankment during impact and when it reached the crest, broke in two (laterally) at the leading edge of the wings. The fuselage, wings, and tail section stopped and settled back on the slope. The powerplants, nose section, and the bulk of the cargo slid varying distances toward the runway and up on it for a distance of about 100 yd. Fire followed impact and the majority of the wreckage was consumed.

The cockpit area was damaged to such an extent that the positions of most of the control levers could not be determined. Three main fuel gauges showed 1,600 lb. of fuel remaining, and one showed 1,700 lb. The alternate tank fuel gauges indicated empty. The copilot's altimeter was set at 29.86 and the pilot's altimeter was set at approximately 29.85. The wing flap indicator was damaged, but indicated a full-flap extension. The main inverter power switches were found in the "on" position

[1] A condenser discharge flashing light rated at approximately 10,000,000 candle power.



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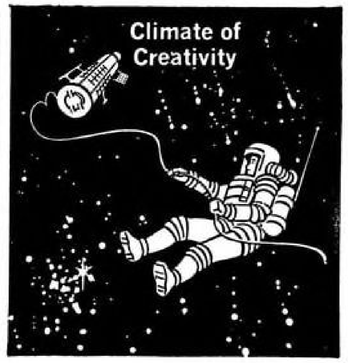

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and disassembly of both main inverters indicated that they had been rotating at the time of impact. The emergency inverter power switches were also found in the "on" position, but disassembly revealed that this inverter was not rotating at the time of impact.

The No. 1 VHF[5] transmitter and receiver were set at 134.1 mc., and the No. 2 VHF transmitter was set at 124.5 mc., and the receiver was set at 125.4 mc. The backup frequency monitored by GCA at Shemya during an approach is 121.5 mc. (VHF Guard), and is the frequency which GCA expects a controlled aircraft to use if the pilot needs to transmit to GCA during the final approach.

The landing gear was fully extended and locked. The wing flaps were extended beyond the 30-deg. position and the landing lights were extended. It could not be determined from physical examination of the switches whether any portion of the external lighting system was on or off. One witness, standing in front of the Northwest Airlines operations building, about midpoint of the runway, stated that he saw the navigation lights, landing lights, and rotating anti-collision light of the aircraft before it crashed.

All of the wreckage was found at the point of impact and forward of it. Examination of the aircraft and flightpath area revealed that the aircraft had not collided with any foreign objects prior to impact.

During examination of the powerplants, the fuel and oil strainers and the sump plugs were found to have been in apparently good condition and free from foreign matter. Firewall shutoff valves were in the open position, and the No. 4 fuel selector was on "main." All other selectors were damaged by impact or fire. Spark plugs were removed from all engines and were found to be free from any indications of fouling or peening. No fuel, oil or ADI[6] fluid samples were available; however, the aircraft had been serviced with 115/145 octane fuel at Anchorage. All propeller blades received extensive damage and were bent in various degrees toward the face. Several blades were broken off the propeller hubs, but examination of the blade fractures revealed no evidence of fatigue or breakage prior to impact. Examination of the propeller governors and propeller assemblies revealed engine rpm.'s to have been as follows: No. 1: 2,413 rpm., No. 2: 2,407 rpm., No. 3: 2,420 rpm., and No. 4: 2,416 rpm. The positions of the propeller dome pistons were as follows: No. 1: 32 deg; No. 2: 30 deg.; No. 3: 33 deg.; and No. 4: 31 deg. The specified low-pitch stop was 30 deg. The shim plate markings were reasonably similar to the dome piston settings.

There was no evidence to indicate that the cargo had shifted prior to impact. The weight distribution of the cargo was such that the center of gravity remained within safe limits. The maximum allowable takeoff weight was 107,000 lb. and the adjusted takeoff weight at Anchorage was 107,006 lb. The maximum allowable landing weight was 92,360 lb. At 0135, when the flight was approximately 50 mi. east of Shemya, an entry was made on the Flight Engineer's Fuel Management log showing a gross weight of 92,346 lb. The log also showed that at 0135, the four main fuel tanks had 1,800, 1,950, 1,950, and 1,800 lb. of fuel, respectively, remaining. The four alternate tanks had been empty, according to the log, approximately 1 hr. 30 min. prior to the 0135 log entry.

According to the Alaska Airlines flight manual, the rpm. setting for the engines was to have been 2,400 for final approach (for four-engine operation) and 2,600 rpm. (for three-engine operation). The manual also stated that 120-130 kt. should be maintained while descending on the glide slope to the airport.

On the day following the accident it was discovered for the first time that an electric power cable lying along the side of the runway had been cut two days prior to the accident to allow construction vehicles to pass over the area. This cable was the powerline leading to the six pairs of red approach lights off the end of runway 10, as well as to two of the four green threshold lights, and to the first four pairs of runway lights. This condition was not reported by previous landing aircraft, nor was a Notice to Airmen concerning this irregularity issued by Northwest Airlines, the operator of the airport. By splicing the cut cable and replacing a transformer in the circuit, all the formerly inoperative lighting was restored. The strobe beacon was not included in the cut circuit, although it was disconnected by the impact of the wreckage. The main rheostat, which controls all lighting intensity (except the strobe light), was set on maximum brightness during the flight's approach.

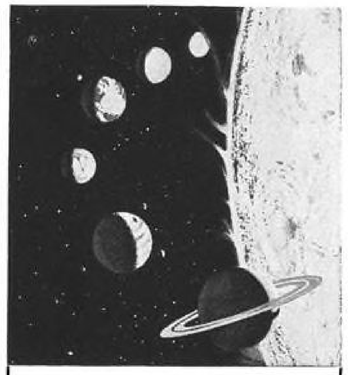
The GCA unit used at Shemya was an AN/FPN-33 Quad Radar manufactured by Gilfillan Brothers, Inc., of Los Angeles, Calif., and was operated under contract to Northwest Airlines, Inc., by the Micro-Craft Corp. The GCA equipment was given a complete functional check by the GCA maintenance man and the operator prior to its use on July 20, 1961, and was operating, according to them, within tolerances. During the 12-hr. period preceding this flight's approach, six other aircraft had made successful GCA approaches to Shemya, using the same equipment manned by the same controller.

On May 3, 1961, and July 12, 13, 14, and 15, 1961, the GCA facility was flight-checked by the FAA and found to have been within tolerances. However, it was pointed out by the flight check crew in their report at the time of the latter flight check that, "It would appear from personal examination that the present radar antenna system now in use . . . has deteriorated and worn beyond its normal life and tolerances, and it is anticipated that it will be difficult to maintain within acceptable tolerances in the very near future."

On July 22 and 24, 1961, the facility was again flight-checked by the FAA and found within tolerances. The check pilot gave the controller a proficiency rating of "very good" on all of the checks. Air/ground communications on 134.1 and 121.5 mc. were found to have been satisfactory by the flight inspection team.

The GCA controller had been employed as an air traffic controller for approximately nine years, eight of which included operation of GCA equipment. He had been operating the GCA at Shemya since the summer of 1957, using the same equipment that was in operation at the time of this accident. His tours of duty on Shemya were continuous since 1957, but were for periods of 90 days, with a 90-day rest period in between. He was the only controller during each of his tours of duty. His then-current tour of duty began Apr. 18, 1961, and he was scheduled to begin a rest period on Aug. 1, 1961. He stated that he conducted an average of 100 to 130 instrument approaches to Shemya per month. Flight CKA 779 was the 83d GCA approach that he had conducted since June 20, 1961. The types

[5] Very High Frequency.
[6] Anti-Detonation Injector.



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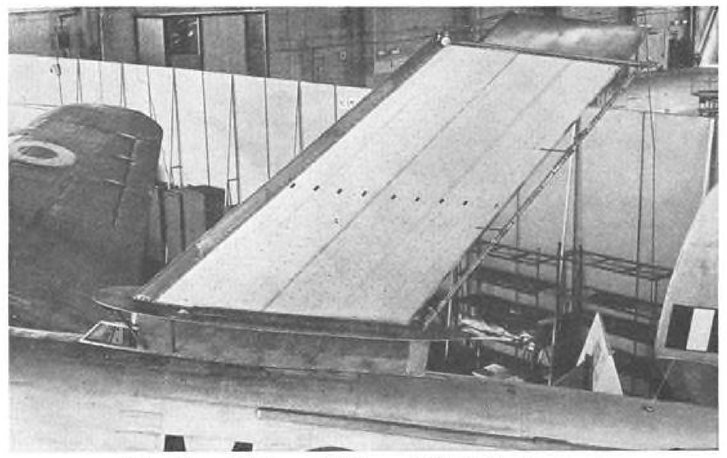

Air-Breathing Wing Flight Tested

Flight testing of an air-breathing wing, mounted vertically on the top fuselage of a Lancaster PA-47A bomber, has started at Cranfield College of Aeronautics, England. Suction wing was designed and built by Handley Page. Suction through surface slits is provided by two Budworth gas turbine engines mounted in the airplane directly below the wing. Shape is a 70 deg. cropped delta with slot blowing at all edges and vanes provided to divert thrust.

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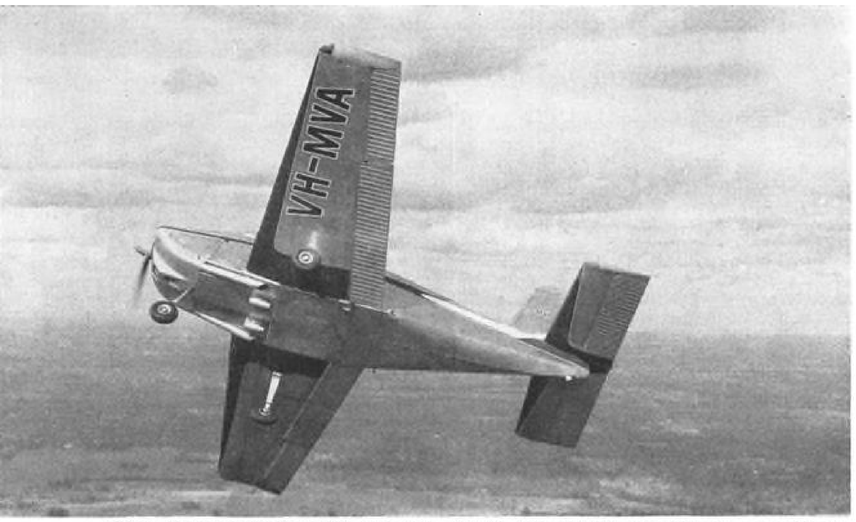
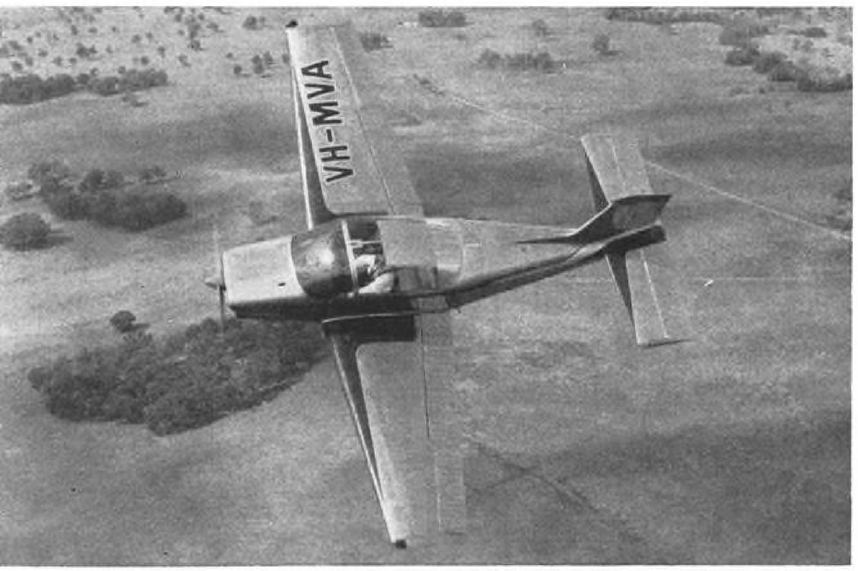


Victa Airtourer is all-metal, two-place aircraft designed for executive or personal use.

Australians Unveil Two-Place Business Plane

Airtourer, manufactured by Victa, Ltd., of Sydney, has full span ailerons and flaps, spring-type tricycle gear, bubble canopy and a single-spar, tapered chord wing. Split flap is under fuselage. Cockpit is lined with plastic and instrument panel moves forward under 6g shock.



Airtourer is powered by 100-hp. Continental O-200A or a 115 hp. Lycoming O-235. Useful load is 650 lb. and gross weight is 1,650 lb. Wing span is 26 ft., length is 20 ft. 9 in. and height is 6 ft. 10 in. Airtourer cruises at 126 mph. and has a top speed of 133 mph. Aircraft is fully acrobatic. Service ceiling is 15,000 ft. and aircraft has a range of 840 mi.

of aircraft controlled during these approaches had been U.S. military as well as U.S. civil aircraft. The radar installation at Shemya is unique in that it is the only privately-owned and operated facility of its kind serving U.S. civil air carriers. The radar operator need not be certificated by FAA, nor need he demonstrate his continued competence to perform his assigned control functions, nor is he required to undergo recurrent training such as is required of FAA controller personnel. At Shemya, the installation of electronic equipment need not be approved by appropriate authority within the FAA.

Flight Crew

The flight crew consisted of Captain Edward F. Bowman, Alternate Captain Galvin W. Sargent, Copilot John F. Bird, Jr., Flight Engineer William Donovan, Flight Engineer Dwight Babcock, and Navigator Edson A. Marahrens. The crew was to alternate its duties in order that no one would become fatigued at his duty station and, as well as could be determined, this requirement was met. Captain Bowman, Copilot Bird, and Flight Engineer Donovan had flown N 6118C into Shemya Airport, landing at 1952 on July 12, 1961, and again at 1024 on July 14, 1961. Both landings were accomplished after ground-controlled approaches in Instrument Flight Rules (IFR) weather conditions.

From its origination at Paine Field, Everett, Wash., on July 20, 1961, the flight's progress had been continuous. The flying time from Paine Field to Travis AFB was 2 hr. 36 min. The flight was on the ground at Travis AFB for 3 hr. 17 min. The flying time from Travis AFB to Anchorage was 8 hr. 59 min. The flight was on the ground at Anchorage 1 hr. 18 min. The flying time from Anchorage to the time of impact was 6 hr. 30 min.

Testimony of Alaska Airlines flight operations supervisory personnel and examination of the crew's training records indicated that all qualifications and proficiency requirements had been met except for the qualification into Shemya Airport by Captain Bowman.

Analysis

Flight CKA 779 is considered to have been planned in conformance with existing company procedure and applicable regulations. At Travis AFB the cargo was loaded in a manner which did not adversely affect the safety of the flight's operation. There is no evidence that the cargo had shifted prior to impact. The aircraft had been modified for hauling cargo in accordance with approved specifications.

The aircraft had been serviced with the proper type of fuel, and it is believed that the ADI and autofeathering systems were capable of normal operation.

Examination of the powerplants revealed that all four engines were capable of producing adequate power. Judging from the examination of the propeller assemblies, the power being developed by the engines was that customarily used to execute successfully a GCA approach to a normal landing under the existing weather conditions. The minima applicable to the captain for a GCA approach at Shemya were: ceiling 400 ft. and visibility ¾ mi. The weather

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ENGINEERING METALLURGIST — B.S. or M.S. in Metallurgical Engineering plus 2 years experience in industrial physical materials laboratory work to perform laboratory tests involving physical, fatigue testing and metallography.

SENIOR ENGINEERING METALLURGIST — M.S. or PhD in Metallurgy or Metallurgical Engineering plus 2 years experience in industrial or academic physical metallurgical laboratories to perform advanced physical metallurgical testing and research.

CERAMIC ENGINEER — B.S. or M.S. in Ceramic Engineering plus 3 years experience in aerospace industry or related fields to perform work in refractory materials research and development which includes ceramic materials, protective coatings, and electromagnetic materials.

SCIENCE INFORMATION SPECIALIST—Advanced degree in Library Science with an undergraduate degree in Engineering or a Physical Science to perform work exclusively directed to the support of research programs, through literature searches, etc. Experience is essential.

SPACE SYSTEMS ANALYSIS — PhD's in engineering, physics or mathematics are needed for work on advanced scientific and military space projects. These assignments will involve conceptual design studies which will include feasibility studies, evaluation of system requirements, and evaluation of various approaches. The individual will not only be responsible for performing such work himself, but will also be expected to coordinate studies by groups of technical specialists. In addition, he will make customer contacts and maintain customer liaison.

OPERATIONS RESEARCH ANALYSTS — Operations Research and Systems Analysis (For Space Systems) — Individuals with desire to do broad conceptual analysis in the need for, requirements for, and the determination of capabilities of proposed systems to meet future space needs. Advanced degrees and experience in systems thinking desirable.

SENIOR AEROSYSTEMS ENGINEERS — M.S. and PhD's in EE and Physics who have experience in one or more of the following:

Radar and Microwave, Data Processing and Data Correlation, Infrared and Optics, Countermeasure Techniques

to perform research and development on contracts involving air and space vehicles, ground installations involving radar cross section techniques, and reconnaissance data processing.

AERODYNAMICS ENGINEERS — B.S., M.S. or PhD to conduct theoretical and applied studies in the area of supersonic and hypersonic compressible, viscous, real gas flows. This work is directed toward the complete appraisal of the aerodynamics of re-entry of orbital and space vehicles.

About General Dynamics / Fort Worth:

Virtually the entire spectrum of engineering and scientific disciplines and skills is encompassed in the Engineering programs, which support the National Space Effort. Pioneer in the technological development of the Southwest, General Dynamics/Fort Worth is continuing this role in the era of aerospace.

Project activities range from data acquisition and processing systems to logistic systems; from low speed to hypersonic advanced-wing vehicle systems; from satellite systems to space radiation effects studies. Laboratory and test equipment supporting the programs include: complete electronics, nuclear, and test laboratories; a hyperthermal research facility; an ultra-high-pressure physics laboratory; both special and general purpose computer facilities.

General Dynamics/Fort Worth offers a hospitable locale, with a mild, even climate and abundant recreational-educational facilities, in a community of 400,000 population. For additional information concerning the above openings, write Dept. 3-8, General Dynamics/Fort Worth, P. O. Box 748A, Fort Worth, Texas. An equal opportunity employer.

GENERAL DYNAMICS | FORT WORTH

transmitted to the flight by the GCA controller, according to his testimony, was ceiling 200 ft. and visibility ¼ mi.

Our examination of fuel management logs, the fuel quantities indicated on the main tank gauges, coupled with the fuel report given approximately 26 min. prior to the accident, and the lack of any foreign matter in fuel lines, strainers, and sumps, leads us to conclude that fuel flow to all engines was normal prior to impact and was commensurate with the throttle settings.

Control surfaces and control mechanisms seem to have been in normal operation. There is no evidence that any of the aircraft systems malfunctioned.

Aircraft Structures

Examination of the structures of the aircraft showed that they were integrally sound before impact. The landing gear was down and locked, and the wing flaps were properly and fully extended for completion of the final approach and landing. The landing lights were extended and believed to have been on inasmuch as they were observed by an eyewitness to have been on. Since the landing lights were on, it is believed that the aircraft was below the clouds during some portion of the approach. Use of these lights in the clouds would have caused adverse reflection to have been experienced by the crew.

Consequently, this would have hampered their ability to make visual contact with the runway.

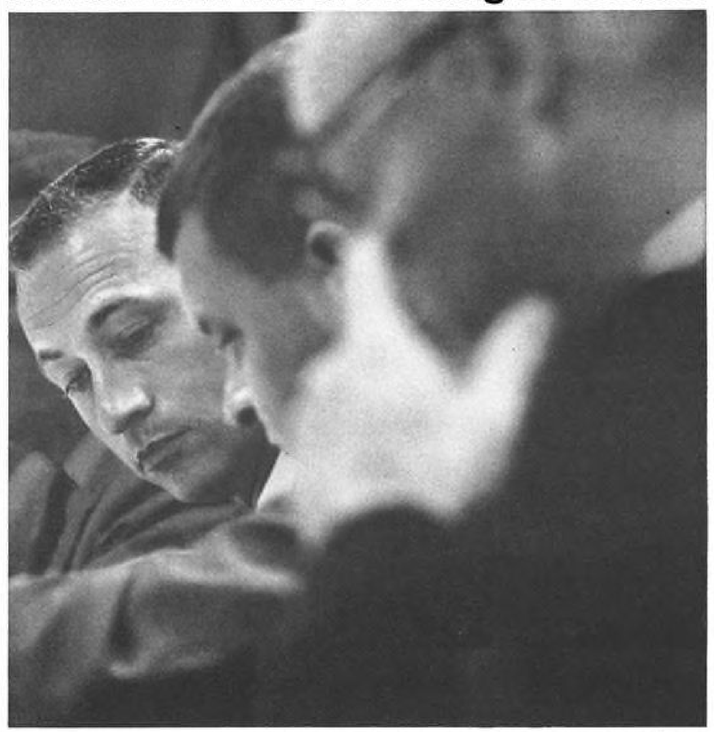
The No. 1 VHF radio equipment aboard the aircraft was operating normally, at least until the time the GCA operator actuated his transmitter on 134.1 mc. to give instructions to the flight upon beginning the GCA final approach. If, during the final approach, the flight were to have transmitted a distress message on that frequency it would not have been heard by the GCA controller; however, it would probably have been heard by persons standing in the Northwest Airlines operations building who were monitoring 134.1 mc. and 121.5 mc. The lack of any transmissions on either frequency by the flight supports the view that no emergency existed. Since the No. 2 VHF receiver was tuned to 125.4 mc. and the associated transmitter to 124.5 mc., it is assumed that they were either mistuned or not used.

Airport Weather

The weather conditions existing at Shemya Airport at the time of the accident averaged a 200-ft. ceiling and ½-mi. visibility. The ceiling was reported to have been varying from 100 to 300 ft. and the reporting of a ceiling of 200 ft. is a permissible practice by the U. S. Weather Bureau under these conditions. The forward visibility of the crew when it was over the approach lights could have been as low as ½ stat. mi. if the aircraft had been clear of clouds in that area. Conditions of temperature and moisture in the approach zone were not conducive to structural icing, and it is therefore not considered to have been a problem. Also, according to the sun and moon data, the accident occurred during the hours of complete darkness.

It is believed that the captain knew the reported weather conditions to the extent

Wanted: Men who are looking for trouble.



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Electromagnetics. For studies in energy propagation and field theory pertinent to such areas as communications antennas, radar cross-sections, and plasma sheaths.
Fluid mechanics. For analyses of subsonic, supersonic and hypersonic flows.
Communications. To conduct analysis and integration of new concepts in telemetry command, detection, and tracking systems.
Experimental aerodynamics. To work with a group that will support theoretical aerodynamic research with experimental approaches and will initiate experimental research to fill voids in the theoretical techniques.
Operations research. To visualize complete weapons systems, and apply basic knowledge to new and diversified problems.
Guidance and controls. To conduct study and analysis of sensors and computers.
Systems research. To work on systems performance optimization.
Numerical analysis. To develop large-scale numerical procedures for aerodynamic design and flow field analysis.
Avionics. To work on the design, development, and analysis of avionics systems for airborne applications.
Reliability. To assess the reliability and optimize the configuration and mission profiles of space systems.
Chemical research. To work on the development and applications of structural adhesives for aerospace vehicles.
Metallurgical research. For research and development on materials and joining.

If you'd like more information about these opportunities and others that may be available, write to Roy L. Pool, Engineering Center Personnel Office, 1001 East Broadway, Hawthorne, California.

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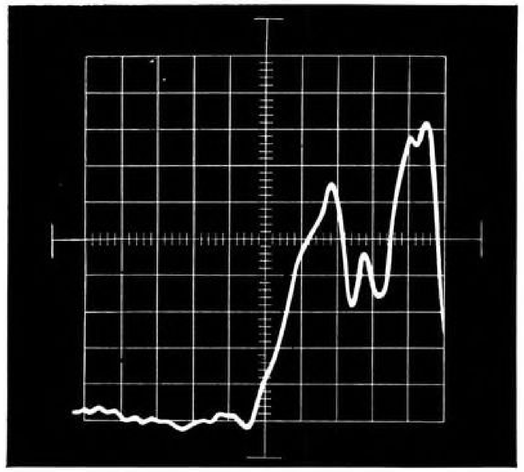
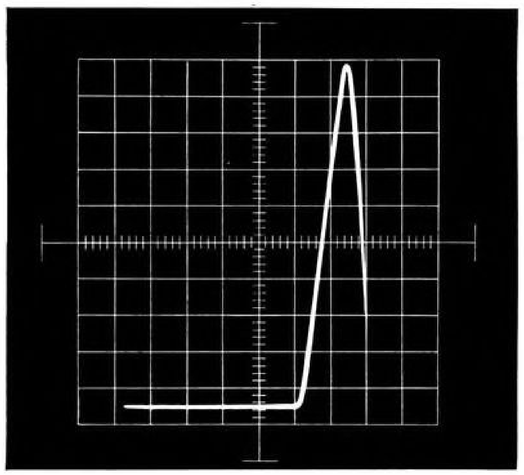
IBM asks basic questions in mechanical analysis

What is the best design?



This is an example of the force-time relationship of impact printing as the striking head of an output printing device comes into contact with its platen.



After modifications were made in the printing mechanism, the force-time relationship reflected a cleaner impact, producing a sharper impression from the printer.

As computers go faster, so must the machines which work with them. The tremendous speed at which these mechanisms function magnifies traditional problems of wear, elasticity, and timing. To meet rigorous new standards of performance, IBM engineers are applying the techniques of mechanical analysis to the development of high-speed mechanisms.

Through a combination of experimental measurements and mathematical analyses, IBM engineers attempt to determine exactly what is taking place at any given instant during the machine cycle. For example, our engineers recently were given the assignment of increasing the operating speed of the output printing element in a data processing system by as much as twenty-five percent without major redesign. To do so, they progressively varied mass, spring forces, and the elasticity of several components, and measured resulting changes in the system's physical characteristics. By translating these experimental results into mathematical terms, they were able to arrive at a solution to the problem which might have been impossible to obtain using only trial-and-error methods.

The exact description of the way in which many variables interact during the machine cycle requires advanced measurement and analysis techniques. For example, the impact curves shown above were produced by a mechanical structure with several degrees of freedom—a system extremely complicated to calculate. IBM engineers chose to alter one structural member slightly to produce an overriding, dominant frequency. They could then analyze the structure's operation mathematically.

Mechanical analysis is helping IBM engineers to create mechanisms with fundamentally new designs. For instance, in a revolutionary new typewriter, the IBM Selectric,™ they were able to design a mechanism to compensate automatically for wear and elasticity in the print-selection system. In an important new development in disk storage, they used a hydraulic actuator to position magnetic read-write heads which float on air bearings. And they have developed a high-speed printer, controlled by a computer's program, which prints by means of engraved type suspended on a chain which moves past the paper at high speed. Mechanisms with advanced designs like these are helping to make it possible to take full advantage of the immense capabilities of the computer.

If you have been searching for an opportunity to make important contributions in mechanical analysis, space, programming systems, or any of the other fields in which IBM scientists and engineers are finding answers to basic questions, please contact us. IBM is an Equal Opportunity Employer. Write to: Manager of Professional Employment, IBM Corp., Dept. 524Y3, 590 Madison Avenue, N. Y. 22, N. Y.

indicated to him by the GCA controller. It must be assumed that he was monitoring his altimeter and knew that when he passed through his minimum altitude if he had not established visual reference to the airport or ground, or if he had been advised by GCA that he was exceeding the safety limits, he would have had to execute the required missed-approach procedure. Since he did not execute the procedure, did not question the condition of the weather, and since he was not advised by GCA to abandon his approach upon reaching a critically low altitude, it is assumed that he had visual contact with the runway and was contemplating a successful landing.

The controller stated in his testimony that he saw the aircraft target over the end of the runway.

However, this target return must have been from part of the wreckage which continued up the runway from the point of impact.

Faulty Lighting

The six pairs of red approach lights, two of the green threshold lights, and the first four pairs of runway lights beyond the two operating threshold lights were not lit. The single strobe light was lit; however, its beam was directed 4½ deg. above the glidepath angle of 3 deg. As an aircraft goes below the beam of the strobe light the effectiveness of the light is greatly reduced. For example, at a point 50 ft. below its directed beam, the effective strength of the beam is reduced by as much as 75%.

The captain could not have known that the approach lights and some of the threshold and runway lights were inoperative since this information had not been given to him. It is also believed that he would not have flown below his minimum altitude had he not had some portion of the runway lights in sight. The Board concludes, however, that the existing lighting situation was a factor in causing the captain to improperly orient himself with the runway. The Board further concludes that the captain knew he was below the glidepath throughout the approach but did not believe it to be critical.

Safety Zone

It should be noted that although the approach procedure was flight-checked and approved by the Flight Standards Service of the Federal Aviation Agency, apparently no consideration was given to the fact that the AN/FPN-33 is not deemed suitable by the Aviation Research and Development Service, the Aviation Facilities Service or the Air Traffic Service of FAA for use as an FAA-operated air traffic control facility. Another significant point to be noted is that the Flight Standards Service, in its flight checks of this facility, utilized a lower-limit safety zone line which extended 1½ deg. below the center of the glidepath. The Air Traffic Service has established, for facilities under its jurisdiction, a safety zone limit of ½ of 1 deg. under the center of the glidepath. A displacement value of 40 ft. below glidepath at 1 mi., therefore, would not be considered alarming by the controller operating under the concept of a 1½-deg. safety zone, whose lower limit at that point would be 159 ft. below center of glidepath; whereas, were the controller utilizing the standards prescribed by the Air Traffic Service, he would

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A radiation effects physicist, to do research with emphasis on solid state devices.

A flight test engineer, who can conceive programs, estimate manpower requirements and costs.

A reliability engineer, to perform reliability analyses of space systems and subsystems in proposal and development phases.

Stress analysts, to develop fresh analytical techniques and apply them to new space structural concepts; to do stress analysis and design optimization studies on advanced space vehicle structures.

A plasma physicist, to join our growing program in the measurement of plasma properties, spectroscopy, diagnostics, accelerators, and power conversion devices.

A mathematician-physicist, to concentrate on systems analysis and operations research applied to military and non-military space systems.

Physicists experienced in electro-optical imaging devices and laser theory; engineering mathematicians interested in detection theory, reconnaissance and tracking; electronic engineers who know their way around statistical communications theory and noise phenomena; for new and original work in satellite detection systems.

For more information about these and other opportunities, write to W. E. Propst, Space Personnel Office, IIII E. Broadway, Hawthorne, Calif. You will receive a prompt reply.

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be commencing to take action to order a pullup and missed-approach procedure to be executed had the aircraft deviated to the extent indicated.

However, a finite value in feet cannot be estimated accurately on a radar scope with the type of presentation provided for the AN/FPN-33. For this reason, the military services have instructed their controllers to refrain from the practice of providing foot values of displacement from centerlines of azimuth or elevation when utilizing precision radar equipment with this type of display.

Furthermore, although the controller was directly involved in the control of civil air traffic under instrument flight rules, FAA did not enforce any requirements for certification and area rating, current medical certificate, Class 2, or current proficiency in radar operation or other aspects of air traffic control.

Probable Cause

The Board determines that the probable cause of this accident was the absence of approach and runway lights, and the failure of the GCA controller to give more positive guidance to the pilot during the last stages of his approach.

By the Civil Aeronautics Board:
Alan S. Boyd, Chairman
Robert T. Murphy, Vice Chairman
Chan Gurney, Member
G. Joseph Minetti, Member
Whitney Gillilland, Member

Investigation and Depositions

The Civil Aeronautics Board was notified of the occurrence of the accident at 0350 Alaska Daylight Time July 21, 1961. An investigation was immediately initiated in accordance with the provisions of Title 7 of the Federal Aviation Act of 1958.

Depositions ordered by the Board were taken in Anchorage, Alaska, on Aug. 4, 1961, and in Seattle, Wash., on Aug. 8, 1961.

The Carrier

Alaska Airlines, Inc., is an Alaska Corporation with principal offices at 2320 6th Ave., Seattle, Wash. The corporation is the holder of air carrier operating certificate No. 802 issued on Sept. 23, 1946, and revised Feb. 12, 1958. The corporation holds air carrier operating certificate No. 802 authorizing its charter and special services operation conducted under Part 42 of the Civil Air Regulations. The corporation holds a certificate of public convenience and necessity issued by the Civil Aeronautics Board.

The Aircraft

The aircraft was a Douglas DC-6A, manufactured as a cargo aircraft for Alaska Airlines under serial No. 45243 on Oct. 20, 1957. The total time on the airframe at the time of the accident was 10,600:30 hr. The last major inspection was conducted 146:11 hr. prior to the accident.

The powerplants consisted of four Pratt & Whitney R2800 CB 17 engines with propeller model No. 43E60-483-P9/6895 E-8. The time since overhaul on the engines was as follows: No. 1: 601:47 hr.; No. 2: 601:47 hr; No. 3: 1,481:26 hr.; and No. 4: 1,028:34 hr. Time since overhaul of the propellers was as follows: No. 1: 3,248:03 hr.; No. 2: 1,280:37 hr.; No. 3: 107:46 hr.; and No. 4: 1,597:39 hr.

Flight Personnel

Captain Edward F. Bowman, age 44, had been employed with Alaska Airlines since Nov. 17, 1946. He had 13,019:31 total flying hours, 1,117:34 hr. in DC-6 equipment, 4,219:00 hr. night time, and 2,051:00 hr. actual instrument time, 28:00 hr. of which were flown in the last month preceding the accident. Captain Bowman possessed ATR No. 54701 showing certification in DC-3, DC-4, DC-6, DC-7, and C-46 aircraft. His last route proficiency and instrument checks were conducted Mar. 14, 1961. No route checks had been conducted over the particular route involved in this accident since the flight was conducted under the provisions of Part 42 of the Civil Air Regulations. Captain Bowman's first-class medical certificate was dated May 3, 1961.

Cocaptain Galvin W. Sargent, age 41, was hired by Alaska Airlines on June 16, 1961. He had a total of over 13,000 hr. on four-engine equipment, including the DC-6. He had 714:12 hr. of actual instrument time. He was given a DC-6 captain's proficiency and instrument check on June 21, 1961. Captain Sargent possessed ATR No. 35549-40 with ratings in Martin 202-424, DC-4, DC-6, DC-7, C-46 and Boeing 377; single and multi-engine land and commercial privileges. The date of his last first-class medical examination was June 23, 1961.

Copilot John F. Bird, Jr., age 29, was hired by Alaskan Airlines on Apr. 13, 1959. He possessed a flight engineer certificate No. 1439330 and commercial pilot certificate No. 1358925, airplane multi-engine land and instrument rating. He completed first officer qualifications on DC-6 equipment May 21, 1961. Mr. Bird had accumulated 2,061 hr. pilot time, of which 101 hr. were in DC-6 equipment. He had also 150 hr. of actual instrument time. His DC-6 engineer time was 780 hr. Mr. Bird possessed a first-class medical certificate dated May 25, 1961.

Flight Engineer William Donovan, age 27, was hired by Alaska Airlines on Apr. 13, 1959. He possessed a commercial pilot certificate No. 136608 with single and multi-engine land and instrument privileges. He had accumulated 1,175:55 pilot hours. He had a flight engineer certificate No. 1443248 and had completed training as a flight engineer with Alaska Airlines. The date of his first-class medical certificate was May 31, 1960.

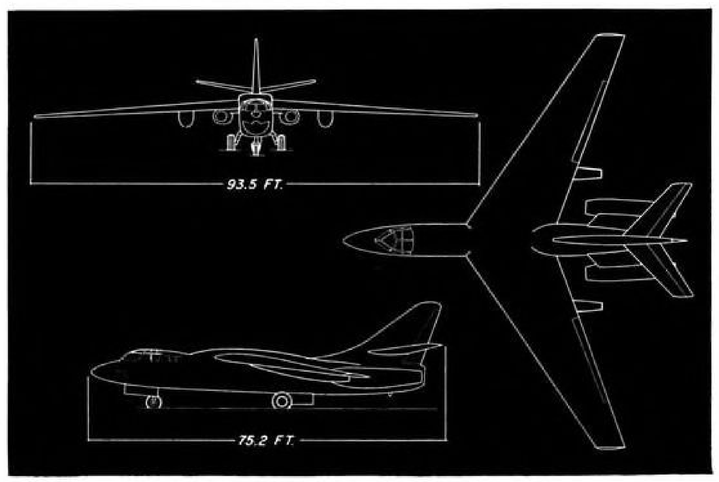
Flight Engineer Dwight Babcock, age 28, was hired by Alaska Airlines on May 15, 1961. He possessed an A&P certificate No. 1329061 and a flight engineer certificate No. 13880698.

He had approximately 1,200 hr. as a flight engineer in DC-6 equipment. The date of his last first class medical examination was June 28, 1961.

Flight Navigator Edson A. Maralrens, age 41, was hired by Alaska Airlines July 17, 1961. He possessed approximately 13,000 hr. as a flight navigator and held certificate No. 1020664. This was his first flight with Alaska Airlines.

The GCA Controller

Mr. John R. Rohrbough, Jr., age 30, possesses control tower operator certificate No. 1336747 issued on Apr. 3, 1956. On Dec. 6, 1956, he was rated as a senior controller at Ontario International Airport, Calif. Prior to receiving his initial certificate, he had four years experience as a GCA operator for the U. S. Air Force with rating at Scott AFB, Ill., Keesler AFB, Miss., Biggs AFB, Tex., and Holloman AFB, N. M. The date of his last Class 2 medical examination was 1958.



Northrop X-21 Configuration Shown

Changes in the configuration of the USAF/Northrop X-21 laminar flow control demonstration aircraft are shown in this three-view. First of two aircraft will be completed in December and flight tests are due in early 1963. Round shape atop the fuselage is a fairing designed to accelerate air spilling over from the wings to increase lift and improve air pressure distribution. Fairing also contains bleed air lines.

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WHO'S WHERE

(*Continued from page 23*)

Changes

Dr. Bernard Levine, manager of applications research, Martin Co.'s Space Systems Division, Baltimore, Md. Also: **Joseph Sternberg,** formerly chief of the Exterior Ballistics Laboratory, U.S. Army Proving Ground, Aberdeen, Md., has been named to the engineering staff of Martin's Space Systems Division.

Werner A. Thomann, director of industrial programs, General Atomic Europe, Zurich, Switzerland, an associated company of General Atomic Division of General Dynamics Corp.

Dr. Raymond D. Egan, manager-advanced communications, Granger Associates, Palo Alto, Calif. **Robert D. Baker** succeeds Dr. Egan as manager of r-f equipment.

Dr. William E. Parkins, manager, Research Division, Atomics International, a division of North American Aviation, Inc., Canoga Park, Calif.

Capt. Athelstan S. M. Rendall, VC.10 flight manager, British Overseas Airways. Also: **Capt. Frank W. Walton,** deputy manager; **Capt. Jack Nicholl,** in charge of fleet training.

Earle K. Gates, associate head, NORAD Command System Department of The Mitre Corp., Bedford, Mass. Also: **Lawrence L. Holmes,** head of Mitre's Wiesbaden (Germany) office.

Thomas W. Coughlin, division manager, Cambridge (Md.) Division of Airpax Electronics, Inc.

B. F. Dittman, chief engineer, Torrance (Calif.) plant of Vickers, Inc., a division of Sperry Rand Corp., succeeding **W. K. Deacon,** now operations manager.

Dr. Fred L. Niemann, assistant director for technical programs, National Aeronautics and Space Administration's new North Eastern Office, Cambridge, Mass.

Kenneth F. Miller, director of applied research, Trimpot Division of Bourns, Inc., Riverside, Calif., and **Edward J. Bresnen,** manager of material.

Roy H. McGregor, manager-aerospace marketing and contracts, Beech Aircraft Corp., Wichita, Kan.

Donald L. Stevens, general manager, TRW Computers Co., a division of Thompson Ramo Wooldridge, Inc., Canoga Park, Calif.

Dr. George A. Garrett, technical assistant to the vice president, Lockheed Missiles & Space Co., Palo Alto, Calif.

Dr. James N. Shoolery, sales manager, Instrument Division, Varian Associates, Palo Alto, Calif.

Joseph Holzman, operations director, Fairchild Stratos' Aircraft-Missiles Division, Hagerstown, Md.

Dr. Behrend Du Waldt, associate head, Electromagnetic and Communications Techniques Department, Electronics Research Laboratory, Aerospace Corp., Los Angeles, Calif.

Dr. Leo S. Mason, head of the section on electronic warfare, command and control problems, strategy and readiness, and research and development, Operations Evaluation Group, Arlington, Va. Also: **Dr. James K. Tyson,** chief of the section on air and undersea warfare.

Dr. James N. Waggoner, in charge of the newly established Life Sciences Department, Garrett-AiResearch, Los Angeles, Calif.

Electro-Optical Division, Perkin-Elmer Corp., Norwalk, Conn., has announced the appointment of the following managers: **Charles B. Hazzard-Systems Marketing; Charles J. Jones-Product Marketing; Peter Moller, III,** Product Planning.

Donald S. Jones, general manager, Scintilla Division, The Bendix Corp., Sidney, N. Y., succeeding **George E. Steiner,** retired.

William I. L. Wu, director of research and development, Singer Metrics Division, The Singer Manufacturing Co, Bridgeport, Conn.

John S. Auld, general manager, Allen B. Du Mont Laboratories Divisions of Fairchild Camera and Instrument Corp., Clifton, N. J.

Larry S. Winston, aerospace ground equipment manager, Cleveland Pneumatic Industries, Inc., a subsidiary of Pneumo-Dynamics Corp., Cleveland, Ohio.

Fred T. Weisman, chief engineer, Bonanza Air Lines.

William D. Fowler, general manager of the newly established Systems Division of Whirlpool Corp., St. Joseph, Mich.

Morris R. Lynn, operations manager, Airtek Dynamics, Inc., Compton, Calif.

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telemetry engineers — Senior Engineers are required with a BSEE or MSEE experienced in the development of all types of FM/FM telemetry components, design of airborne and ground systems including PAM/PCM and data handling and processing and data display elements.

underseas warfare — Senior Engineers with BSEE or MSEE experienced in design of Sonar Transducers for Anti-Submarine Warfare and Underwater Navigation and Range Instrumentation. Additional requirements exist for Torpedo Guidance Systems Engineers involving semi-conductor circuitry.

military navigation — Senior Engineers with BSEE and experience in low frequency electronic circuit design, aircraft instrumentation, involving transistor techniques, and the design of high power transmitters.

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ENGINEERS & SCIENTISTS in the fields of space vehicle power and propulsion

The Propulsion and Power Systems Department of the Aerospace Vehicles Laboratory has several unusually interesting openings for engineers and scientists who are interested in the fields of space vehicle power and propulsion. The openings are at all levels of experience—from recent graduates to the senior staff level. Most of the positions will involve design and analysis of power and propulsion systems for satellite and space probe application. Specifically, some of the areas of specialization are:

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LETTERS

Bus Kudos and Boos

We are very much interested in your kind words on the editorial page of your Oct. 1 issue concerning the Mobile Lounges at the Dulles Airport, especially since kind words on these huge "taxis" have been so notably few.

Your extremely fair evaluation of these controversial vehicles is, therefore, deeply appreciated both by Chrysler and by Budd.

JOEL H. SQUIER
Manager, Advertising and Public Relations
The Budd Co.
Philadelphia, Pa.

I applaud your editorial in the Oct. 1 issue, but take exception to your suggestion that U. S. airlines adopt the European system of airport buses.

This system reduces the flexibility of boarding a large number of passengers, and virtually cuts off any passengers who arrive after the bus has left even though they are in time for the flight. I feel that any system dependent on a set time of departure for the ramp, such as a bus, is not the solution, but some transportation system is needed which operates continuously right up to departure time.

D. P. EDKINS
Lynnfield Center, Mass.

I can only agree with you that changes are definitely needed in passenger handling, and add that they are needed more in aircraft ground handling techniques. The use of large, cumbersome buses is not the answer as, outside of passenger comfort, they create more problems than they solve. These buses weigh 76,000 lb. and now cost around $850,000 instead of the earlier estimated cost of $250,000 each, and their capacity is only 90 people. This means that two machines (which dwarf the plane), weighing 152,000 lb. and costing $1,700,000, have to be used for each incoming and outgoing flight; this cost is exorbitant but is not all.

Instead of having one terminal, we have now created a second special and costly loading and servicing area. For what? Baggage is now changed twice instead of once; the passengers load and unload twice and with no saving of time.

Time and aircraft ground handling costs are the missing ingredients, not more passenger comfort.

While everyone is shouting for passenger help they are forgetting about the airplane. If more attention was paid to new aircraft handling concepts, the passenger handling problem would be solved for the most part and without additional logistic problems by having two terminal areas.

Aircraft handling hasn't changed since 1903 as they are still being towed, first by the tail wheel and now by the nose wheel. Pulled first by man and now by 45,000-lb. monstrous tractors and still with speed limits of only 5-7 mph. It's ridiculous!

The new Jet Age is here and with it has come many new problems in the ground handling of large jet aircraft. Some of these are: engine noise, odors and blast in the terminal area, high fuel consumption, engine overhaul cost, heavier aircraft ground loads and shortage of terminal space. These are the "real" reasons for the need for new handling concepts, not simply passenger comfort. Anyone who thinks differently is just evading the issue. There are others, all of which make present ground handling methods obsolete as they are only "stop-gap" methods.

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.

In the past few years new devices for handling people have come into being, such as, nose-in terminals (which are the most practical), mechanical piers and loading ramps, satellite terminals and buses, but none of these have or will solve our aircraft-handling problems.

The jet airplane uses several hundred gallons of fuel while on the ground; about $200,000 worth of fuel a year per plane. On top of that, the engines if run only an hour a day on the ground would total over 1,400 hr. per plane a year for a four engined aircraft. If the plane could be moved satisfactorily without using its own power, then a savings of over $200,000 a year per plane could be realized. (The cost saved on the engine operating time should more than balance out the cost of operating the moving equipment.)

In addition to the bus and terminal concepts, a good deal of research has gone into the wheel-moving devices but they, too, have drawbacks. Three major ones are: time consumed for hook-up, slow speed and strain imposed on the aircraft by the unsymmetrical forces set up by powering only one set of wheels. (However, wheel movers do lend themselves very nicely to tandem landing geared aircraft.) Also, the traction advantage is limited to the percentage of the aircraft's weight bearing on the powered wheel. For example, a 300,000 lb. plane has approximately 37,000 lb. on each main wheel, thus a wheel mover would have to have a separate attachment to each wheel for maximum traction.

With the weights of aircraft going up, along with those of the ground-handling equipment and their costs, there is really only one sound concept to explore; that of aircraft carrying vehicles. The primary advantages of this concept are: utilization of the aircraft's full weight for traction, faster moving speeds, lower ground loads and no structural strain on the aircraft due to towing attachments.

Several carrying designs have been made: a trailer (which has to be towed); a large flatbed vehicle on railroad tracks (which is a fixed installation and has a high initial cost). However, last year a new self-propelled, aircraft carrying vehicle was patented and overcomes the old drawbacks of this concept. It also provides additional benefits, aside from those mentioned above. These are: the use of existing taxiways and ramps of all major airports, unqualified maneuverability and maximum utilization of terminal space, due to nose-in docking, plus space for some servicing equipment.

This lengthy explanation is necessary in order to impress the importance of this problem. A quote from a Douglas Aircraft Co. booklet states, "Structural repairs to aircraft damaged by collision with mobile equipment has cost one airline $1,000,000 annually." Another operator has over $100,000 a year damage to nose wheels from towing. United Air Lines has 20 Caravelles; up to April of this year one half of them had received major damage from ground equipment. And the list goes on.

Let's take care of our major problems first, then add the frills.

ROY P. GIBBENS
Quality Engineer
Martin Co.
Orlando Aerospace Division

Huskie Engine

Your article in the Oct. 8 issue of AVIATION WEEK (p. 102) on Kaman Aircraft Corp.'s Huskie 3 was a comprehensive description of the only U. S. medium-class twin-turbine helicopter.

It is important, however, that one statement regarding the Boeing T-60 engines which power this new aircraft be clarified. The article states that the T-60 ". . . has a power/weight ratio that compares favorably with aircraft . . . engines." This is most undeniably true because the T-60 is an aircraft engine, not a stationary engine as you mention. The T-60's 0.40 weight/power ratio, we feel, is highly competitive in the turboshaft engine field.

The T-60 started from a Navy R&D contract for a helicopter powerplant. The greatest share of the development of this engine was carried out with company funds aimed directly at the helicopter turbine engine market. The result of this investment is a 600 hp. turboshaft engine weighing 240 lb. with a 0.65 specific fuel consumption and a growth potential to more than 700 hp.

I would also like to point out that one of the major features of the T-60 is its use of single-stage components to give the engine a very real built-in reliability factor. The T-60 does not have multi-stage compressors as implied in the article. The powerplant utilizes a double-sided single-stage compressor with a pressure ratio of 6.2:1. This is undoubtedly the highest performance for any operating single-stage compressor.

Other than these two items, the Kaman Huskie 3 AVIATION WEEK coverage was, as always, authoritative, accurate and highly interesting.

A. F. HOBBS
Public Relations Representative
The Boeing Co.
Industrial Products Division
Seattle, Wash.

(Boeing's turbine family, not the YT-60 itself, had its beginning in engines for marine and industrial use.—Ed.)

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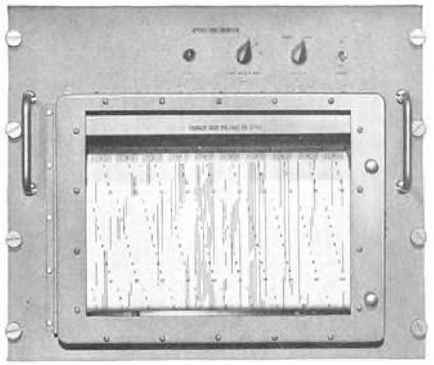

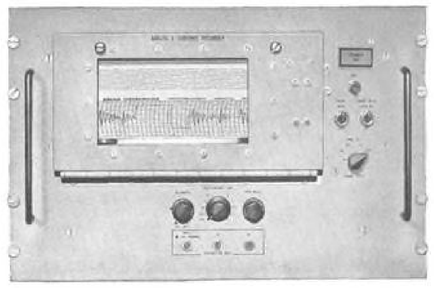

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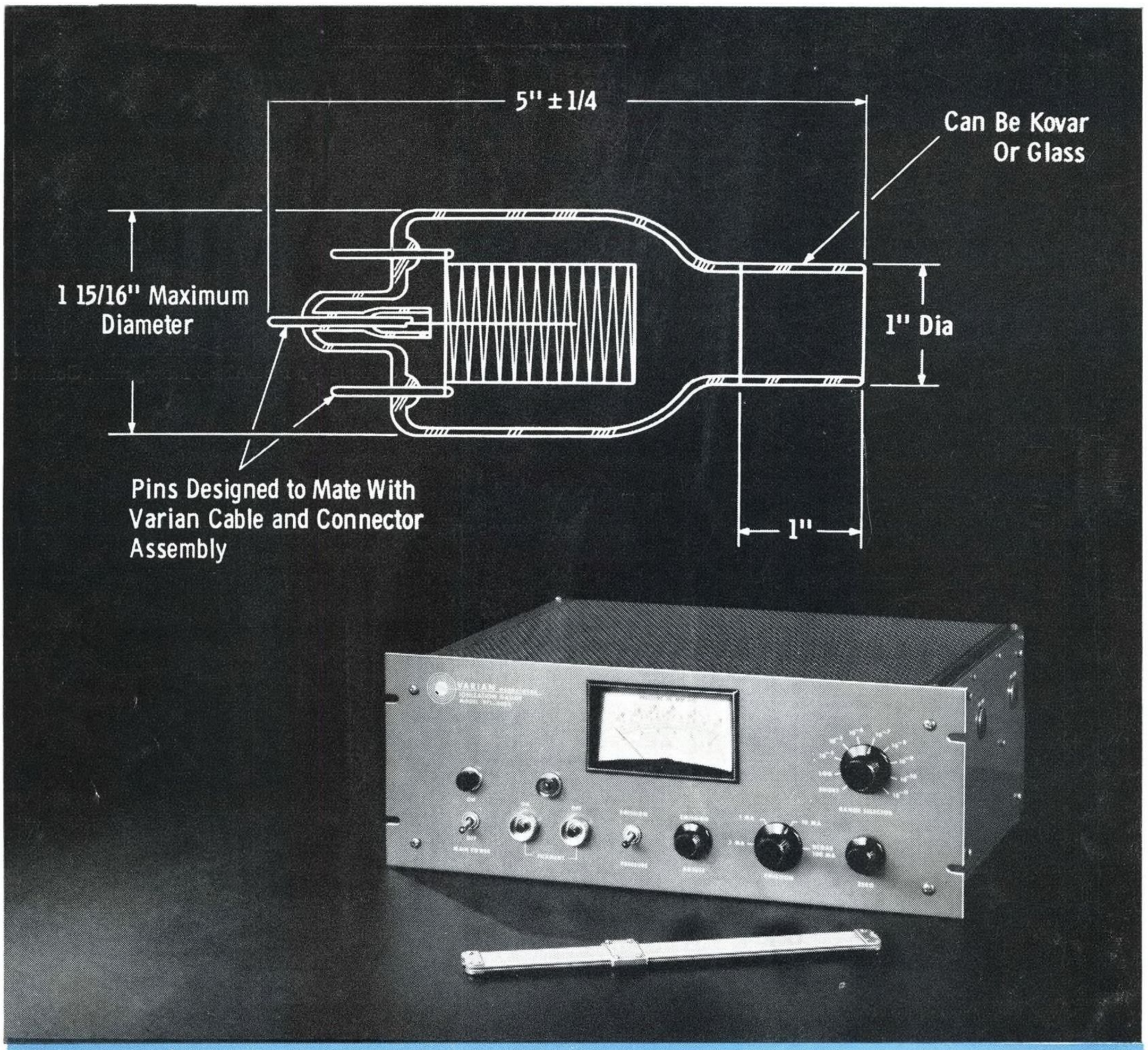

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