Aviation Week & Space Technology

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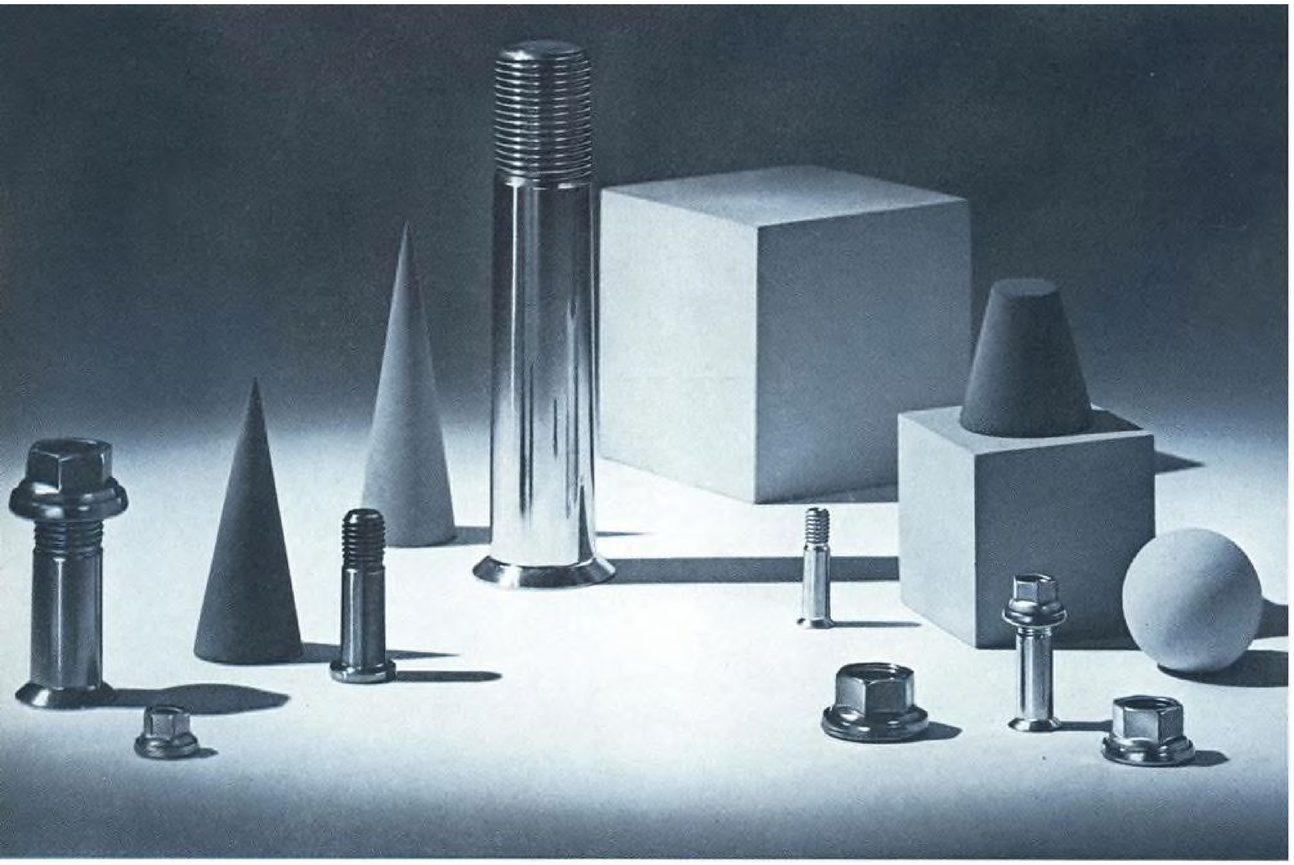
A McGraw-Hill Publication

February 11, 1963

Manned Aircraft Future Viewed By McNamara

Sperry Rand Laser Gyro





SIMPLE PROVEN GEOMETRY
COMPLEX AEROSPACE FASTENING
= **Taper-Lok® by Voi-Shan**

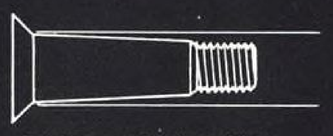
Taper-Lok, a simple self-contained structural fastener system, is now in production at Voi-Shan. It combines a tapered shank bolt and self-locking washernut.

The ground, close tolerance tapered shank bolt is pulled to an interference fit into a tapered hole by the nut, giving automatic alignment of structural members. This interference fit results in full shank bearing and uniform loading of all the fasteners used, inducing radial stresses in the adjacent structure.

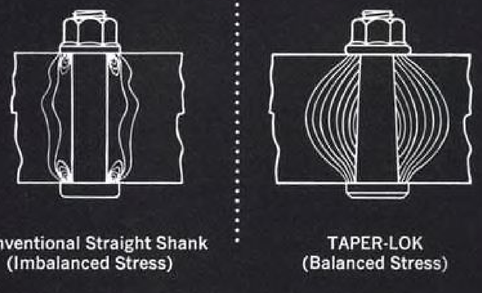
The washernut consists of a self-locking nut which spins free on a captive washer, which in turn remains stationary against the structure during installation. This unified assembly also eliminates washer handling problems.

1. Taper-Lok as a self-sealing fastener provides a positive fuel seal by its simple proven geometry.
2. It is the only fastening system carrying military approval for this type of application **without the use of a sealant.**
3. Structural joint fatigue strength is greatly increased by Taper-Lok.
4. Considerable weight saving is gained—time and labor saving also result, by elimination of sealing compounds.

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Total Taper is Relatively Slight
0.0208 inch per inch.



Conventional Straight Shank
(Imbalanced Stress)

TAPER-LOK
(Balanced Stress)

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AEROSPACE CALENDAR

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

Feb. 21-22—Western Region Conference, American Society for Quality Control, Flamingo Hotel, Las Vegas, Nev.

Feb. 26-Mar. 1—19th Annual Technical Conference, Society of Plastics Engineers, Statler Hilton Hotel, Los Angeles, Calif.

Feb. 28-Mar. 1—Government Contracts Briefing Conference, Sheraton Hotel, Philadelphia, Pa. Sponsors: Federal Bar Assn.; Bureau of National Affairs.

Mar. 3-7—Seventh Annual Hydraulics, Gas Turbine, Aviation and Space Meeting, American Society of Mechanical Engineers, Statler Hilton Hotel, Los Angeles.

Mar. 4-5—Space Age Technology Measurement Symposium, Stanford Research Institute, Palo Alto, Calif.

Mar. 4-10—Third Inter-American Symposium of Astronautics, Ibirapuera Park, Sao Paulo, Brazil.

Mar. 6-7—Disc File Symposium, Hollywood Thunderbird Inn, Hollywood, Calif. Sponsor: Informatics, Inc.

Mar. 6-8—Annual Meeting, American Ordnance Assn.'s Packaging Division, Brookley AFB, Ala. Host: Air Force Packaging Laboratories, Mobile Air Materiel Area.

Mar. 7-8—National Propulsion Meeting, AIAA/NASA Lewis Research Center, Hotel Carter, Cleveland. (Classified).

Mar. 11-13—Electric Propulsion Conference, American Inst. of Aeronautics and

(*Continued on page 7*)

AVIATION WEEK & Space Technology

February 11, 1963
Vol. 78, No. 6

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AEROSPACE CALENDAR

(Continued from page 5)

Astronautics (AIAA), Broadmoor Hotel, Colorado Springs, Colo.

Mar. 15-16—Pacific Computer Conference, Institute of Electronic and Electrical Engineers, California Institute of Technology, Pasadena, Calif.

Mar. 18-20—Space Flight Testing Conference, American Institute of Aeronautics and Astronautics (AIAA), Cocoa Beach, Fla.

Mar. 18-21—1963 Western Metal Exposition and Congress, Pan-Pacific Auditorium/Ambassador Hotel, Los Angeles.

Mar. 18-22—Spring National Convention, Society for Nondestructive Testing, Ambassador Hotel, Los Angeles, Calif.

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

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

Mar. 28-29—Fifth International Symposium on Electron Beam Technology, Hotel Sheraton Plaza, Cambridge, Mass. Sponsor: Alloyd Electronics Corp.

Apr. 1-3—Launch and Space Vehicle Shell Structures Conference, American Institute of Aeronautics and Astronautics, El Mirador Hotel, Palm Springs, Calif.

Apr. 2-3—Eighth Annual Business Aircraft Safety Seminar, Flight Safety Foundation, Barbizon Plaza, New York, N. Y.

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

Apr. 10—1963 National Value Engineering Conference. For information: Dr. David Miller, coordinator of special programs, Los Angeles State College, 5151 State College Dr., Los Angeles 32, Calif.

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

Apr. 16-18—Optical Masers Symposium, United Engineering Center, New York, N. Y. Sponsors: Polytechnic Institute of Brooklyn; Institute of Electrical and Electronics Engineers; American Optical Society; Armed Services.

Apr. 16-19—1963 USAF Aerospace Fluids and Lubricants Conference (unclassified), San Antonio, Tex. Managed by Southwest Research Institute.

Apr. 17-19—Annual Technical Meeting and Equipment Exposition, Institute of Environmental Sciences, Statler Hilton Hotel, Los Angeles, Calif.

Apr. 17-19—International Nonlinear Magnetics (INTERMAG) Conference. Institute of Electrical and Electronics Engineers, Shoreham Hotel, Washington.

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

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

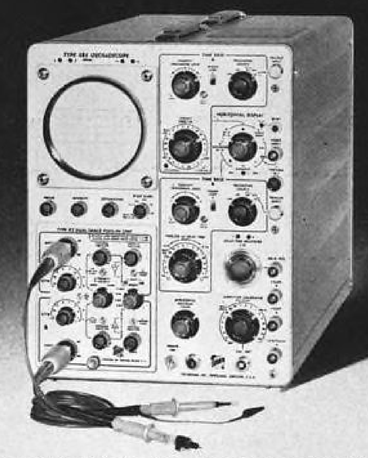
Apr. 22-23—Annual Meeting, National Aeronautical Services Assn., Washington, D. C.

Apr. 22-24—Second Manned Space Flight

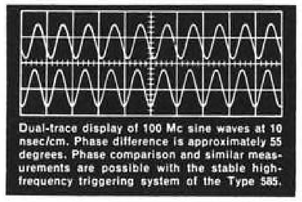
(Continued on page 9)

DC-TO-80 MC *at 10 mv/cm*
DC-TO-85 MC *at 100 mv/cm*

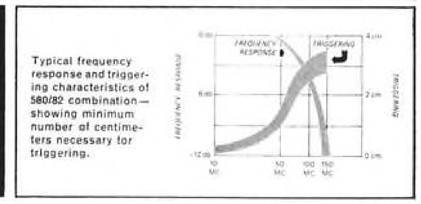
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Tektronix Type 82 Plug-In Unit in a Type 581/585 Oscilloscope



Supplied small size passive probes provide high input impedance characteristics. Probes increase input R to 10 megohms and decrease input C to approximately 7 pf. Risetime (of supplied probe, plug-in unit, oscilloscope) at over-all sensitivity of 0.1 v/cm is approximately 5¼ nsec.



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AEROSPACE CALENDAR

(*Continued from page 7*)

Symposium, AIAA/NASA, Marriott Hotel, Dallas, Tex.

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

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

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

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

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

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

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

May 2—Bioastronautics Conference, AIAA/Aerospace Medical Assn., Los Angeles, Calif.

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

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

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

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

May 7-9—Electronic Components Conference, Institute of Electrical and Electronics Engineers, Marriott Twin Bridges Motel, Washington.

May 13-15—National Aerospace Electronics Conference, Institute of Electrical and Electronics Engineers (IEEE)/AIAA, 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 Electrical and Electronics Engineers, Miramar Hotel, Santa Monica, Calif.

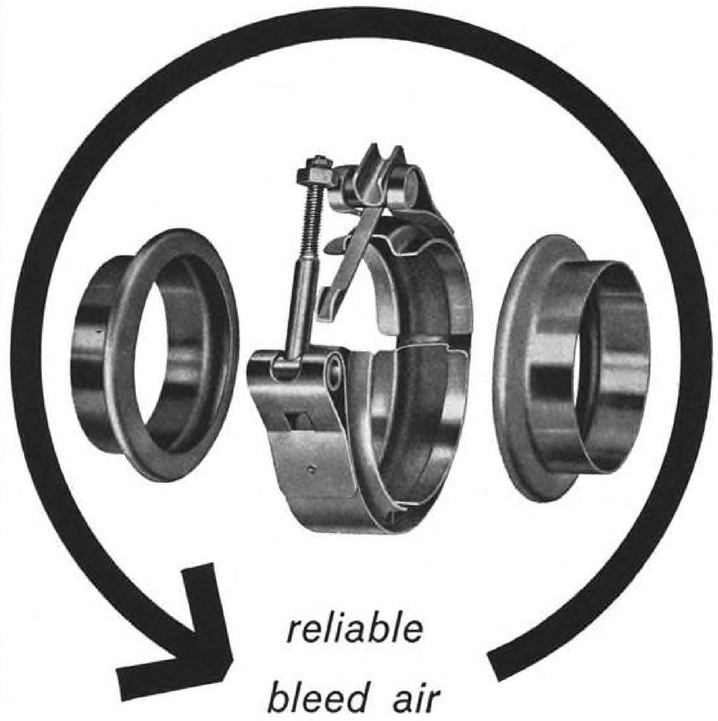
May 20-22—National Telemetering Conference, Hilton Hotel, Albuquerque, N. M.

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

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

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

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



duct couplings

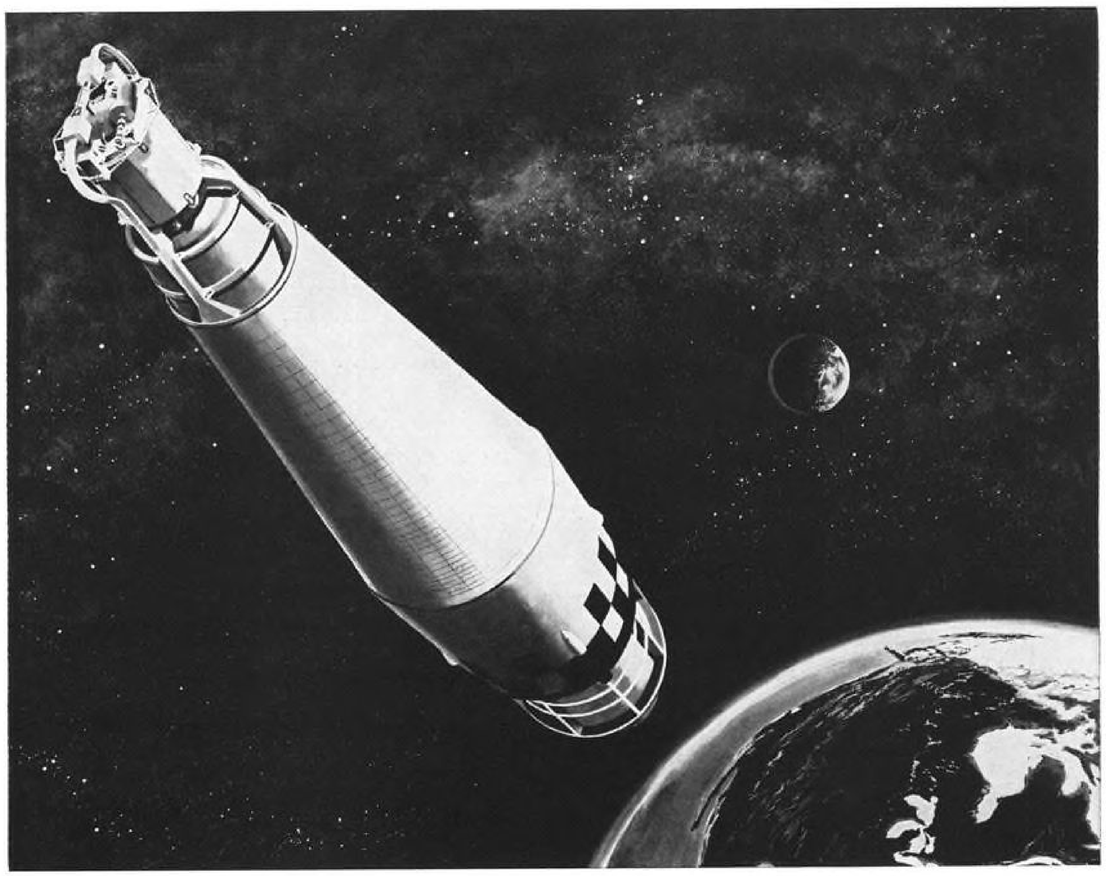
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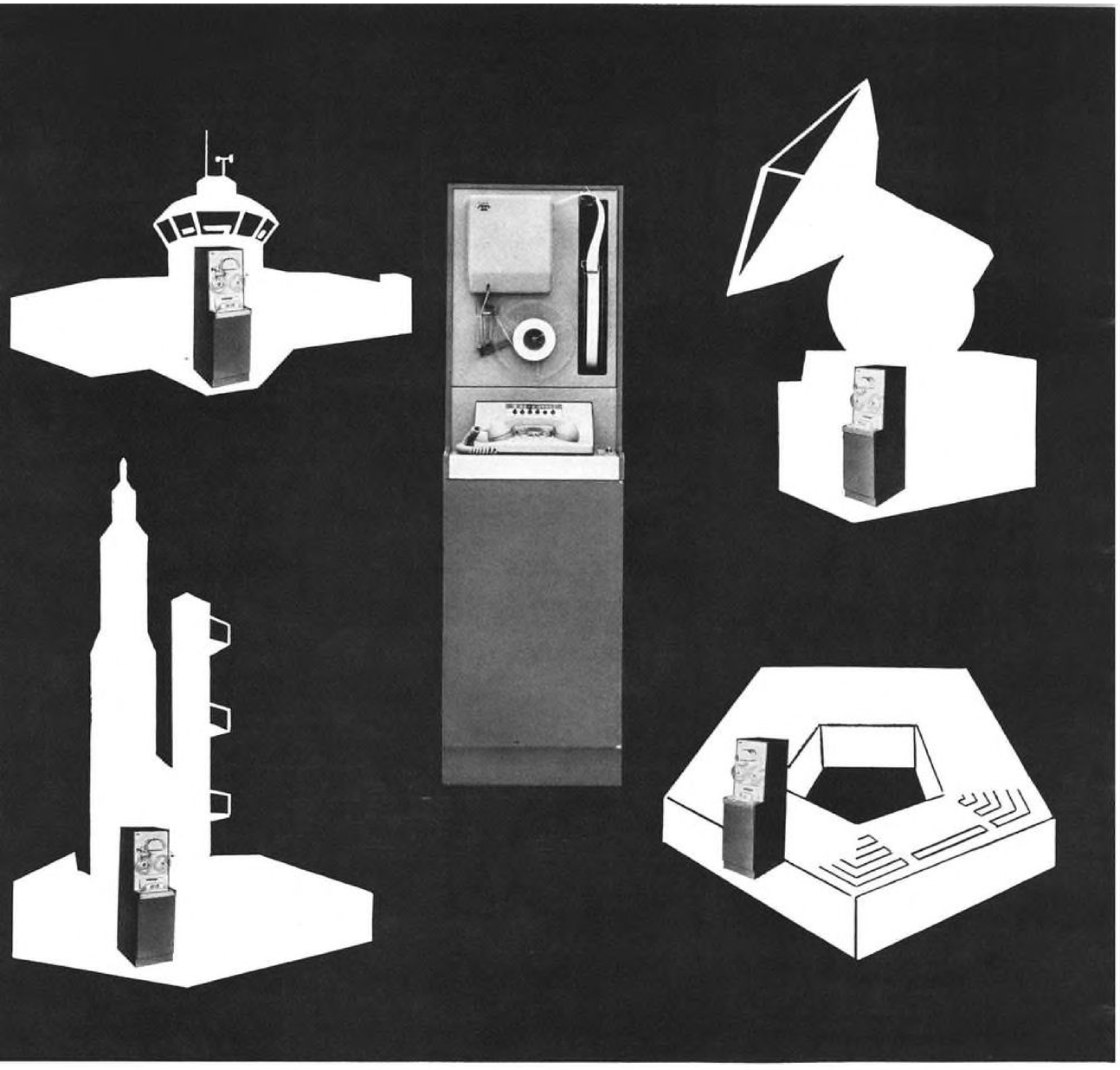
Bringing a plane down on a carrier deck calls for a lot more than an ordinary amount of strut strength. Nevertheless, the durability demonstrated here is designed into every strut we build—whether it winds up on a carrier-based fighter or a land-based bomber.

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The transmitter console includes a Teletype CX tape reader and signal serializer; the receiving console, a Teletype BRPE tape punch and signal deserializer. Facilities are provided for mounting modulating and demodulating equipment for digital-tone conversion, as well as alternate voice communication.

Applications cover a wide range of areas where volume and speed are important considerations—trunk line transmission between message centers, data collection, data distribution, data interchange, computer input and output.

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An .18-mil oxide coating (60% thinner than standard) reduces tape thickness, while polyester backings of normal thickness assure no loss in strength or change in physical properties. And the thinner coating of high potency oxides provides closer head-to-tape conformity and improved high frequency resolution in the bargain.

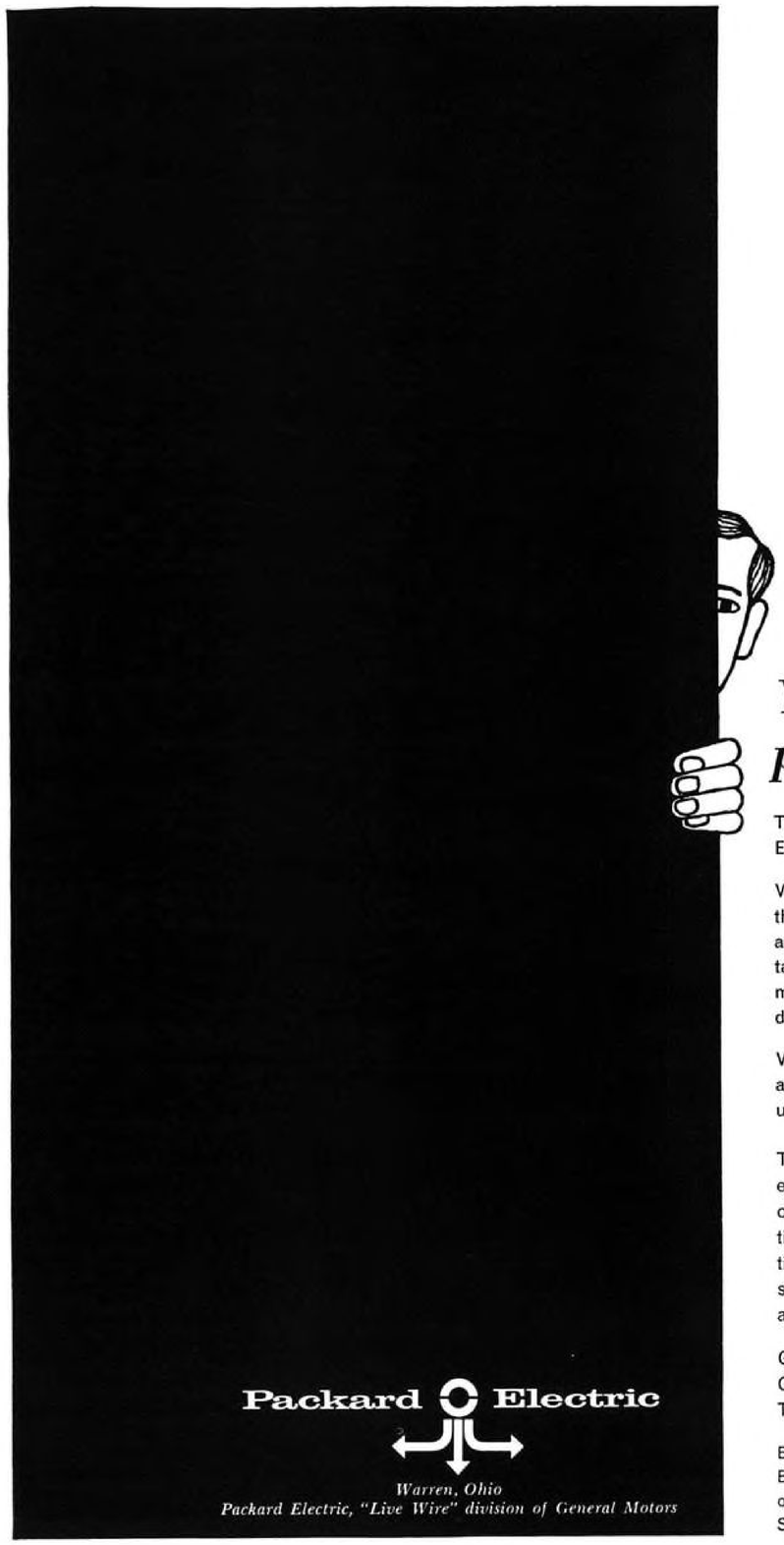


Heavy duty oxide-binder formulation shrugs off heat as high as 225°F, minimizes rub-off to assure 15 times the life of ordinary tapes. Conductivity is 1000 times that of ordinary coatings, drains off dust-attracting static. Silicone lubrication protects against head wear, extends tape life. Choice of 7 thin coat heavy duty tapes meets all high frequency and short wavelength requirements.

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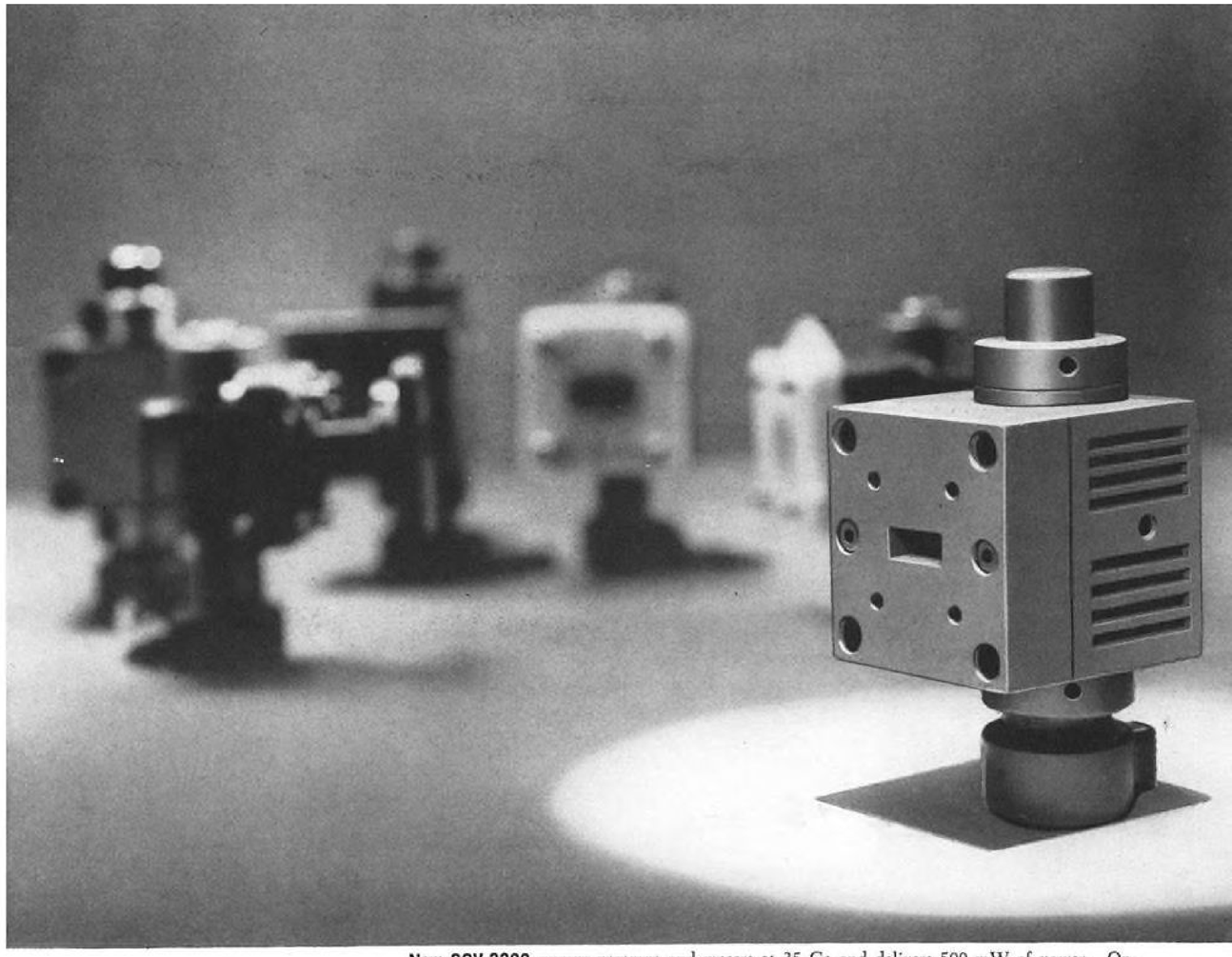
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New miniature, high-power oscillators push range to 40 Gc for paramp pumping

A new family of V band two-cavity klystron oscillators provides high power levels for parametric amplifier and maser pumping, doppler systems, and FM communications systems. These tubes cover the frequencies from 31 to 40 Gc. You now get off-shelf to 60-day delivery of two-cavity oscillators from Sperry Electronic Tube Division at any frequency from 12.5 to 40 Gc.

The unique combination of 500 mW power output at frequencies up to 40 Gc, exceptional AM stability, and small size is found only in Sperry's two-cavity design.

These Sperry miniaturized pump tubes weigh just 12 ounces—yet offer the performance formerly found only in much larger, heavier tubes.

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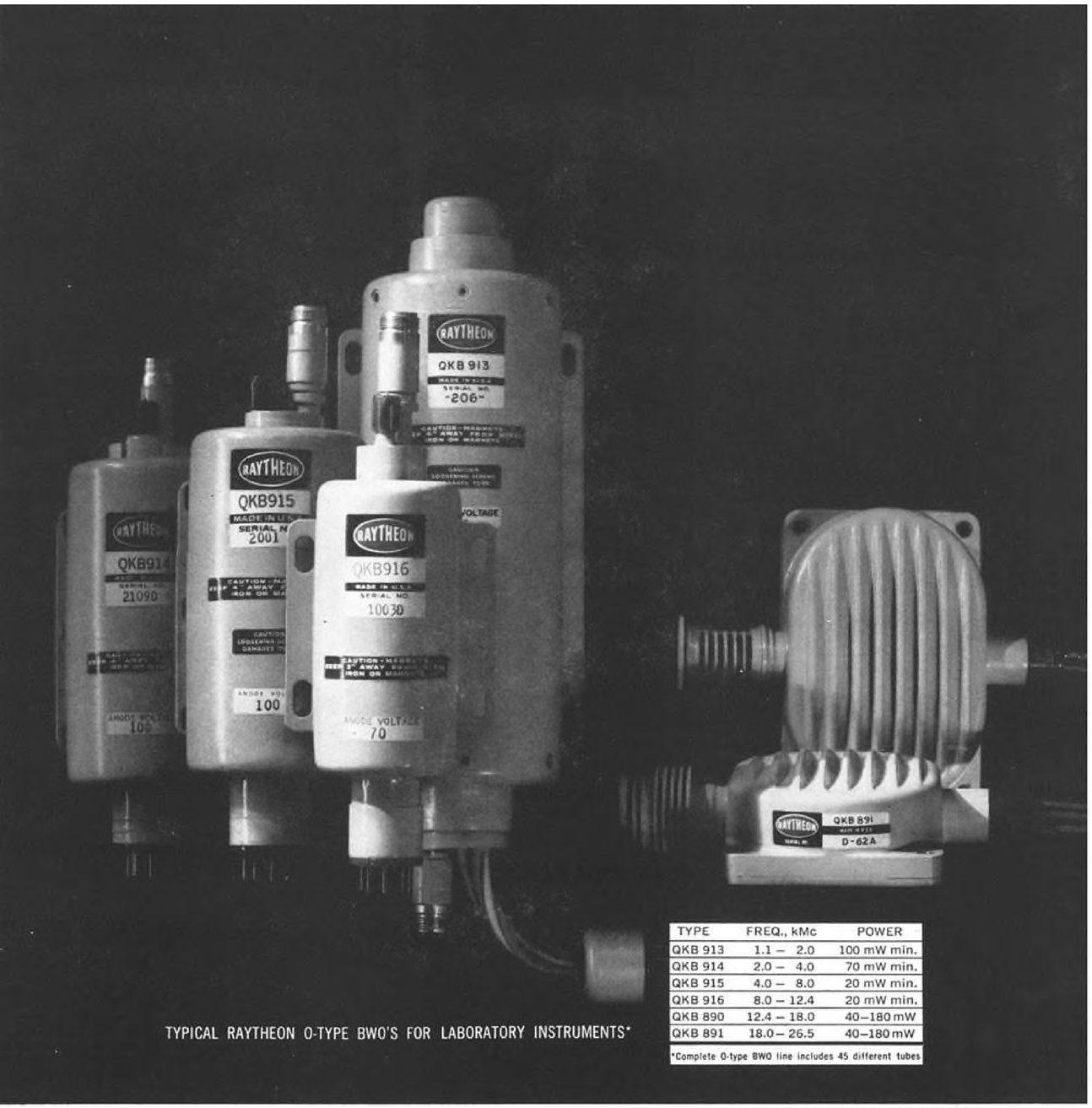
Use of two-cavity klystrons also permits considerable system simplification, since equipment such as reflector power supply, automatic power leveler, and — in most applications — automatic frequency control can be eliminated.

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TYPE	FREQ., kMc	POWER
QKB 913	1.1 — 2.0	100 mW min.
QKB 914	2.0 — 4.0	70 mW min.
QKB 915	4.0 — 8.0	20 mW min.
QKB 916	8.0 — 12.4	20 mW min.
QKB 890	12.4 — 18.0	40—180 mW
QKB 891	18.0 — 26.5	40—180 mW

*Complete O-type BWO line includes 45 different tubes

Why 3 out of 5 BWO's in new microwave signal generators are Raytheon

Certainly it's more convenient to select from Raytheon's 45 different BWO's. But most needs are met with six tubes covering 1 to 26.5 kMc (above). They're unusually compact and incorporate grids for low-voltage pulse and amplitude modulation or the application of AGC. Write for more reasons in technical data. Raytheon Co. □ Microwave and Power Tube Div., Waltham 54, Mass.

RAYTHEON

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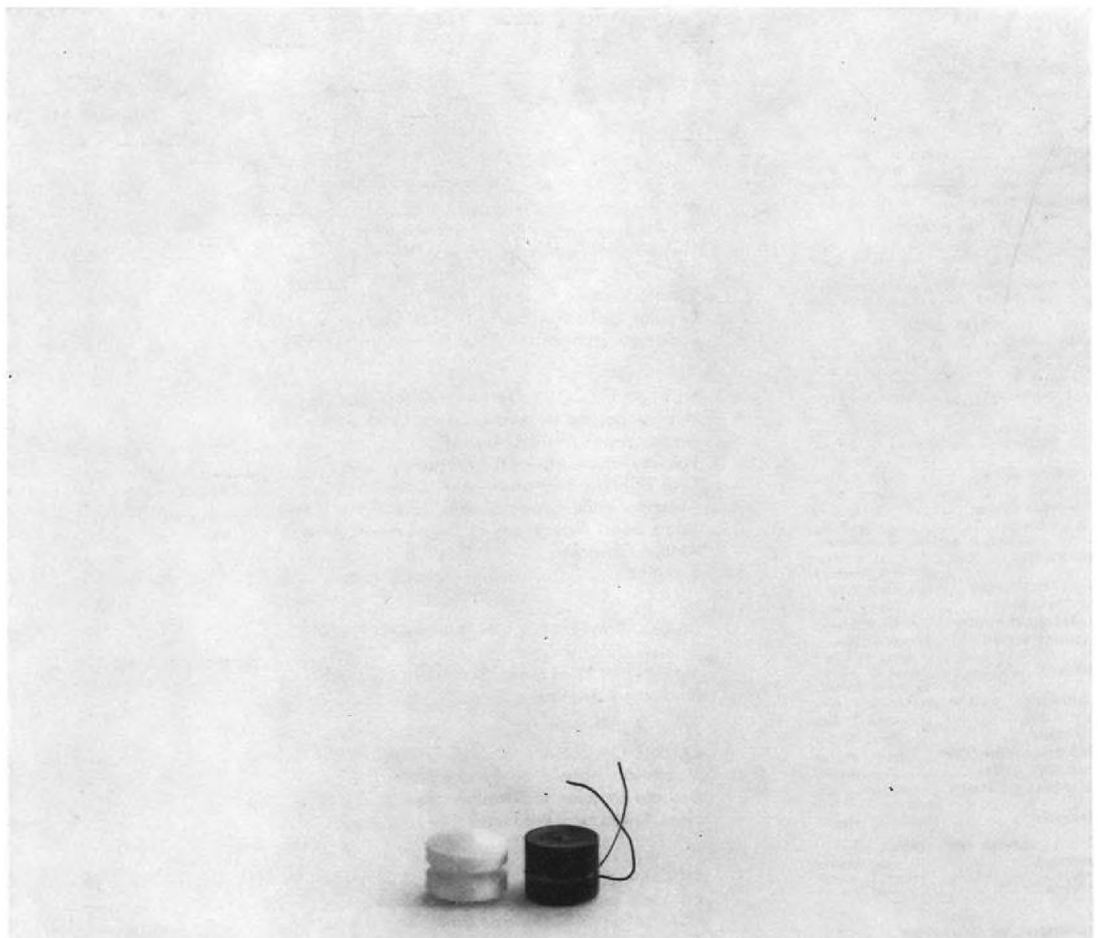
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COVER: Laser gyro, developed by Sperry Rand Co., is a radically different type of angular rotation sensor with no moving parts. It measures Doppler shift in frequency of two contrarotating laser beams circulating in an optical ring made up of four (or more) lasers and reflecting mirrors. (For other details and photos of the Sperry laser gyro, see p. 98.)

PICTURE CREDITS

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EDITORIAL

Loud But Late

Belatedly, the Kennedy Administration appears to be discovering an old axiom that the simple truth given at the time to the American people on matters that affect their safety will avoid considerable future political embarrassment. The Cuban crises from the Bay of Pigs to the Soviet MRBM deployment elicited the greatest effort by the Kennedy Administration to manage the news given to the American public so as to create the maximum favorable public image for itself by dispensing a minimum of simple truth. The fact that these efforts would eventually produce exactly the opposite of the image intended was easily predicted by virtually everybody but the participants in this flim-flam routine. It is an old story in official Washington and it always has the same sorry ending, which is one of the great virtues of the American form of government as opposed to those whose structure more readily permits concealment of facts for longer periods.

The extraordinary Defense Dept. photo-intelligence briefing at which Secretary Robert McNamara presided last week in the State Dept. auditorium (see p. 31) was pretty conclusive proof that, at least on the politically-potent Cuban situation, official secrecy and managed news have hit the Administration where it hurts. Mr. McNamara, as he always does when he feels it necessary, put on a remarkable show with his lantern slides and photo-interpreters in reviewing the Soviet military buildup in Cuba, as refracted through the camera lenses carried on some 400 aerial reconnaissance missions since last July. The photography ranged from pinpoint shots taken at 500 ft. that enabled measurement of ground objects accurately within inches, to far-ranging shutter-snapping of Soviet ships almost to the harbor mouths of their home ports. This is truly one of the most remarkable military performances in the cold war. It was not done by "whiz kids" with sharp pencils in the Pentagon. It was done by the operational military commands, by pilots, by mechanics, by phototechnicians and interpreters and by many other facets of an organization that was equipped, trained, ready and efficient when the challenge was flung to it, and the fate of this nation depended on its professional capability under fire. President Kennedy has passed out some medals and citations to some units most directly involved. But it would not be unseemly either if Mr. McNamara and his amateur strategists doffed their hats more noticeably in the direction of a vital job almost perfectly executed by military professionals both old and young.

There were some interesting lessons to be learned from the photo record of the Soviet military deployment in Cuba. First is the tremendous scope of this effort, involving, as it did, deployment of a substantial air, sea and land defensive force of missiles, ships, aircraft and armored units to secure the island as a base for launching its ballistic missiles toward the U. S. and its jet bombers toward the rest of the Caribbean.

Second was the quality of the military equipment the Soviet committed to its Cuban gamble. Almost everything that poured into Cuba between August and October was first-line Russian hardware and personnel, from the elite guards of the ground forces to the rocket regiments manning the Sandals and Guidelines and the Red Air Force pilots and MiG-21s. Only the Il-28 Beagles were second-rate equipment in the Soviet scale, although they would have been an infernal nuisance in the Caribbean area.

What was the prize Chairman Khrushchev sought from this expensive cast of his military dice after his Dec. 15 operational readiness date was reached? Fortunately, we may never know. But it must have been some extraordinary coup he envisioned to justify such a huge commitment so far out on the Soviet logistic tentacles.

Third, the speed, skill and initial deception with which this Soviet deployment was executed was a surprising rebuff to those who still denigrate the USSR technical capability and still think the Soviets are primarily peasants plodding along behind oxen and wooden plows. It should also be noted that despite the excellence of U. S. photo-reconnaissance, it did not uncover the vital first evidence of the ballistic missile deployment (AW Feb. 4, p. 23). The hairline by which the Soviets missed their gamble to present us with a fait accompli of MRBM missiles bristling from across the Florida Straits should never be forgotten. For as noted elsewhere, the six Sandal MRBM squadrons first achieved this operational readiness for a double nuclear salvo from each of their 24 launch pads on Oct. 28—six days after President Kennedy's warning to the nation and on the very day that, back in Moscow, Chairman Khrushchev decided that his gamble had failed and agreed to dismantle and withdraw the missiles, then ready to fire. It was an extremely close shave and only eyeball reconnaissance and two-legged intelligence provided the vital clues that enabled the vast photo-reconnaissance machinery to become effective.

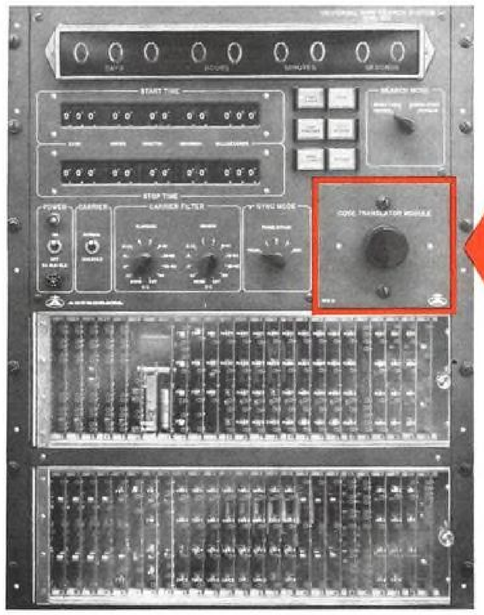
The big question raised by Mr. McNamara's show was: why was it done in February instead of a first installment the week of Oct. 22 and similar chapters as the events—withdrawal of Soviet missile and bomber forces from Cuba—unfolded? Mr. McNamara was asked that question at his briefing and replied that he felt it would have degraded the U. S. intelligence-gathering capability. This is a weak rejoinder. The primary U. S. intelligence-gathering capability as the Cuban crisis unfolded was photo-intelligence. Its use and efficiency was certainly no secret to the Soviets or anybody else. We think the answer is simply that the Administration and some of its amateur public relationists thought they could carry off their gambits without really letting the American people know what was going on. Their post-crisis efforts to leak "authorized" versions of how splendidly they behaved backfired badly until the credibility factor of top Administration spokesmen and their brothers began to deteriorate rapidly. At the same time the barrage of congressional criticism found willing ears among a public which felt it had been flim-flammed with a "managed" version of what really transpired in Cuba last fall, just as it had become certain that the authors of the Bay of Pigs invasion had used official secrecy to attempt to hide that fiasco.

It is too bad that the managed news concept undermined the Administration's public credibility factor so badly in the two Cuban episodes, because its record during the fall missile crisis is one of which it can be justifiably proud. It was a fine performance, of a character badly needed after years of supine retreat before the Communist threat. There is little to criticize in its current policy of waiting to see if the Soviet armored forces are really beginning to deploy homeward, as the initial movement of Frog missiles might indicate, before applying stronger pressures.

Cuba is still a festering sore in this hemisphere. This nation eventually will have to pay a stiff price to remove its contagion. We think the American people are willing to do what must be done to solve the Cuban problem, but they deserve more honest reporting from their leaders than they received prior to Mr. McNamara's recent briefing.

—Robert Hotz

When a new time code is introduced...

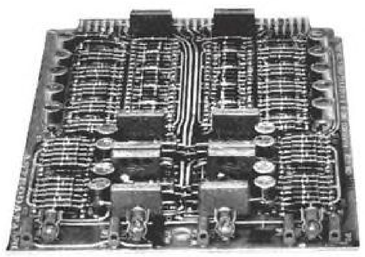


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...to forestall system obsolescence



Indicative of the MIL-type quality built into Astrodata timing equipment are the many extras carefully designed and incorporated into each system. The circuit cards, for example, are glass epoxy boards for maximum resistance to moisture and temperature; test points and indicator lights on the cards facilitate easy system checkout from the front without removing the cards. Included also are such construction refinements as strain-relief mounted components, tin immersion plated mounting eyelets, rhodium-plated connector contacts, taper pin connector contacts, "worst-case" operating tolerances for all components.

Astrodata Model 6222 Universal Automatic Tape Search System has been designed to prevent system obsolescence each time a new time code format is introduced. Circuitry common to all time code translating is built into the system—circuitry peculiar to each time code is built into individual plug-in modules.

When working with IRIG, NASA, AMR and other formats already in existence, you merely insert the appropriate plug-in module to change from one code format to another. When a new time code format is introduced, it is necessary only to add a corresponding plug-in module.

All solid-state construction, using exceptionally conservative design criteria, gives you maximum protection against downtime. More than 40 systems have been installed to date. All customers report excellent operation... names on request.

Considerable savings accrue to users because of Astrodata's years of experience in the design and manufacture of time code generation, translation, telemetry and tape search systems combined with a modular approach that permits many engineering and production economies.

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WHO'S WHERE

In the Front Office

John C. Barnes, president, Hayward Scientific Glass Co., a subsidiary of Hycon Mfg. Co., Monrovia, Calif.

Charles D. Perrine, Jr., executive vice president, General Dynamics / Pomona, Pomona, Calif. **E. R. Peterson** succeeds Mr. Perrine as vice president-research and engineering.

James S. Rice, vice president and general manager, Curtiss Div., Curtiss-Wright Corp., Caldwell, N. J.

Sidney L. Briggs, vice president-administration, General Precision's Information Systems Group, Glendale, Calif.

Cannon Electric Co., Los Angeles, Calif., has appointed the following as vice presidents: **James H. Cannon**-new products; **Paul G. Kaponya**-industrial relations; **Melvin H. Lockett**-finance. Also: **Dr. Edward Witting,** director of research and development.

Joseph J. Healy, vice president-Eastern region, Flying Tiger Line.

John R. King, executive vice president and treasurer, Rimak Electronics, Inc., North Hollywood, Calif.

Paul S. Mirabito, corporate vice president-administrative programing, Burroughs Corp., Detroit, Mich.

John M. Ward, vice president, Haveg Corp., Wilmington, Del.

B. F. Raynes, executive vice president, Rohr Corp, Chula Vista, Calif. Also: **Charles E. Cantwell,** manager, Rohr's Riverside (Calif.) plant.

John Jipp, a vice president, Precision Instrument Co., San Carlos, Calif.

Gen. Thomas D. White (USAF, ret.), formerly chief of staff, United States Air Force, has joined the staff of Sverdrup & Parcel & Associates, St. Louis, Mo., as consultant on domestic and foreign programs.

Clyde W. Kaericher, secretary and assistant treasurer, Giannini Controls Corp., Duarte, Calif., succeeding **J. Murray Wilson,** now executive assistant to the president.

Sidney Browne, technical adviser to the senior vice president for engineering-R&D, Page Communications Engineers, Inc., Washington, D. C., a subsidiary of Northrop Corp. Formerly Mr. Browne was Deputy Chief, Communications Group, SHAPE Air Defense Technical Center, The Hague.

Maj. Gen. Harry McK. Roper (USA, ret.) has retired from General Electric Co. as a consultant with the Defense Evaluation Operation.

Elmer J. Grommet, controller and treasurer, Menasco Manufacturing Co., Burbank, Calif. Also: **Edward P. Tighe,** controller, California Div., and assistant treasurer of the corporation.

F. A. Fisher, assistant vice president, Air Reduction Sales Co., with offices in Huntsville, Ala.

Brig. Gen. Tarleton H. Watkins, director, Assault Airlift, Headquarters, Tactical Air Command, Langley AFB, Va.

Air Commodore David Nigel Kington-Blair-Oliphant, vice president, Ordnance Board, War Office, Air Ministry, London.

(Continued on page 108)

INDUSTRY OBSERVER

► Air Force's Aeronautical Systems Div. last week was studying industry proposals for airborne reconnaissance subsystems evaluations program under which competitive evaluations of reconnaissance sensors will be conducted. Types of sensors to be investigated will include photographic, radar, infrared, electro-optical and passive countermeasures. Contract award will be made late this spring.

► **National Aeronautics and Space Administration plans to transmit in real time the television pictures to be taken by a slow-scan camera installed within the MA-9 capsule (AW Jan. 21, p. 59) during its 18- to 22-orbit flight, now scheduled for late April or early May.**

► High-temperature structural applications of zirconium diboride-molybdenum disilicide for leading edges of lifting re-entry vehicles have been evaluated on a small scale. Air Force's Aeronautical Systems Div. has asked industry to submit proposals by Feb. 20 for scale-up to sizes large enough for realistic evaluation to generate preliminary design data for temperatures approximating 3,500F.

► **Initial test flight of the giant Russian Ilyushin Il-62 airliner was made in mid-January with veteran Test Pilot Vladimir Kokkinaki at the controls of the aircraft.**

► Atlas Agena B vehicle has been selected to launch Biosatellite, the name NASA has given to the capsule that will carry monkeys and other biological specimens in orbit. Recoverable Discoverer-type capsule will be adapted with a life cell and environmental system. First launch is scheduled from Pacific Missile Range next year.

► **Navy is exploring development of a new type of anti-submarine warfare destroyer capable of carrying manned helicopters for attack missions.**

► Army Satellite Communications Agency has asked industry to bid on the ground-communications system for the Air Force's medium-altitude, random-orbit satellite system in a procurement separate from, but coordinated with, the recent Air Force proposal request (AW Feb. 4, p. 31).

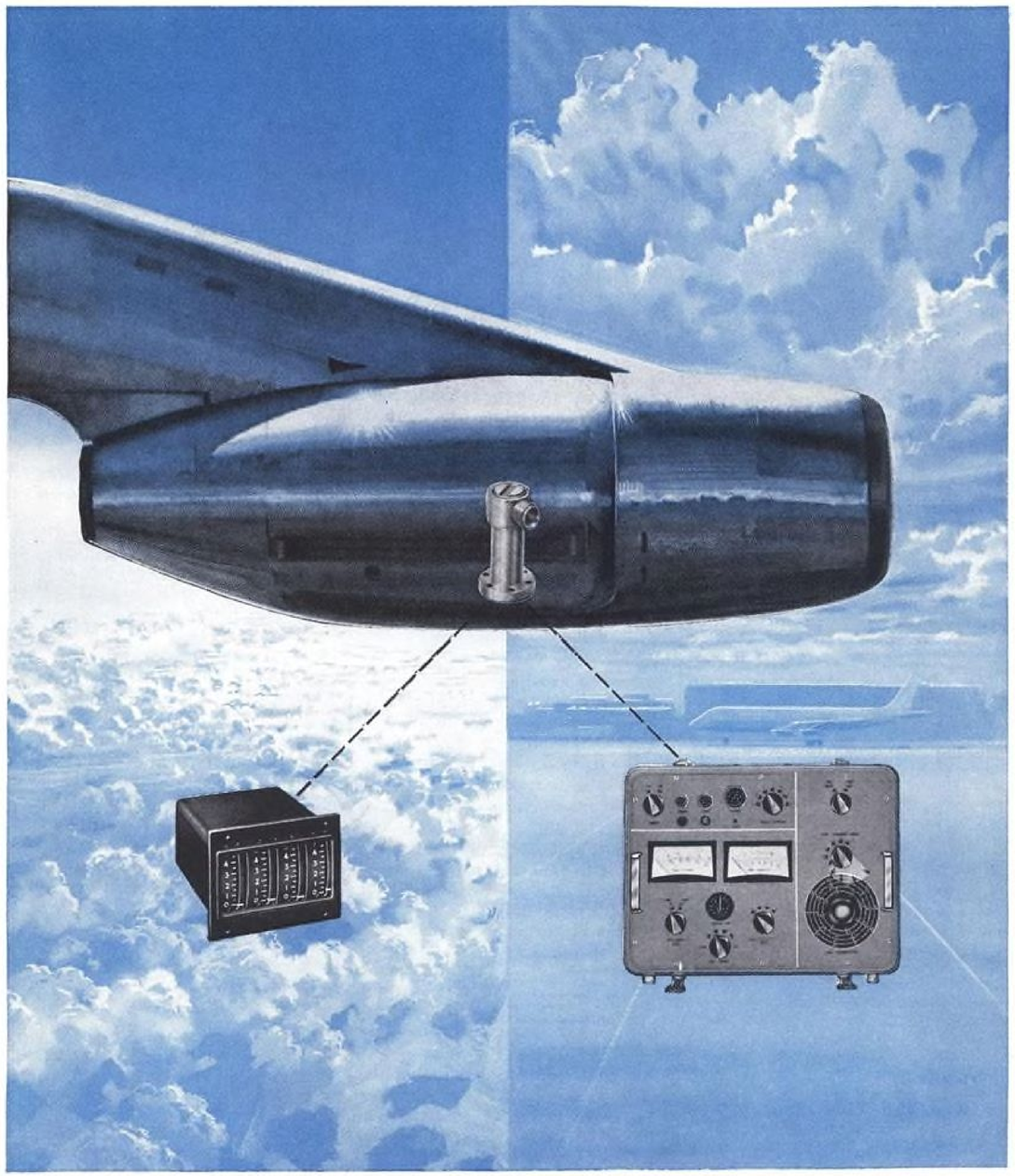
► **Plan to transfer all spare Mercury-Atlas launch vehicles from the Mercury project to Gemini has been formed within NASA. Transfer decision will not be made until after Maj. Gordon Cooper's MA-9 flight, because studies are still progressing on a three-day MA-10 mission (AW Jan. 14, p. 29). Atlas will launch the Agena B target in the Gemini mission.**

► Naval aircraft soon will take over much of the surveillance now performed on the northern reaches of the DEW (Distant Early Warning) Line by radar picket ships. Studies showed aircraft were more effective than ships patrolling the stormy waters off Greenland and Iceland.

► **Digital propellant-loading control system will be designed and built for servicing Saturn C-1 space booster stages with liquid oxygen-kerosene and liquid oxygen-liquid hydrogen. System will be required to withstand 150 db. acoustical noise over frequency range between 100 and 20,000 cps. Industry proposals for the task must be submitted to NASA's Launch Operations Center, Cocoa Beach, Fla., by Feb. 18.**

► Zero-length launch booster for the F-111 (formerly TFX) bi-service tactical fighter is tentatively scheduled to be given a pre-flight test during the middle of 1967. Booster will be mounted on the tied-down F-111 mockup.

► **Whistler propagation through the ionosphere will be investigated in an industry study to be supported by Air Force Systems Command's Rome Air Development Center. Study will seek to determine wave intensity at a receiving station after ionospheric attenuation resulting from collisional absorption in D, E and F regions, reflection losses caused by steep gradients in the refractive index, and discontinuities in the magneto-ionic duct.**



Vibration/ Cockpit Monitoring...On-the-Line Analysis. Sperry teams the Turbine Vibration Indicator (TVI) with the Turbine Vibration Analyzer (TVA) to take the guesswork out of engine vibration. In flight, the TVI continuously monitors each engine—provides the pilot, on the new vertical scale multiple indicator, with quick and positive presentation of any engine abnormality. On the ground, the TVA diagnoses the individual elements of the vibration, points out the nature and extent of any damage without the need for extensive engine tear-down. In the test cell and on the production line, too, the TVA as a performance test instrument greatly reduces lead time and costs. Write for technical data. *AIR ARMAMENT DIVISION, Sperry Gyroscope Company, Great Neck, N.Y.*

SPERRY
DIVISIONS OF SPERRY RAND CORPORATION

Washington Roundup

Navy Reorganization

Radical shakeup of the Navy's organizational structure is expected to abolish the existing "two-Navy" system. Development and procurement bureaus such as BuWeps and BuShips now report directly to the secretary along one line, while the operational and doctrinal Navy under the chief of naval operations reports along a separate line.

Chief of naval operations' office has no direct authority to tell the bureaus what to do, with the recently-created exception of the deputy chief for development, who reports to both CNO and the secretary. The new organization will resemble the staff organizations of the Air Force and Army, forming a single pyramid.

Air Force made the first move to bring its applied research, development and procurement under one roof, and logistics under another, early in 1961. It has recently modified this (see p. 34). Army combined all these functions into one command last year. In the Navy's case, however, there may be legal complications which would require congressional action.

House Space Hearings

House space committee now expects to begin its "posture" hearings about Feb. 25 to explore U.S. gains, delays and present status. Chairman George Miller told AVIATION WEEK & SPACE TECHNOLOGY he hopes to wait until NASA budget hearings begin, probably after Mar. 1, for subcommittees to make detailed examination of reprograming of funds, combustion instability problems in the F-1 engine (AW Feb. 4, p. 26), and the decision to use lunar orbit rendezvous rather than earth orbit rendezvous in the Apollo program.

Subcommittees have been reduced from four to three. Rep. Olin Teague retains chairmanship for manned flight, Rep. Joseph Karth for space science and Rep. Ken Hechler for advanced research and technology. Duties of the former applications and tracking and data acquisition subcommittee will be split between Rep. Teague and Rep. Hechler.

Deadline of Mar. 15 has been set by Douglas Aircraft Corp.'s board of directors for a decision on whether to produce the 2086 short-haul turbojet transport, to be known as the DC-9 (AW Feb. 4, p. 38). Debate on this question occupied a good part of last week's board meeting.

Soviet Views U.S. Space

Soviet Chief Marshal of Aviation Konstantin Vershinin claims that "the expenditures to be made by the Pentagon for aviation technology, rocket weapons and military cosmic means in 1965 will be respectively 30, 44 and 26% of the over-all sum to be earmarked for these types of weapons. In 1970 these amounts will be 19, 40 and 41% respectively."

Although any direct comparison is difficult, Vershinin's forecast would require a great increase in military space spending. In the Fiscal 1964 Defense Dept. budget just presented to Congress, military astronautics accounts for $1.6 billion, which is 17% of the research and development portion of the budget. Aircraft account for 10% and missiles for 31.5%. There are no space funds in the procurement expenditures portion of the new budget. Aircraft account for 37% of the procurement total, missiles for 22%.

Air Force, which openly disagrees with Army over close support aircraft types and missions (see p. 37), turned down a chance to manage the counter-insurgency (COIN) aircraft program because USAF thinking centers around faster aircraft. Navy was reluctant at first but agreed to take on the program in order to enter a new development field (see p. 35).

New Assault Helicopter

Competition for a new assault helicopter to be used in theaters such as South Vietnam is planned by Army. Specifications are still to be put into final form and requests for proposals should go to industry within a few weeks.

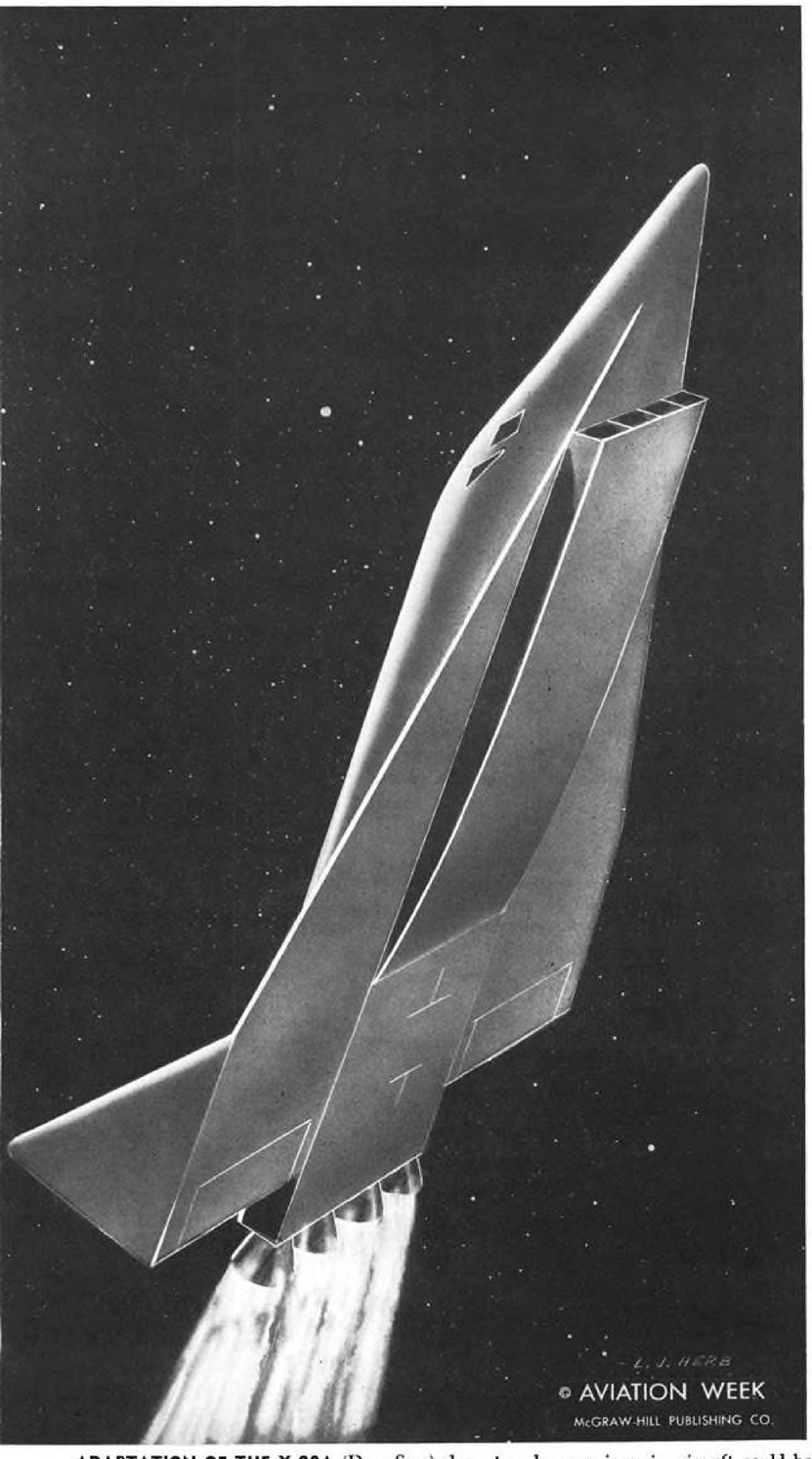
A 50-man Electronics Research Task Group was formed Feb. 8 to do the planning for NASA's proposed Electronics Research Center. The group will be located in Boston and will be disbanded when the permanent center is established, or if Congress declines to approve of the center. Some group members would remain as the nucleus of the center's staff.

Soviet Astronomer Nikolai A. Kozyrev claims to have discovered evidence of molecular hydrogen in spectrograms of gases issuing from the Aristarchus crater, the brightest spot on the moon. This "testifies to the presence of high temperatures in the interior of the moon, just as in the depths of the earth," according to Soviet reports. Prof. Kozyrev claims the first evidence of volcanic activity on the moon, based on a flare observed in the center peak of the crater Alfonse on Nov. 3, 1958.

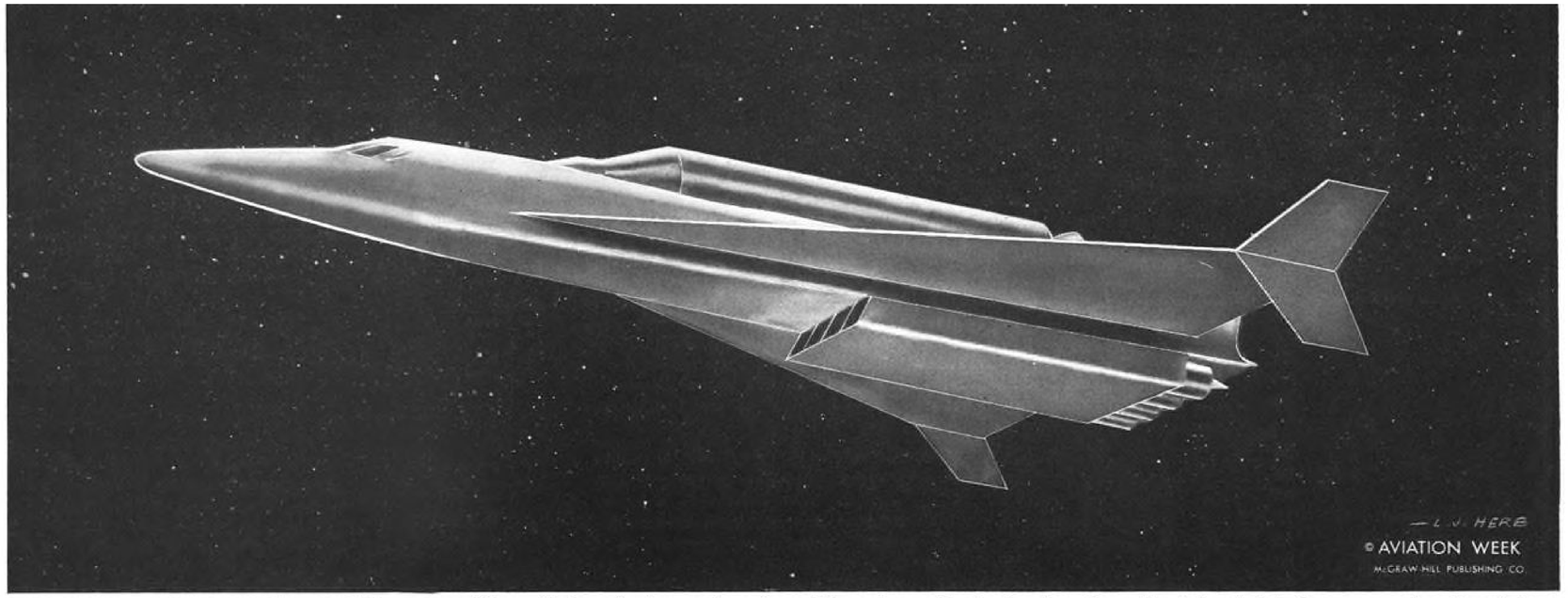
LOST in Outer Space

This week's candidate for the Longest Outer Space Title (LOST) is a member of the Defense Dept. Tripartite Technical Cooperation Program, Sub-Group M, Military Space Research. His title: Assistant to the Deputy Special Assistant to the Assistant for Space Office, Deputy Director, Research and Engineering (Tactical Warfare Programs).

—Washington Staff



ADAPTATION OF THE X-20A (Dyna-Soar) shape to a hypersonic cruise aircraft could be accomplished by installing a hydrogen-fueled ramjet engine system under the glider fuselage. Performance goals of such a system would be between Mach 6 and orbital velocity, at altitudes above 500,000 ft. Air Force and National Aeronautics and Space Administration are conducting analytical studies into hypersonic vehicles.



GENERALIZED CONFIGURATION SHOWS possible application of a hypersonic cruise vehicle system as the booster stage for a chemical rocket to ferry men and equipment to an orbiting space station. Powerplant would be a cluster of hydrogen-fueled ramjet engines with a large inlet scoop. System concept is under study by both National Aeronautics and Space Administration and USAF Systems Command's Aeronautical Systems Div. In this view, the rocket is carried piggyback and would be erected and launched from within the hypersonic vehicle.

USAF, NASA Planning Hypersonic Research Aircraft

By Edward H. Kolcum

Washington—Air Force and National Aeronautics and Space Administration have begun two-year analytical studies to determine what concepts and requirements will dictate design of the manned hypersonic aerospace research vehicle that will follow the X-20A (Dyna-Soar).

Although current work being conducted by the two agencies is largely independent, it is coordinated to the extent that research tasks in critical areas have been apportioned, joint working panels have been formed to assure rapid information exchange and a fundamental goal has been established.

The goal is to arrive at a national policy position by 1965 on whether the next generation aerospace research vehicle should be an air-breathing cruise vehicle, a single-stage-to-orbit Aerospace Plane, a combination of the two, or an entirely new concept. When this position is determined, it is expected that Defense Dept. and NASA will request substantial funding for a jointly-managed hypersonic vehicle system which will have hardware and program status.

Agreement to conduct cooperative studies into the hypersonic research vehicle area was made last November after preliminary discussions which began three months earlier. Basis of the agreement is that NASA and Air Force decided which agency will conduct system research in the broad areas of aerodynamics, propulsion, loads and structures, materials and performance tradeoffs.

These areas also are the names of the five working panels, each of which has co-chairmen from Air Force Systems Command's Aeronautics Systems Division and NASA. Team is headed by Laurence K. Loftin, Jr., of NASA's Langley Research Center, and John Balch of ASD at Wright-Patterson.

USAF hopes that the studies will determine whether a suborbital hypersonic cruise vehicle is technically necessary as a precursor to a single-stage-to-orbit Aerospace Plane. At this point, NASA believes the craft will be powered by a hydrogen-fuel ramjet engine system—not because this is the best propulsion system, but because there is not enough data available to eliminate a suborbital air-breathing vehicle as the next step.

USAF has been working on the Aerospace Plane concept for four years, and has allotted about $46 million to it through Fiscal 1963. Funding level this year is $20 million, which probably will be slightly increased in Fiscal 1964.

Although NASA is spending $1 million in Fiscal 1963 on research programs relating to hypersonic air-breathing vehicle systems, the agency feels it will be able to investigate the system in depth during Fiscal 1964, for which $5 million has been requested.

NASA's program in headquarters is managed by John B. Parkinson, chief of aerodynamics, and A. J. Evans, technical assistant for special projects, both in the aeronautical research office.

Evans said the NASA work will contribute to basic information on the feasibility of a hypersonic vehicle, performance parameters the system should have, whether it should go to orbit or cruise at high Mach numbers just below orbital velocity, and the operational need for such a system.

Parkinson pointed out that there is primary NASA interest in a hypersonic air-breathing vehicle as the first stage—actually a recoverable booster—which could launch a chemical second stage carrying a manned satellite inspector or supply payload to an orbiting space station. (See AVIATION WEEK & SPACE TECHNOLOGY drawing above). Advantages in addition to the recoverable and re-useable booster would be the ability to orient the second stage in space, thus eliminating the narrow launch window available for minimum-energy rendezvous missions. Another potential mission would be as a 10,000-mi. range cruise aircraft, he said.

Parkinson said NASA will concentrate on ramjets as propulsion systems, and that propellants have been narrowed to hydrogen and some storable fuels. Research will continue on supersonic burning, variable geometry engines, inlets and jet exhausts for these air-breathing systems. NASA plans to do a considerable portion of its work in-house at Ames, Langley, Lewis and Flight Research Center. At present, the agency is deciding whether any study contracts will be let to industry.

NASA also hopes to determine optimum abort systems, tradeoffs between horizontal and vertical takeoff and landing and similar operating aspects. Configuration of the vehicle will not be established for some time. The agency is conducting studies on generalized shapes with large cylindrical bodies, large engine inlets and large delta wings with sweeps ranging to 75 deg.

In its studies, ASD is examining five propulsion concepts and expects to phase out the ones that are less promising during the next two years.

Propulsion systems under study are air-collection devices, supersonic combustion ramjets, and turbo accelerators, which would be the first stage for a second stage chemical rocket or ramjet.

Various aspects of the Aerospace Plane are under study both at Wright-Patterson AFB and by contractors. Primary study contractors are Marquardt, General Dynamics, Linde Co., and Garrett. Additional contracts (see box) will be awarded soon.

A major problem which the two agencies expect to resolve during the next two years is whether talent and money are available to conduct research programs simultaneously for suborbital cruise and single-stage to orbit vehicles.

Hypersonic Studies

Washington—Air Force has requested proposals for configuration studies of hypersonic vehicle systems and expects to award two or three contracts this month to airframe manufacturers.

U.S. Pushes Idea of Multi-Lateral Force

By George C. Wilson

Washington—Kennedy Administration is looking beyond the international storms created by its immediate defense policies and is going ahead with long-range plans for a multi-lateral nuclear force which would bring sharp changes in the U. S. aerospace industry.

State Dept. task groups already are studying ways to implement the concept of a force drawn from several countries but serving under one command. Unlike the North Atlantic Treaty Organization structure, the multi-lateral force would not allow individual nations to recall their men and equipment once they were assigned.

President Kennedy has shifted from merely welcoming such a force to actively pushing for it. But he and other Administration leaders readily admit that implementing the multi-lateral force will be extremely difficult, especially since President Charles de Gaulle of France has shown he is determined to develop a nuclear force of his own.

But the Administration's determination to internationalize defense is clear. It follows that multi-lateral strategic forces would be supported by weapons and equipment developed and produced on a multi-lateral basis. Therefore the long-term trend is definitely toward international competition for military research and development contracts.

Negotiations over the next several months will indicate the chances of actually creating a multi-lateral force. Major question right now is who should command a multi-lateral force. Or, as State Dept. policy makers put it, how many fingers should be on the nuclear button?

Smaller countries such as Belgium, Luxembourg and The Netherlands welcome the type of protection such a force could provide but they naturally want some representation on the command structure, even though their contribution would be conventional and not nuclear weapons. Yet any representative command runs the risk of trying to fight a war by committee.

Other sticky issues are the requirements for membership in the nuclear armed force, whether such weapons as bombers should be manned by mixed crews or by nationals of the same country; the command language; the targets, and the mix of weapons.

So far, the Kennedy Administration has provided philosophic but not specific answers to these and scores of other questions raised by the multi-lateral force concept. Administration officials declare it is too early to expect specific answers. They contend that the whole matter is under study and will take months, if not years, of negotiation. Livingston T. Merchant, former assistand secretary of state for European affairs, was called out of retirement to work toward implementing the multi-lateral concept. He has been consulting with U. S. and foreign military officials as part of the effort.

Basic rationale for the multi-lateral force is that the time has come to go beyond NATO and build a truly united Western force. Kennedy Administration argues that it makes no sense for other countries to duplicate the expensive development work already done by the U. S. on nuclear weapons. Instead, other nations should supply conventional forces and rely on the U. S., Britain and France for missiles and other nuclear arms.

Such a unified force has been discussed for years but the impetus for the U. S. to implement it came during the Nassau talks Dec. 18-21 between President Kennedy and Prime Minister Macmillan. The formal statement after those talks focused on the U. S. offer to supply Britain with Polaris missiles, without nuclear warheads, to supplant the USAF-Douglas Skybolt missiles which originally were slated for British Vulcan bombers (AW Dec. 24, p. 21).

But Administration leaders went beyond this in a background press conference. They said the Nassau agreement was of "immense importance" and would help achieve these four major objectives of the Kennedy Administration's nuclear policy:

- **"Clear recognition"** that strategic nuclear war is indivisible.
- **Prevention of both** the further spread of nuclear weapons and further development of independent national nuclear forces.
- **Recognition that nuclear forces** cannot deter all forms of political and military aggression and therefore conventional forces continue to be needed.
- **"Institutional arrangements** for greater cohesion in the Western world."

Nuclear Policy

The U. S. and British governments devoted only a 1½-page communique, issued last Dec. 21, to the explanation of how the Nassau agreement affected nuclear policy.

Paragraph 9—one of the few clear paragraphs—states that nuclear war is indivisible in this wording:

"The President and the Prime Minister are convinced that this new plan will strengthen the nuclear defense of the Western Alliance. In strategic terms this defense is indivisible, and it is their conviction that in all ordinary circumstances of crisis or danger, it is this very unity which is the best protection of the West."

The confusing paragraphs relate to the assignment of nuclear forces to NATO. Paragraph 6 states that both the U. S. and Britain might assign part of their strategic and tactical nuclear forces to NATO immediately. But these forces still would be subject to recall from NATO by the U. S. and Britain. Therefore, such nuclear forces would bolster NATO but they would not fulfill the concept of a multi-lateral force that serves under one command.

Paragraph 7 of the communique said the U. S. agreement to supply Britain with Polaris missiles, without nuclear warheads, should be considered as a step toward a truly multi-lateral Western force. The language: "Returning to Polaris, the President and the Prime Minister agreed that the purpose of their two governments with respect to the provision of the Polaris missiles must be the development of a multi-lateral NATO nuclear force in the closest consultation with other NATO allies. They will use their best endeavors to this end."

Paragraph 8 requires the U. S. to supply Polaris missiles, less warheads, to Britain "on a continuing basis" and states the U. S. "will also study the feasibility" of providing support facilities for the Polaris submarines Britain will build. The resulting U. S.-British Polaris submarine fleet would be assigned to NATO under the agreement. Further, this fleet would be assigned to the future multi-lateral force if it is formed.

While negotiations for a multi-lateral force are in progress, the Nassau agreement pledges that British Polaris forces will be considered as part of the West's defense—not Britain's alone. The language: "The Prime Minister made it clear that except where H. M. G. (Her Majesty's Government) may decide that supreme national interests are at stake, these British forces will be used for the purposes of international defense of the Western Alliance in all circumstances." State Dept. officials insist the "supreme national interests" escape clause does not alter the U. S.-British commitment to develop an international force.

Thus the assignment of U. S. and British nuclear forces to NATO at this time is designed to pave the way for the formation of a truly multi-lateral NATO force later. The case for a multi-lateral force was argued in several Administration speeches as long as six months before the Nassau meeting. The following excerpts from these speeches help explain why the Administration is fighting so hard for a multi-lateral force in spite of the controversies swirling around even its present nuclear policies (see p. 30):

- **Defense Secretary Robert S. McNamara** at the University of Michigan June 16, 1962 ". . . Relatively weak national nuclear forces with enemy cities as their targets are not likely to be sufficient to perform even the function of deterrence. If they are small, and perhaps vulnerable on the ground or in the air, or inaccurate, a major antagonist can take a variety of measures to counter them. Indeed, if a major antagonist came to believe there was a substantial likelihood of it being used independently, this force would be inviting a pre-emptive first strike against it.

"In the event of war, the use of such a force against the cities of a major nuclear power would be tantamount to suicide, whereas its employment against significant military targets would have a negligible effect on the outcome of the conflict. Meanwhile, the creation of a single additional national nuclear force encourages the proliferation of nuclear power with all of its attendant dangers.

"In short, then," McNamara said, "limited nuclear capabilities, operating independently, are dangerous, expensive, prone to obsolescence and lacking in credibility as a deterrent. Clearly, the United States nuclear contribution to the alliance is neither obsolete nor dispensable."

Military Targets

The nuclear strategy of striking at the enemy's military targets rather than cities "magnifies the importance of unity of planning, concentration of executive authority and central direction. There must not be competing and conflicting strategies to meet the contingency of nuclear war," McNamara said.

"We are convinced," McNamara continued, "that a general nuclear war target system is indivisible, and if, despite all our efforts, nuclear war should occur, our best hope lies in conducting a centrally controlled campaign against all of the enemy's vital nuclear capabilities, while retaining reserve forces, all centrally controlled.

"We know that the same forces which are targeted on ourselves are also targeted on our allies. Our own strategic retaliatory forces are prepared to respond against these forces, wherever they are and whatever their targets. . . . The character of nuclear war compels it. . . . We have undertaken the nuclear defense of NATO on a global basis. This will continue to be our objective . . . We want and need a greater degree of alliance participation in formulating nuclear weapons policy

Macmillan Upheld on Polaris Accord

London—Censure move by the opposition Labor Party on the British government's defense policies—centering on the much disputed Nassau Polaris agreement with the United States—was defeated in Parliament by a vote of 330 in favor of Polaris and 236 against.

An intense debate brought out these major points:

- British Polaris submarines will be entirely manned by Royal Navy crews, under control of the British government to maintain the policy of a completely independent deterrent.
- Britain will pay no research and development charges on Polaris A-1 and Polaris A-2 versions, but has agreed to a 5% surcharge on Polaris A-3 as its R&D contribution (AW Feb. 4, p. 37).
- President Kennedy offered to share Skybolt development costs with Britain, if the nation saw fit to continue with the missile, but emphasized that the U. S. would not buy any Skybolts from Great Britain. The offer was declined, according to Prime Minister Harold Macmillan, because of Britain's limited resources and because of the need to work through an American company on a weapon for which the U. S. armed forces had no use.
- Hound Dog was offered as a weapon for the Royal Air Force V-bombers, but this weapon was turned down primarily because construction of the V-bombers made utilization impracticable.
- Since 1948, Great Britain has spent $2.8 billion on maintenance of its independent nuclear deterrent. Total figure includes research and development, capital cost of the V-bomber force—about 180 aircraft—their weapons and the country's contribution to the Thor missile bases, now being phased out of service. Minister of Defense Peter Thorneycroft admitted, however, that the total figure included costs of Blue Streak, now in limited development as a space booster, and Blue Water tactical missile, which was canceled.

Another important factor revealed in the debate is that Britain will assign the V-bomber force to NATO if the government can negotiate a "satisfactory" agreement with the other allies. At present, Bomber Command is working out details with the Strategic Air Command.

As Thorneycroft put it:

"We would keep the V-bombers in British Bomber Command. That is important for its morale, discipline and above all for its fighting efficiency, but there is much discussion taking place in NATO about the control system and details of assignment. I do not wish to prejudge that."

Thorneycroft charged that the opposition Labor Party is against a British deterrent, and added:

"Some oppose even American bases here, and for this they are prepared to give up an independent foreign policy, to leave France the only nuclear power in Europe, to fade out the V-bombers and cancel Polaris."

Leading the attack on the government, Labor's defense spokesman, Patrick Gordon-Walker, estimated the cost of 100 Polaris missiles—the number needed for four or five submarines planned by the government—at about $140 million. The submarines, he contended, would cost about $980 million. Adding to the deterrent cost, Gordon-Walker said, is development of the TSR-2 tactical strike fighter, which he said was about $1 billion.

Gordon-Walker said that he thought the Polaris submarine today is the least vulnerable weapon, but claimed that no weapon is immune to counter forces.

"The United States is already thinking of a weapon system to replace Polaris altogether. With this long process ahead of us, we may well find that when we get them, or soon after we get these weapons, they will be already far advanced toward obsolescence and that new and infinitely more expensive alternative systems are being worked out . . ."

Despite the defeat of the opposition's censure motion, the British government will be faced with another important defense issue later this month, when the White Paper on defense for 1963 is published.

This is followed by funding allocations for the three services, all open to debate in Parliament.

Mirage Pilot Training

Paris—Fourth preproduction Dassault Mirage 4A twin-jet strategic bomber made its first flight on Jan. 23 and French air force announced it had begun pilot training on the initial Mirage bomber prototype which first flew in June, 1959.

First flight of Mirage 4A-04 marks the completion of the preproduction program. Initial deliveries of 50 Mirage bombers will begin late this year. French air force expects to be fully operational with its Mirage bomber fleet by mid-1965 (AW Jan. 14, p. 30).

to the greatest extent possible. We would all find it intolerable to contemplate having only a part of the strategic force launched in isolation from our main striking power."

• **President Kennedy** in Philadelphia last July 4—"We do not regard a strong and united Europe as a rival but as a partner. To aid its progress has been the basic objective of our foreign policy for 17 years.

"We believe" Kennedy said, "that a united Europe will be capable of playing a greater role in the common defense, of responding more generously to the needs of poorer nations, of joining with the United States and others in lowering trade barriers, resolving problems of currency and commodities and developing coordinated policies in all other economic, diplomatic and political areas. We see in such a Europe a partner with whom we could deal on a basis of full equality in all the great and burdensome tasks of building and defending a community of free nations . . . building the Atlantic partnership will not be cheaply or easily finished.

But I will say here and now on this day of independence that the United States will be ready for a declaration of interdependence—that we will be prepared to discuss with a United Europe the ways and means of forming a concrete Atlantic partnership, a mutually beneficial partnership between the new union now emerging in Europe and the old American union founded here 175 years ago."

• **McGeorge Bundy,** special assistant to the President, before the Atlantic Treaty Assn. at Copenhagen, Denmark, last Sept. 27—". . . Behind the general failures named appeasement, how often in the 1930s it was a narrow suspicion of the wrong people that became the immediate cause, or excuse, for inaction—the Italians mistrusting the French, the French mistrusting the British, the British mistrusting the Czechs, Mussolini mistrusting everyone until in a final irony he was the last to try trusting Hitler. This detailed record of the follies of nations which tried to act alone carries a deeper lesson than simply the warning against appeasement. And that lesson is that already in the 1930s no foreign nation could serve itself well if it tried to serve itself alone. . . . A third lesson from the 1930s is that governments without courage can be expected at critical moments to take wrong decisions which they will defend on grounds of domestic political necessity. . . .

"It would also be wrong," Bundy said in discussing U.S. nuclear policy, "to suppose that the reluctance which we feel with respect to individual, ineffective and unintegrated forces would be extended automatically to a European force, genuinely unified and multilateral, and effectively integrated with our own necessarily predominant strength in the whole nuclear defense of the alliance."

Bundy then added a statement which President Kennedy has since contradicted by pressing hard for a multilateral force.

"We ourselves," Bundy said, "cannot usurp from the new Europe the responsibility for deciding in its own way the level of effort and of investment which it wishes to make in these great matters."

Defense Policy Topples Canada's Leaders

Ottawa, Canada—New defense policy for Canada was probable last week when a coalition of opposition parties ousted the Conservative government headed by Prime Minister John Diefenbaker amid charges that he failed to fulfill nuclear arms commitments to the Western alliance.

The Social Credit and the New Democrats joined the Liberal Party and passed an amendment on a 141-to-111 vote which said the Conservative government had lost the confidence of the people because of its wavering and confusing defense policy.

Before the vote on Feb. 5, Defense Minister Douglas Harkness resigned because of what he called "irreconcilable" differences with Diefenbaker. Harkness had urged that Canada accept nuclear warheads from the U.S. for North American Air Defense and North Atlantic Treaty Organization forces (AW Feb. 4, p. 37).

The controversy over Canada's defense policy erupted into a national issue after the U.S. State Dept. issued a press release which traced negotiations for supplying nuclear warheads to Canadian forces. The release said two Boeing Bomarc B anti-aircraft missile squadrons were deployed to Canada in 1962. However, the Canadian government never agreed to accept nuclear warheads even though the Bomarc B is useless without them.

State Dept. also said the Canadian government has not proposed "any arrangement sufficiently practical to contribute effectively to North American defense" nor has it agreed to accept nuclear arms for its NATO forces.

Diefenbaker agreed in 1958 to accept Bomarcs after cancelling the Avro CF-105 Arrow program partly on grounds that manned interceptor aircraft were obsolete. In 1959 Canada also agreed to modernize its NATO force with Canadian-built Lockheed F-104G strike-reconnaissance fighters, which further committed Canada to accepting nuclear weapons.

The first of eight Canadian reconnaissance-strike NATO squadrons of CF-104Gs is stationed at Zweibrucken, Germany. But the aircraft are not operational since they are not armed with nuclear weapons. They are flying only with camera pods since no provision was made in the CF-104Gs for conventional armament.

Also at issue is whether Canada should accept nuclear missiles for its 66 McDonnell F-101B Voodoo jet interceptors. The aircraft had been flown by the USAF armed with Douglas MB-1 Genie nuclear-tipped missiles but were equipped with Hughes Falcon missiles with conventional warheads for Canadian use.

Diefenbaker assailed the U.S. for intruding in Canada's affairs and declared such recent events as the Nassau agreement justified a review of his country's defense policies. He said the U.S. cancellation of the Douglas Skybolt indicated Canada's Bomarc's were of questionable value.

But these and other arguments failed to stave off the no-confidence vote. Elections will be held Apr. 8. The principal issue appears certain to be the role Canada should play in the Western alliance, with emphasis on the question of accepting U.S. nuclear warheads. The nuclear weapons issue brought these developments in other nations:

• **France.** President de Gaulle said last week that Britain's decision at Nassau to combine its defense with that of the U.S. rather than Europe was a major reason for France's opposing Britain's entry into the Common Market. De Gaulle said British Prime Minister Macmillan had told him in December that Britain and France should "unite our forces and put everything together." British diplomatic sources denied this.

• **West Germany's** role in the defense of Europe was the subject of much concern in both the East and West because of the defense treat recently signed with France. Moscow attacked the treaty and warned in a note to both nations that nuclear armament of West Germany would be considered a threat to the Soviet Union. At the same time, West Germany assured the U.S. that the new alliance would not lessen West Germany's participation in NATO.

Extent of Cuban Missile Threat Revealed

Washington—Soviet Sandal medium-range ballistic missile squadrons were at operational readiness, capable of firing a double salvo of nuclear warheads at U.S. targets from 24 launch pads in Cuba, on last Oct. 28—the day that Chairman Nikita Khrushchev informed President Kennedy he would order them dismantled and removed from that island—U.S. Defense Dept. officials revealed here last week during an extraordinary two-hour photo-intelligence briefing.

The briefing by Defense Secretary Robert S. McNamara and John Hughes, special assistant to Defense Intelligence Agency Director Lt. Gen. Joseph Carroll, was aimed at answering congressional critics of the Administration's Cuban policy, who charged that Soviet military strength in Cuba is increasing.

Six squadrons of Soviet mobile Sandals were completely operational for the first time on Oct. 28, although they achieved their first limited capability with a single squadron operating under field conditions on Oct. 14 at San Cristobal in western Cuba.

U-2 Photos

The first deployed Soviet Sandal squadron was photographed by a USAF-Lockheed U-2 near San Cristobal early on the morning of Oct. 14. Its initial deployment indicated the Sandals had arrived either late the previous day or during the night, but were already capable of a single-strike salvo from temporary positions. Other U-2 high-altitude photo coverage later on Oct. 14 revealed two other Sandal squadrons deploying in the San Cristobal area, one still on the road with its convoy of missile trailer-erectors, fuel and oxidizer vehicles, nose cone vans and troop transports, and another fanning out into the area where it later built a permanent-type firing base.

By Oct. 28, the Soviet missile troops had six sites operational, including four in the San Cristobal area in western Cuba and two at Sagua La Grande in central Cuba. Each of these squadrons had four concrete launch pads, permanently-sited guidance gear, nuclear warhead storage facilities and revetted vehicle parks for fueling trucks, oxidizer trailers, nose cone vans, and missile checkout tents. They were equipped with two Sandals for each pad, giving them a second strike capability.

Interpretation of the low-level oblique photos taken of the sites revealed that the Sandal missile first seen in the Moscow armed forces day parade of 1961 was 70.3 ft. long, of which the booster section measured 59.6 ft. and the nose cone, transported separately in special vans, 10.7 ft. Missile diameter at the tail was 5.4 ft. Defense Dept. still credits this missile with a range of 1,100 naut. mi., although pre-Cuban assessment of its range was between 500 and 700 naut. mi. The Sandal was deployed in Cuba on the same type trailer-erectors on which it was hauled through Red Square in the Moscow parades. DOD officials said flatly that the Sandal squadrons were equipped with nuclear warheads in Cuba during the October crisis.

Soviet target for operational readiness of the four planned IRBM sites in Cuba was Dec. 15, according to Defense Dept. officials. Three of the sites were nearly completed by Oct. 28, two at Guanajay in western Cuba and one at Remedios in central Cuba. A fourth site was planned for Remedios, but construction was never started. Each of the IRBM sites was to be equipped with four launch pads with a double strike capability of two missiles for each pad.

Five Soviet ships loaded with IRBMs and their related equipment were on the way to Cuba on Oct. 23 when the U. S. blockade was announced. They were among the 18 Soviet ships that turned back to Soviet ports after that date. The only IRBM support equipment actually spotted in Cuba were special fueling trailers, although guidance installations, launch pads and nuclear warhead storage facilities were under construction.

After Oct. 23, Soviets reacted to USAF and Navy low-altitude photo cover of specific missile sites already spotted by high-altitude U-2 coverage by installing radar-controlled mobile 57 mm. anti-aircraft batteries around the sites. They also attempted to conceal and camouflage missiles, fuel trucks, warhead storage areas, power generators and guidance installations. Defense Dept. officials indicated these moves were ineffective, and displayed pictures taken from a photo plane showing Soviet troops running toward their guns while the plane was already pulling out of range.

U. S. has admitted loss of only a single U-2 during the Cuban operations. It was hit on a high-altitude mission by an SAM-2 Guideline missile credited with an 80,000-ft. altitude capability and a 30-mi. slant range. Soviets still have 24 Guideline sites with six launch pads each and a total of 500 missiles in Cuba, giving almost complete coverage of the island. DOD said more than 400 photo sorties have been flown over Cuba since last July.

First indication that the Soviets would withdraw their missiles from Cuba was revealed by photo reconnaissance on Oct. 29 at San Cristobal, where the missile-erectors had been moved from their positions next to the firing rings and flame deflectors into a storage area. By Nov. 1, the last of the six Sandal sites was being vacated at Sagua La Grande and photos showed the final Soviet convoy pulling out.

By Nov. 9, photos of IRBM sites showed their concrete launch pads also broken up, power and guidance cable trenches filled in and the concrete control bunkers leveled. Both Sandal and IRBM missile troops and construction units were followed along their roads back to Cuban ports by photographic coverage several times a day, and the ships carrying the missiles were photographed at sea regularly.

Soviet Il-28 Beagle bombers and Mascot trainers were deployed at San Julian airfield at the western tip of Cuba and Holguin in northeast Cuba. Main activity was at San Julian, an established permanent base, where 33 Beagles and Mascots were delivered in crates and seven eventually assembled in flyable condition. Four of these seven planes were Mascot trainers evidently intended to check out Cuban crews for bomber operations. Nine Il-28s at Holguin, a newer field consisting only of a runway with no base facilities, never got beyond the initial uncrating stage.

Beagle Disassembly

Disassembly of the Beagles and Mascots at San Julian began on Nov. 25, and by Dec. 4 this field and Holguin were clear of bombers. Photo reconnaissance followed the crated bombers from San Julian to the port of Mariel where they were loaded aboard Soviet freighters as deck loads, and from Holguin to the port of Neuvilas where they were also taken aboard Soviet ships. The last Il-28s left Mariel on Dec. 5. Ships carrying the bombers were photographed by U.S. aircraft all the way back to their home ports on the Baltic and Black Seas.

Total of 42 MiG-21 Fishbed fighters have been deployed at three Cuban airfields—Santa Clara, Camaguey and San Antonio. The first MiG-21s were spotted by photo-reconnaissance on Sept. 5 at Santa Clara where they were emerging from crates. By Oct. 17, a total of 39 MiG-21s had been photographed fully assembled. The next day a USAF photo plane caught the first MiG-21 in the air shortly after take-off from Santa Clara. By Nov. 20, the MiG-21s were being fitted with Soviet AA-2 missiles similar to Sidewinder (AW July 24, 1961, p. 28). There has been no photo evidence that any MiG-21s have left Cuba.

Gilpatric Explains Defense Decision Policy

Washington—Deputy Secretary of Defense Roswell L. Gilpatric recently outlined the philosophy behind the radical shift toward centralization of decision making in the Defense Dept. and explained the methods he and Defense Secretary Robert S. McNamara use in making the one thousand or so major management decisions they must handle each year. He told the National Defense Committee of the National Assn. of Manufacturers:

"Much has been said during the past 12 months about the trend toward centralization of decision-making within the military establishment. Some comments have been critical, others have been approving. What I have to say . . . will be explanatory.

"As I see it, there are basically only two choices open today to a defense secretary as to how he should go about his job. One is to conceive of his function as primarily policy-making with his determinations backed up by fiscal sanctions, that is, budget ceilings. Under this concept, most of the decision-making in such important areas as military planning and programing would be handled by the Joint Chiefs of Staff and the principal commands and in other significant areas such as research and development and procurement would be delegated to the service secretaries and their staff. Under the other concept of the role of the Secretary of Defense, he retains in his own hands, assisted by his civilian and military advisers, the basic decision-making power in all of the areas just mentioned, leaving to the military and civilian components of the services and the commands the responsibility for executing his decisions and performing the operations called for by them.

"There are several reasons why, in my judgment, the second concept of the Secretary of Defense's role is, under today's conditions, more in the national interest than the first.

"In the first, in contrast to the state of affairs which existed when I was Under Secretary of the Air Force over a decade ago and Mr. [Robert] Lovett was in my position, the principal roles of the military generally cut across service department lines. This is true for example of the strategic mission in which the Navy Polaris operation now plays such a large part, also of the forces for conventional wars—that we call General Purpose Forces—where each of the services has a part, none of which can be performed independently of the other, and of counter-insurgency operations to which, again, each of the four services has a contribution to make.

"Moreover, also in contrast to conditions in earlier periods, all combat operations, as distinguished from support and training, are now in the unified and specified commands functioning directly under the Joint Chiefs of Staff who, in turn, derive their authority from the President, as commander-in-chief, through the Secretary of Defense and do not report to the service secretaries. Accordingly, it no longer makes sense, as it did 10 years ago, to leave to the service secretaries some of the major decision-making except insofar as a service secretary acts as executive agent for two or more services.

"Secondly, the machinery for gathering, analyzing and presenting the data necessary for decision-making has, due largely to the extensive and imaginative use of automatic data computing by the military, advanced to a point where centralized decision-making is both efficient and effective. Nevertheless, it has been said that unless the Office of the Secretary of Defense is to be occupied by an individual with the managerial genius of a Robert McNamara the present system of centralized decision making would break down. In my opinion, this does not follow; let me tell you why.

"In the last budget go-round leading up to the $52.5 billion Defense [Dept.] Budget for Fiscal 1964 which the President recently submitted to Congress, there were in all about 630 subject/issues presented to the Secretary of Defense and myself for determination, following which the services came back with some 70 reclamas requiring further Office of the Secretary of Defense consideration. We dealt with these 700 issues over a period of several months. They ranged in character from such major questions as whether the Nike-Zeus system should be scheduled for immediate production and deployment, whether the Skybolt program should be terminated and whether the RS-70 program should be enlarged, to minor issues involving only a few hundred thousand dollars in appropriations, such as whether the new hospital addition at Andrews AFB should have 150 or 175 beds, or whether new barracks construction at Ft. Jackson should be funded next year or deferred for a later period.

"The data necessary to reach a conclusion on these budget issues, whether they be large or small, is capable of being compiled and presented with all the pros and cons and alternatives in such succinct and readily assimilable form that it was no unbearable chore for Mr. McNamara and myself to make these decisions, within the time allotted, personally and without delegating the task to others.

"In addition to budget issues there are, of course, many other questions that under our system must ultimately be decided by civilian authority, including those relating to force structure, and strengths, new weapon systems, location of new installations, source selection for major production programs and the like. Issues such as these come up from time to time throughout the year rather than being concentrated in a single period such as the annual budget cycle. So far as I know no precise count of such decisions has been kept, but I would estimate them to run in the course of the year to not over three figures.

"In short, the major decision making involved in the management of the military establishment requires perhaps a thousand decisions in the course of the year, most of which are of a character that are susceptible of adequate consideration at the executive level at the average rate of several per day for the individual executive involved.

"Looking at the Defense Dept. decision-making process in these terms, I am not aware, after two years on the job, of any crushing or unmanageable burden resting upon the Office of the Secretary of Defense as a result of the present system of centralization. On the contrary, I believe the present system not only is preferable in theory but works in practice and does not require super men to make it function.

"I do not want to leave the impression, however, that Mr. McNamara and I try to run the entire show by ourselves single-handedly. Managing an organization comprising nearly four million people, spending annually over $50 billion obviously requires the efforts of thousands of individuals in responsible positions. In my judgment, the Defense Dept. is now staffed, on both the military and the civilian side, with personnel of the caliber to fill those positions capably. . . ."

Rocket Exhaust

Proposals to investigate solid-propellant rocket exhaust effects on ground support equipment are being studied by National Aeronautics and Space Administration's Launch Operations Center, Cocoa Beach, Fla. One critical problem area is the sandblasting effect of metal additives in propellants and the possible chemical reaction following the impingement.

Industry submitted proposals in response to NASA anticipation of operations with large, solid-propellant boosters.



Aero Commander Model 1121 Jet Commander currently is undergoing slow-speed flight tests at the company's Bethany, Okla. research facility prior to going to Mojave, Calif., for high-speed flight test. First flight was Jan. 27 (AW Feb. 4, p. 90).

Jet Commander Begins Slow-Speed Flight Tests



Jet Commander is powered by twin General Electric CJ610 engines of 2,850-lb. thrust each. Flight view, above, shows general configuration. Below, liftoff of first flight occurred at approximately 100 kt. Rotation speed was 90 kt.



Development, Procurement Roles Split in USAF Headquarters Shift

By Larry Booda

Washington—Air Force headquarters responsibility for monitoring development and procurement has been divided between two deputy chiefs of staff in a reorganization, effective Feb. 1, which nearly restores the situation that existed before July 1, 1961.

Hardware procurement is directly affected, as development cognizance has been taken from the systems office under the deputy chief for systems and logistics and has been placed under the deputy chief for research and development in the directorate for development planning. The deputy chief for research and development is a new title, replacing that of deputy for research and technology (AW Sept. 10, p. 35).

Two other deputy's offices have also been reshuffled and their names changed. The moves were aimed at bringing the establishment of requirements, programing, planning and active operations responsibilities more in harmony with the methods employed by the Office of the Secretary of Defense.

Reducing Size

The reorganization partly resulted from Project 39 (a), which was initiated last year by Defense Secretary Robert S. McNamara when he directed that studies be made aimed at reducing the size of headquarters staffs and decentralizing management by transferring many functions to field commands.

An immediate result of the studies and reorganization will be the reduction of 1,825 military and civilian billets in the air staff, or 27.4%. The reduction is more than three-quarters completed.

Lt. Gen. Thomas P. Gerrity is deputy chief of staff for systems and logistics. His title remains unchanged. Lt. Gen. James Ferguson is deputy chief of staff for research and development. Gen. Ferguson assumed his position Dec. 1, 1961, and Gen. Gerrity reported to his post, July 1, 1962.

The title of deputy for materiel and deputy for development was created when the Air Research and Development Command was formed in 1951. These titles were changed for the first time shortly after the Air Force Systems Command was formed in the spring of 1961. This command has cognizance over applied research, technology, development and procurement. The Air Force Logistics Command, formed at the same time, takes care of system supply and maintenance.

The directorate of systems acquisition, the directorate of systems services and the 12 designated systems offices will be combined into a directorate of production under Gen. Gerrity. Elimination of the systems offices from the air staff will transfer to Systems Command the responsibility for technical expertise and systems advocacy before the air staff and OSD officials.

In making the change, one of two co-equal assistant deputy chiefs of staff—for systems and for logistics—was abolished. Maj. Gen. William O. Senter has taken the remaining assistant position, while Maj. Gen. Joseph R. Holzapple has been reassigned as director of production. The director of procurement management, Maj. Gen. W. T. Thurman, has been renamed director of procurement policy.

Superficially, the organization under Gen. Ferguson remains the same, with an assistant for nuclear energy and directorates for advanced engineering, science and technology and development planning. However, the assistants for foreign developments and research programing have been eliminated as organizational entities and their functions absorbed or transferred. Gen. Ferguson assumed control of all space development programs last August.

The changed acquisition organization is generally credited to the initiative of Gen. W. F. McKee, who became vice chief of staff last summer after serving as the first commander of the logistics command. Gen. Ferguson and Gen. Gerrity will both monitor the Systems Command activities of Gen. Bernard A. Schriever for Chief of Staff Gen. Curtis LeMay. Gen. Gerrity alone will monitor Logistics Command.

Organization changes made to realign programing, generation of requirements, formulation of plans and direction of operations are more complex. Before Feb. 1, Lt. Gen. David A. Burchinal was deputy chief for plans and programs. His new title is deputy for plans and operations.

Under the old structure, Lt. Gen. Gabriel P. Disosway was deputy for operations. He is now deputy for programs and requirements.

Thus the operations functions were transferred from Gen. Disosway to Gen. Burchinal, and the programs functions were transferred from Gen. Burchinal to Gen. Disosway. The directorate for operational requirements remains under Gen. Disosway.

There are two directorates under Gen. Burchinal, one for plans, the other for operations. This aligns the deputy's staff to actions of the Joint Chiefs of Staff in the formation of operational plans. It also will establish Air Force concepts, objectives and the size and composition of USAF forces. The directorate of operations will determine operational concepts, missions and doctrines, and at the same time carry out actual operations in support of the Joint Chiefs of Staff.

Gen. Disosway has directorates for operational requirements, aerospace programs, command, control and communications, civil engineering and manpower and organization.

Translate USAF Objectives

The programs directorate will translate Air Force objectives into program documents, which are the heart of budget submissions to the secretary of defense. The directorate of operational requirements will be the focal point for determining what the Air Force will need in future weapon systems and major items of equipment.

Among the objectives which the Air Force hopes to accomplish:

- **Optimum working** relationships between elements of the air staff, between the air staff and the major commands and between the air staff and the joint chiefs of staff and the office of the secretary of defense.
- **Manpower savings** by decentralizing management at the staff level. This will be done by placing the functions into the major commands and applies to operations and weapon systems procurement.
- **Elimination of excessive** levels of review.

Advanced U.S. Missiles

Washington—Future strategic retaliatory weapon systems could include new advanced missiles as well as improved versions of existing missiles by the end of Fiscal 1968, Defense Secretary Robert S. McNamara said.

McNamara told the House Armed Services Committee that "an advanced ICBM" project was initiated this year, the possibility of an improved version of the Polaris A-3 is under consideration, and the mobile medium-range ballistic missile system is being developed "for possible application in Europe or elsewhere in the world within reach of Communist bloc targets." Defense Dept. also is doing "a great deal of work on improved propulsion, structures, guidance, etc." for land-based missiles that contribute to the improvement of existing missiles or to new missiles, he said.

USAF's Ballistic Systems Division recently met with industry representatives to outline needed missile studies and development projects (AW Nov. 5, p. 103). Some study awards were announced last month (AW Jan. 21, p. 23).

Future Navy Might Lack Large Carriers

Washington—Possibility of a U. S. fleet without large aircraft carriers or other big combat ships in the late 1970s or 1980s is being studied by a special board convened to take a hard look at the Navy of the future.

Cost-effectiveness analyses conducted by the office of the secretary of defense prodded the Navy into a detailed examination of anti-submarine warfare early last year. Recently, a board began a close scrutiny of Naval aviation. This has been broadened into a study of all Navy doctrine, including non-Polaris submarines.

Defense Secretary Robert S. McNamara revealed what he and his advisers are thinking about present Navy effectiveness in his recent statement before the House Armed Services Committee. Here are some of his points:

- **Attack aircraft carriers.** Even with construction of a conventionally powered carrier starting every other year, the three Midway class carriers, which were built shortly after World War 2, would be 30 to 32 years old by the time they were phased out of the force. "The 20-year rule-of-thumb is an artificial standard for measuring the useful life of naval vessels," McNamara said.
- **Anti-submarine warfare aircraft** carriers. Construction of new ones will be needed eventually, but it is not clear when, according to McNamara. These carriers are all Essex type, former attack carriers from World War 2, and all will soon exceed the 20-year mark. They could be serviceable up to 30 years of age, he said. Proposed new ships would be smaller and slower.
- **Large surface combat ships.** McNamara questioned their need by saying: "The proposed cruisers would carry a Typhon air defense system utilizing a very large radar, which because of its bulk, could be installed only in a vessel of that size. However, there is a question as to whether the benefits to be gained from such a radar would be worth the cost. There is also the long-standing question as to how much it is reasonable to invest simply to defend the fleet against air attack.
- **Destroyer and escort-type ships.** Because of the cost of the Typhon missile system, a smaller-scale version will be built for testing in the test ship Norton Sound. Some destroyers and escorts will be converted to missile-launching ships, but future new construction will depend on the Typhon system.
- **Submarines.** Six new non-Polaris nuclear-powered submarines will be started in 1964. There will be more in the future, but meanwhile, 26 conventionally powered subs will be modernized.

The McNamara statement has made it clear to the Navy that it will have to either justify continuation of its current type force structure, or change it.

The Navy has found that the longer a ship operates, the more its upkeep and overhaul costs. This is especially true of the large aircraft carriers. The cost of operating and maintaining a fleet of 20- to 30-year-old carriers could absorb most of the Navy's budget eventually. It also cannot afford to buy nuclear-powered carriers. These alternatives are being examined:

- **Changing the character** of aircraft operating from carriers or the ships themselves. McNamara indicated his thinking in discussing the anti-submarine warfare carriers. "New developments, either in ships or in ASW weapons or techniques, which we can reasonably anticipate during the next six or seven years, may well make possible the design of radically different types of ASW carriers, or may lead to the reduction of the number required. For example, the successful development of a vertical-takeoff-and-landing aircraft . . . could substantially reduce the size required of an ASW carrier. So, too, the successful design of a destroyer escort equipped with manned helicopters could reduce the number of carriers needed."
- **Changing mission concepts.** Adherence to the doctrine of delivering large nuclear weapons by aircraft has been responsible for development of large, complex aircraft and building of larger aircraft carriers. By abandoning this concept and retaining the ability to participate in less than nuclear war, the size and complexity of aircraft and ships could be reduced. Garrison Norton, the last assistant secretary of the Navy for air before the post was abolished in 1959, warned against Naval aviation's continued encroachment into the strategic deterrence realm." His advice was ignored.

Anti-aircraft protection of the fleet. The Typhon system is built around a radar which extends from the bottom of the ship to the top of a large tower. Radar energy generated below is piped to Luneberg lenses at the top. Multiple targets could be detected and intercepted by missiles at extended ranges.

One proposal is to eliminate long-range anti-aircraft protection altogether, and disperse the ships among the thousands of merchant vessels at sea.

Results of the board's studies will be reflected in future Navy budgets. Increased emphasis on development of VTOL aircraft and air cushion and hydrofoil vehicles can be expected.

COIN Controversy

Washington—Navy and the office of the secretary of defense are trying to resolve differences about how the Navy-managed light counter-insurgency (COIN) aircraft program should be pursued (AW Dec. 10, p. 26).

Defense Dept. argues that quickest results could be gained by first building several prototypes. Navy wants to develop a complete weapon system.

An earlier disagreement among the services on what form the aircraft would take (AW Dec. 24, p. 15) has been resolved. In general, the specifications will call for a twin contrarotating turboprop aircraft weighing 3,500 lb., with a wing span of 20 ft. Landing speed would be 40 kt. with power on and 60 kt. with power off. Takeoff and landing would be made in 500 ft. over 50-ft. obstacles.

Navy contends that it would be more logical to integrate all of the weapons, fire control and the navigation system from the beginning of the program. The navigation system would be a modification of the British Decca system.

Target cost of the aircraft alone is $100,000 each in quantity. The complete weapon system would raise the cost to about $125,000, DOD said.

MA-9 Rescheduled

Cape Canaveral, Fla.—Launch date of Mercury-Atlas 9 (MA-9) was postponed last week when National Aeronautics and Space Administration decided to rewire the autopilot system aboard Atlas 130-D—the booster scheduled for the mission. MA-9 had been scheduled for Apr. 2 but as of late last week, NASA had not established a new target date.

Although there were no problems reported in the autopilot wiring, General Dynamics/Astronautics had developed a new manufacturing technique for making electrical connections inside the autopilot's three canisters and recommended to NASA that it be used on the already-built 130-D. The booster, which had been scheduled to arrive at Cape Canaveral Feb. 4, had passed all test requirements and had been accepted as flight-ready by NASA on Feb. 1. The three prime autopilot canisters and three spares also had passed acceptance checks.

General Dynamics' new manufacturing technique, developed late last year, is said to reduce the possibility of loose or broken electrical connections to almost zero. There are approximately 700 wire connections in the three canisters of the Atlas autopilot. After rewiring, the autopilot canisters and the spares will be revalidated three times.

Re-entry Tests Led to Nike X Decision

Washington—Defense Dept. decision to develop the new Nike X ICBM defense system and not to recommend Nike Zeus production results from extensive re-entry body tests which indicate that atmospheric filtering is the most effective means of discriminating between warheads and decoys.

In one sense, Nike X is a competitor to Nike Zeus since it is expected to receive the bulk of the $450 million which Defense Secretary Robert S. McNamara has requested for ICBM defense in the Fiscal 1964 budget. But in another sense the two systems are complementary, with Zeus designed to intercept targets at altitudes of about 70-100 mi. while Nike X would intercept at altitudes of 20-30 mi.

Nike X is expected to utilize extremely high-acceleration missiles capable of reaching intercept altitude and making a kill within 10-15 sec. after launch. It will utilize a multiple-function phased-array radar that is far more readily suited to hardened installations than existing Nike Zeus radars.

The Nike X concept of relatively low-altitude intercept using missiles armed with nuclear warheads, which might detonate the incoming ICBM thermonuclear warhead in the process of killing it, envisions low-altitude radiation and blast effects that will produce new emphasis on civil defense and shelters.

This is what McNamara was referring to in a statement to the House Armed Services Committee when he said: "The effectiveness of an active ballistic missile defense system in saving lives depends in large part upon the existence of an adequate civil defense. Indeed, in the absence of adequate fallout shelters, an active defense might not significantly increase the proportion of the population surviving an all-out nuclear attack."

The extensive re-entry measurements program sponsored by the Advanced Research Projects Agency under its Project Defender program has shown that the most effective means of discriminating between active warheads and smaller, lighter-weight decoys or debris from an exploded booster case is by observing differences in their trajectories as they enter into the earth's atmosphere.

If there is a great difference between the mass of the warhead and the decoy, 20 to 1 or greater, the difference in trajectories is sufficient to permit detection at moderately high altitudes of roughly 40-50 mi. But if the ratio of warhead to decoy mass is less, discrimination is not possible until lower altitudes.

When Nike Zeus originally was designed, the most important objective appeared to be to accomplish intercept as far out as possible. Knowledge on re-entry characteristics and the discrimination problem was almost non-existent. Now it is recognized that high-altitude intercept greatly reduces the ability to identify decoys and therefore requires the launch of an expensive Zeus to intercept every low-cost decoy in the attack. This makes it relatively easy to saturate such an ICBM defense system, Defense Dept. officials believe.

If the system could afford to wait for deeper re-entry and still achieve a high kill probability, it would be far more difficult for an enemy to confuse and saturate the defenses with decoys. This led to the concept of an extremely high-acceleration missile, known as Sprint. Because of its shorter range, such a missile could be smaller, lighter and less expensive than Zeus missiles. At lower altitudes, the volume of potential intercept airspace is smaller, increasing the intensity of firepower which can be applied by a given number of missiles.

The Army currently is sponsoring Sprint feasibility studies at three companies: Douglas, Martin-Orlando and North American-Columbus. Army Missile Command is expected to issue requests for industry proposals soon (AW Dec. 17, p. 26).

There are other challenging problem areas in the Nike X low-altitude intercept concept beyond that of developing an extremely high-speed missile. The prospect of relatively low-altitude nuclear explosions from the interceptor warhead and possibly the ICBM warhead requires at least moderate hardening of both the missile launch sites and the radar used for target detection, tracking and intercept guidance.

The Nike Zeus, as originally conceived, required three different types of radar: one for target acquisition at long range, another for target tracking and a third for interceptor missile guidance. A fourth type radar was added later for target-decoy discrimination. All are conventional type radars that require large, relatively soft, vulnerable facilities.

Several years ago the Army initiated development of a phased-array electronically scanned radar at Sylvania, known as ZMAR (Zeus multi-function array radar). This type radar, similar in principle to the ESAR (electronically scanned array radar) radar under development by Bendix Radio for space surveillance use, can be used simultaneously for long-range surveillance and multiple-target tracking. Such a radar might therefore be able to perform the functions that required three separate radars in the original Zeus system—target acquisition, discrimination and tracking. It might even be suitable for the fourth function—interceptor guidance. Additionally, the phased-array radar antenna, requiring no large moving structure, can be housed almost completely in a hardened concrete structure, except for one exposed flat face which can be made moderately blast-resistant.

Because ZMAR originally was viewed as a possible hardened replacement for the existing Zeus radars, Western Electric-Bell Telephone Laboratories, prime contractor for Nike Zeus, were given responsibility for supervising the program. Now ZMAR emerges as the primary radar sensor element of Nike X, where its multiple functions and its ease of hardening are required.

Defense Dept. plans to continue its Pacific tests of the Nike Zeus system, incorporating any small changes or improvements in the experimental missiles suggested by the tests. However, no major new design effort is planned. By the time the Zeus tests are concluded late in 1964, Defense Dept. hopes to be ready to evaluate the new Nike X system in a similar series of tests.

While it is too early to obtain accurate estimates of the cost of a Nike X battery, some observers estimate it at about $50 million, compared with an estimated $300/$400 million for a Nike Zeus battery.

If and when this or a future Administration decides to implement an active ICBM defense system, it might decide to deploy both Zeus and Nike X at major urban areas to provide a defense in depth, some observers believe. Zeus would be fired first at any cluster of targets, with little effort to discriminate between warheads and decoys.

Any targets which eluded the Nike Zeus, and which atmospheric filtering showed to be warheads, would then be attacked by Nike Sprint low-altitude intercept missiles. Nike X also might form the core of a hardpoint ICBM defense for protection of hardened missile silos and underground command centers (AW Jan. 7, p. 34).

In explaining the Administration's decision not to seek early deployment of the Zeus, McNamara said, "We recognize that there are some reasons why it might be desirable to proceed immediately with . . . deployment of an anti-ballistic missile system, even one with a limited capability. Such a system might reduce U.S. casualties in the case of a 'small' or 'medium' Soviet attack on our urban areas. Further, it would complicate the design of and tactics for the attacker's offensive weapons.

"But there are even better reasons why we should not proceed at this time with actual deployment of a system," McNamara said. The U.S. still has a great deal to learn about re-entry phenomena and techniques for discriminating between warheads and decoys, he said, as well as about the effects of nuclear detonation from one of our intercepting missiles on other elements of the defense system.

However, McNamara said "we propose to proceed with the greatest urgency in the development of the Nike X system, retaining the option to move ahead with actual production and deployment of such a system if the capabilities of the system and the circumstances should warrant such a decision at some later time."

Pre-Landing Cargo Role Seen for LEM

Washington—Use of the Grumman Lunar Excursion Module (LEM) as a cargo supplier for the Apollo mission is being considered by the National Aeronautics and Space Administration. A firm decision on whether a logistics system is an absolute requirement for the lunar landing mission will not be made for several months.

Use of the bug as a truck is one of a number of studies that will be described at the second NASA-Industry Conference being held here Feb. 11 and 12. NASA will release the list of all studies which it has approved.

Concept of the Lunar Excursion Module modified as a supply vehicle envisions carrying the bug on the Apollo B manned circumlunar mission. While the Apollo spacecraft is in a lunar orbit, the unmanned bug carrying several tons of supplies would be ejected and would touch down at the site selected for manned landing.

In this mission, the braking rocket and landing system could be checked out, and any critical supplies could be delivered before manned landing.

Modification would entail removing all equipment needed for manned flight, along with the lunar takeoff engine, unless it is decided to leave a spare, powered bug on the moon for possible use later.

USAF, Army Differ on Aircraft Types and Mission Assignments

Washington—Air Force last week brought into the open its disagreement with the Army over what types of aircraft should be used by each service and what types are most effective.

Lt. Gen. Gabriel Disosway, USAF deputy chief of staff for programs and requirements, who recently visited South Vietnam, argued that fixed-wing aircraft traveling at speeds above 500 kt. are much less vulnerable to ground fire in close support operations.

He said the Jan. 2 incident in South Vietnam, in which a number of helicopters were destroyed or damaged by ground fire (AW Jan. 7, p. 27; Jan. 14, p. 26), was begun without the support of fixed-wing aircraft as the result of a decision by the South Vietnamese joint staff. This was counter to the policy laid down by Army Gen. Paul D. Harkins, the U. S. commander in South Vietnam, that fixed-wing support should be used as a matter of course, Gen. Disosway said. It was not until about 30 min. after Communist Viet Cong forces had ambushed the fourth wave of helicopters that North American T-28 aircraft were called in to wipe out Viet Cong strong points, he said.

Gen. Disosway also said the Army's Tactical Mobility Requirements Board, or Howze Board (AW June 25, p. 26), had made proposals which encroached on the USAF missions, especially in reconnaissance, assault landing aircraft and in research and development.

Sen. Barry Goldwater (R.-Ariz.) carried the attack further, saying that the Howze Board proposals would increase Army aviation's strength to 30,000 planes and 55,000 pilots and would cost $5 billion per year for the next five years.

"It would assign to the Army many functions now adequately performed by the Air Force and would result in waste and confusion," according to Sen. Goldwater.

Gen. Earle G. Wheeler, Army chief of staff, who also visited South Vietnam, revealed that the obsolescent Vertol CH-21 helicopters operating in South Vietnam were averaging about 68% availability. Problems of operating in unfavorable climatic conditions have increased maintenance difficulties, he said, especially by causing engine changes in 250 to 300 hr. instead of every 600 hr.

Efforts are being made to increase availability to 90%.

Adm. Felt believes that the concept of the armored helicopter has been proved but that fixed-wing aircraft support will be the prime troop support vehicle for the foreseeable future in war theatres such as South Vietnam.

News Digest

Hamilton Standard Division of United Aircraft Corp. will report to United President William P. Gwinn instead of to Charles M. Kearns, Jr., a corporate vice president and former head of Hamilton Standard, under a change announced last week. The division is headed by William E. Diefenderfer.

Meteoroid detection system will be the payload on the eighth and ninth Saturn test launches. Flight systems to be designed and built by Fairchild Stratos Corp., consist of two wings, 10 ft. wide by 96 ft. long. They will be deployed in orbit and remain attached to the S-4 second stage. Outer Mylar skin will be electrically charged and covered with aluminum. Meteoroid puncture will create a pulse.

Morton J. Stoller, NASA director of applications programs, was awarded the agency's leadership medal for directing the U.S. "to its pre-eminent position in development of meteorological and communications satellites."

Brig. Gen. William T. Sewall, commandant of cadets at the Air Force Academy, has been named vice president-operations and engineering for the Air Transport Assn. The post has been vacant since 1958. William B. Becker will be named assistant vice president-operations and Walter A. Jensen will become assistant vice president-air traffic control.

Lockheed Propulsion Co. last week was made a division of Lockheed Aircraft Corp. and propulsion company President Robert F. Hurt was named a corporate vice president.

USAF will buy 1,000 McDonnell F4C and RF4C fighters at a cost of about $1.6 billion over the next five years, Lt. Gen. Gabriel P. Disosway, deputy chief of staff for programs and requirements, said last week. They will be formed into 14 wings of about 75 fighters each. This will include 14 reconnaissance squadrons.

First Titan 2 ICBM to be launched by an all-Air Force crew was fired from Cape Canaveral Feb. 6 by the Titan Weapons Division of USAF's 6555th Aerospace Test Wing. The missile, carrying a General Electric Mk. 6 reentry vehicle—the heaviest in Air Force's current inventory—was flown more than 6,500 stat. mi. down the Atlantic Missile Range. Launch crew consisted of nine officers and 63 airmen.

New U.S. Air Policy Threatens Merger

Pan American, TWA told that government will not condone a chosen instrument on international routes.

By L. L. Doty

Washington—Proposed Pan American World Airways-Trans World Airlines merger received a severe setback last week with a warning from the U.S. government that a chosen instrument type of operation on international routes will not be condoned under the new air transport policy.

The warning came during a briefing of five carriers on the new policy by the Civil Aeronautics Board and Federal Aviation Agency. The new policy, although not formally adopted by the White House, is ready for implementation (AW Feb. 4, p. 39).

The stand against the chosen instrument principle is being interpreted to mean either that the merger will be rejected, or that a third carrier will be certificated on North Atlantic routes if the proposed merger is approved.

The new policy, as outlined in the briefing, is quite similar in context and philosophy to the details of the findings of a survey conducted last year by private consultants, disclosed for the first time by AVIATION WEEK & SPACE TECHNOLOGY (Sept. 10, p. 53). The briefing was called as a direct result of violent industry reaction to a disclosure late last month that a team of top government officials was planning to discuss the policy with the six European governments before revealing it to U.S. carriers. The team tour of six European capitals was subsequently postponed for several months, without explanation.

The new policy has been withheld from the public and the airline industry under a State Dept. classification of "confidential," because, according to one White House spokesman, it has a direct effect on "U.S. foreign relations." However, one government official admitted to AVIATION WEEK & SPACE TECHNOLOGY that there was some fear the airlines, once they became acquainted with the policy, might attempt to scuttle those phases of it with which they disagreed.

Airline officials attending the meeting were allowed to read the policy, but not one was permitted to leave the room with a copy of it. Attending were: Charles Beard, president of Braniff Airways, and an associate; Juan Trippe and Hubert Schneider, president and vice president of Pan American respectively; Charles Tillinghast, president of TWA and his Washington vice president, Thomas Taylor; Richard Jackson, president of Seaboard World Airlines and vice president John Mahoney; Robert L. Griffith, vice president of Delta; and Donald Nyrop, president of Northwest Airlines, and an associate. The briefing was conducted by FAA Administrator N. E. Halaby and CAB Chairman Alan S. Boyd. Stuart G. Tipton, president of the Air Transport Assn., and Harvey Wexler of the ATA were present as observers.

Although most of those who attended the briefing were reluctant to discuss their reaction, this much is evident: the new policy undermines the arguments presented in recent months by Pan American and TWA for their merger.

The policy kills one of the principal aims of the proposed merger—reduction of U.S. competition on major international and around-the-world routes. Under the policy, not only is the U.S. strongly opposed to the chosen instrument concept, but it will not permit the formation of any cartels or pools that will restrain competition.

From the foreign carriers standpoint, the policy is liberal. It was developed on the premise that U.S. carriers can compete effectively with foreign flag carriers and that emphasis should be placed on the expansion of the market rather than on the share of the market U.S. carriers should have.

In addition, the new policy is designed to conform with President Kennedy's trade expansion program. The policy presumes that U.S. international air transportation is an important segment of this program, and that the role of the government is to assist in the growth of international civil aviation so that airlines can make their contribution to the expansion of foreign trade.

In this connection, the U.S. is not concerned with the unfavorable dollar flow resulting from the use of foreign flag carriers by its citizens, on the basis that this disadvantage is offset by the salutary benefits of competition.

There will be no attempt to compel foreign flag carriers to restrict capacity or reduce schedules at this time. There will be an attempt, however, to persuade foreign flag carriers to limit their capacity and schedule frequency to present levels. The feeling is this will allow traffic to catch up with available seats.

During the briefing, several carriers indicated they may withdraw their support of recent industry moves to establish control over capacity provided by foreign flag carriers. Air Transport Assn. is sponsoring legislation calling for an exchange of traffic statistics with foreign airlines and the introduction of new restrictive powers in the provisions of foreign air carrier permits. The new policy opposes this action and calls for lower fares in international markets.

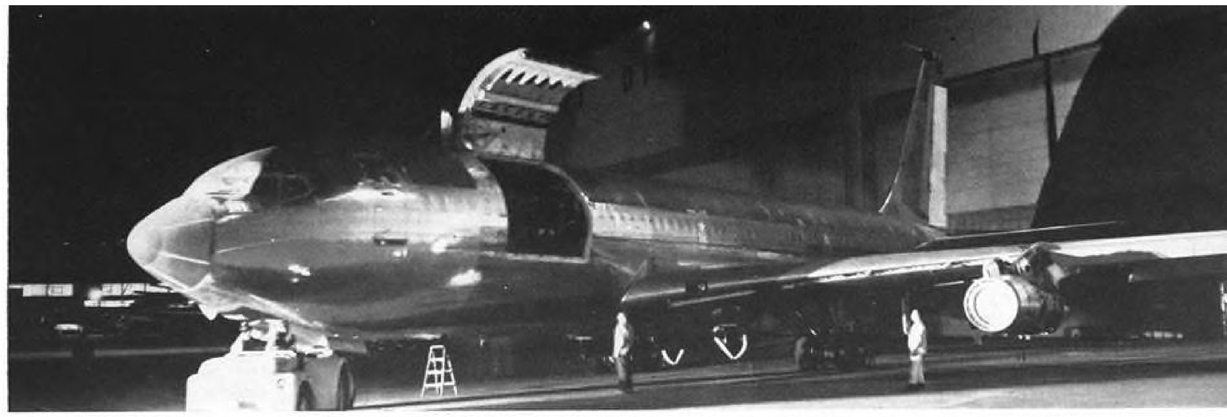
The new plan also seeks a cargo policy disassociated from that covering passenger traffic. It would establish these points of cargo policy:

The flow of cargo to and from foreign ports will not be restricted to specific route patterns. The reasoning is that cargo destinations are more numerous and often different from passenger destinations. Cargo should be allowed to move directly to its specified market with a minimum of off-loading and trans-shipment. There should be no restrictions on cargo capacity. Cargo rates should be lowered.

Strong consideration will be given to the negotiation of air transport service agreements with other countries on a multilateral rather than a bilateral basis. Historically, airline agreements have been developed on a bilateral basis, with the Bermuda principles serving as a guide to the terms.

Bermuda principles will be retained for a while but chances are strong they will be subjected to searching re-evaluation soon. Multilateral principle adoption would mean a complete overhaul of all U.S. air agreements.

During the briefing, the subject of sixth freedom traffic was raised. Sixth freedom traffic is that which moves from one country on the flag carrier of a second country to a third. In the past, the U.S. has held that some airlines, particularly SAS and KLM have handled a larger amount of this traffic than is authorized under the terms of bilateral agreements. As a means of resolving this problem, it was suggested that sixth freedom be redefined to include only passengers who continue on to a third country after a stopover in the second country. Restrictions then would be placed on the number of passengers who make direct connections to a destination in a third country.



Boeing 707-320C Nearing First Flight

First flight of the Boeing 707-320C convertible passenger-cargo transport is scheduled for mid-February. Aircraft is shown on the ramp at Boeing's Renton, Wash., factory after rollout recently. Aircraft, which retains all major systems of the 707-320B turbofan transport, has an integral cargo-handling system and a 7x11-ft. cargo loading door. Aircraft can carry 80,000-lb. of cargo or as many as 188 passengers.

Hughes Battles to Avoid Court Appearance

By James R. Ashlock

New York—Attorney for Howard R. Hughes last week was considering halting his pre-trail examination in Trans World Airlines' $155 million anti-trust suit against Hughes Tool Co., a move that could halt depositions and block Hughes' scheduled appearance today at Los Angeles.

Chester C. Davis, Hughes' lawyer in New York, revealed this possibility after Judge Charles Metzner of the U.S. District Court denied his motion to dismiss the case, which Davis held should be handled by the Civil Aeronautics Board and not the courts.

Davis was also considering asking the Circuit Court of Appeals for a stay of Metzner's denial. But to have any effect on Hughes' appearance, this would have had to come before 5 p.m. Friday. TWA's lawyers were confident that the Appeals Court would support Judge Metzner's action.

If he halts arguments, Davis would be resting on his own interpretation of the law. He told Metzner that he still feels there is a question of whether the matter belong in the courts.

Every matter involving Hughes Tool Co. with TWA has had to have CAB approval, Davis held, adding that he felt there is no reason why the current litigation should be handled by any other body.

John Sonnett, TWA's counsel, said he would interpret a cessation of arguments by Davis as a default of the case, leaving the court to make a judgment. If the court's award wasn't satisfactory in light of TWA's demands, Sonnett said, TWA would press the matter further.

Sonnett conceded that Davis' resting his case could, in effect, mean an end to the pre-trial proceedings, and there would be no need to interrogate Hughes.

Davis, as defense attorney, was granted first rights to calling witnesses for depositions, and everyone appearing so far in the more than 80 sessions has been from the plaintiff's side. But TWA and its allied groups have insisted that Hughes be called as well, and a subpoena for Hughes was presented to Davis as Hughes' representative. Thus Davis is faced with either continuing the proceedings, or finding means to stop them in an effort to ease the opposition's insistence on questioning Hughes.

Recent Supreme Court decision concerning Pan American and Pan American Grace Airlines (Panagra) was the basis for Davis' motion to dismiss the case. (AW Jan. 21, p. 42).

TWA had seven days to answer the motion. But realizing that the court must act on it before Hughes could be made to appear, and since only 10 days then remained before Hughes' scheduled appearance, TWA's attorneys presented their answer the day after the Hughes group filed.

The airline's counsel maintains that the Hughes-TWA dispute, involving an individual and one airline, cannot be likened to the Pan American-Panagra case, which was a basic route disagreement between two carriers.

Seeking an opinion on the CAB's jurisdiction, Davis filed a request that the Board launch an investigation into the relationship between TWA, its financial backers and Pan American (AW Feb. 5, 1962, p. 43).

Davis charged that the lending institutions—Metropolitan Life Insurance Co., The Equitable Life Assurance Society of the United States, and Irving Trust Co.—conspired to gain control of TWA and make it a captive outlet for high-interest loans. Ernest R. Breech, board chairman of TWA, and Charles C. Tillinghast, Jr., president of the carrier, participated in the conspiracy, the complaint stated.

Davis charged that Juan T. Trippe, president of Pan American, conspired with Breech and Tillinghast toward merging the two carriers. Metropolitan, of which Trippe is a director and finance committee member, was a party in initiating and fostering the merger negotiations, Davis claimed.

The merger, he said, is sought "not because it would necessarily be in the best interests of TWA and all of its stockholders, or preferable to other mergers, but because Hughes Tool Co. would be permanently eliminated as the controlling stockholder of the resulting airline."

Davis asked for prompt action by the CAB on his request, saying that he could not continue his case against the defendants in court until the CAB determines whether the parties now controlling TWA have violated any provisions of the Civil Aeronautics Act.

Attorneys for Metropolitan, Equitable, and TWA's financial advisers, Dillon, Read & Co., said that Davis was legally wrong not only in naming them in the CAB filing, but also in including them in his $366-million counterclaim to the TWA suit.

"What Mr. Davis is doing here, after more than a year of tramping up and down the garden path and costing us hundreds of thousands of dollars, is trying to delay the taking of depositions from Hughes," said John R. Hupper, counsel for both Equitable and Metropolitan.

Hupper, with Charles L. Stewart, representing Dillon, Read, said Davis' charges were baseless because their organizations were involved in no phase

of aeronautics. Davis replied that it was up to the CAB to determine their involvement.

Also last week, the CAB denied for the second time a TWA motion to delay a stockholder vote on the merger proposal. TWA's request that the vote be held 60 days after public hearings on the merger was denied by the Board's Bureau of Economic Counsel, which had earlier rejected TWA and Pan American's original proposal for a vote 60 days after final approval of the merger.

Delaying a stockholder vote on the proposed merger has been a major consideration in TWA's and Pan American's strategy to avoid counteraction by Hughes.

Suit by Hughes to block the merger would, in both carriers' opinions, stall indefinitely their effort to join, snarling it in litigation that could last for years. And the surest way to arouse Hughes, TWA and Pan American feel, would be to vote his 78.2% of TWA stock for the merger.

Carriers felt that if Hughes were pressured into taking an early position, it would be against the merger. He is facing a reduction to 29% of his interest in the merged airline, and the litigation between himself and TWA remains unresolved.

However, months would pass even before public hearings on the merger filing. This would provide time for efforts to settle with Hughes on the litigation, and also to try to overcome his objections against voting his stock.

Postponing a stockholder vote also protects the three-man trusteeship controlling Hughes' TWA stock (AW Feb. 4, p. 47), since an advisory opinion from the Board would offer a defense against any Hughes counteraction. However, TWA feels confident of its right to vote the stock, because it is stipulated in the trustee agreement with Hughes that the trustees can vote his interest in a merger. TWA's lawyers, as well as independent counsel, agree that TWA could legally uphold this right even if Hughes pleaded in court that his interest was being threatened.

TWA faces conflicting considerations. On the one hand, it feels the obligation to force Hughes into a public appearance to protect the lending institutions charged in the litigation. However, the airline also is anxious to avoid imperiling the proposed merger. Many observers close to the issue feel that forcing Hughes to appear would bring an anti-merger declaration from him as quickly as would the voting of his stock.

While TWA would prefer a CAB decision, or opinion, before voting the stock, the airline realizes that some sort of showdown with Hughes is inevitable. Even though the carrier would like more time to try to negotiate a settlement, it cannot ignore responsibility to the lending institutions, which are primary targets of Hughes' $366-million countersuit.

Defense of the banks' and insurance companies' interests, represented by their multi-million dollar loans to TWA, requires settlement of the litigation as soon as possible.

Persons who have known Hughes throughout his airline association say there is another reason for keeping the pressure on him. Recognized for a hesitancy to make quick decisions, Hughes has developed a reputation for exhausting every delaying tactic, then making a settlement. This encourages his opponents to keep plugging in hopes of an eventual compromise.

Legal sources feel that if and when Hughes does appear, interrogation of him will last at least three or four months. The many lawyers representing TWA and the lending institutions would all want to question him.

Airline industry observers believe that some sort of compromise on the merger proposal will eventually be adopted. A question exists over whether the government can logically approve the merger as presently proposed, mainly because of the great impact it would have on domestic airline business.

Reports have circulated in recent weeks that a plan was being formulated that would involve Pan American buying TWA's international routes from Hughes for $125 million, thus giving Hughes the money to pay off the bank and insurance loans to TWA and regain control of the airline.

But TWA executives are emphatic in denying any consideration of relinquishing the internationl routes, and stress that they aren't Hughes' to sell. Pan American's original approach to TWA concerned only international routes. Pan American sought TWA's overseas network in exchange for a cash sum and rights into such points as Puerto Rico and Alaska. TWA told Pan American then that it would discuss nothing short of a total merger, and TWA's officials say their position remains unchanged.

Talk of a special deal with Hughes also seems unlikely when viewed in relation to the factors that would have to accompany it.

Assuming that Pan American had the $125 million to buy the routes, Hughes could not make the sale until he had regained control of TWA and reorganized its management and board of directors. It is made clear within TWA that the present board would never give up the international segments.

Pan American would also want other concessions, such as rights to cross the U.S. and board passengers at two or three gateways before departing on transpacific flights, a privilege now held by certain foreign flag carriers. Pan American presently may board passengers, for instance, at Chicago, then pick up others in New York or Boston for transatlantic flights. But the westbound restriction poses a gap in the airline's round-the-world system. Pan American would also want government-assurance that another U.S. carrier would not be allowed on the North Atlantic.

But such a plan would involve Pan American trusting Hughes with its money until he could again take over TWA, plus some assurance that the government would grant Pan American's desire for extended gateway privileges and North Atlantic exclusivity. These factors alone are generally considered enough to discourage such a plan.

Anglo-French Marketing Accord

London—Short Brothers & Harland, builders of the Short Belfast turboprop freighter for Royal Air Force, last week signed a cooperative agreement with the French firm S. A. des Ateliers d'Aviations Louis Breguet to market the Breguet 941/942 four-engine STOL transport in the United Kingdom.

Short Brothers has offered the plane to RAF, another indication that OR-351, RAF's requirement for a tactical transport to replace the aging Blackburn Beverleys and Handley Page Hastings, has been de-emphasized if not killed. The requirement decision now is a year overdue, primarily because of the estimated $140 million in development costs for a new design.

Short Brothers, which also has submitted the Vought Hiller tilt-wing transport to RAF, would build the Breguet STOL transport if RAF bought it. Short also will push the aircraft in the civil market, with a license manufacturing tie-up if orders are sufficient. Company stressed that the Breguet 941/942 has no relation to OR-351, at least in its present context calling for a plane the size of the Belfast.

Decision on OR-351 probably has been made, but will not be revealed until the 1963 defense White Paper is published later this month.

Unknown factor is the fate of OR-350, a requirement to replace the Shackleton bomber now used for maritime reconnaissance (AW Apr. 30, 1962, p. 34). Requirement calls for a 1,600-mi. range and versions of de Havilland Trident and Vickers VC.10 have been offered to RAF.

CAB Demands Sweeping Changes In Air Transport Assn. Activities

Washington—Civil Aeronautics Board has strengthened its position in its fight to inspect Air Transport Assn. documents by issuing a new order that gives it sweeping powers to maintain tight surveillance of all ATA activities.

Latest action in the Board investigation of the ATA, now entering its fourth year (AW Mar. 30, 1959, p. 47), denies an ATA offer to settle the case and motion to terminate the CAB inspection.

It orders that the ATA Articles of Assn. will be disapproved unless certain conditions are met within 30 days. This action could bring all ATA activities to a halt.

Principal condition reaffirmed in the Board order, to which ATA is taking exceptional objection is a prohibition against assertion of any claim of attorney-client privilege in any investigation of ATA records and affairs by the CAB. In its order, the CAB stated:

" . . . The ATA shall so conduct its affairs as to preclude [it] . . . from engaging in the practice of law in such a manner as to create a claim of confidentiality based upon an alleged attorney-client relationship between it and its members. . . . " Chances are strong that the ATA will take this issue to court.

Meanwhile, the American Bar Assn. deplored the Board action "as contrary to long recognized legal precedent, as in violation of fundamental rights, and as detrimental to the best interests of air transportation. . . . "

Other CAB conditions which must be met within 30 days are:

- **Air carrier members** of the ATA must agree that the Board shall have access to and authority to inspect all ATA accounts, records, documents, papers and correspondence.
- **ATA conferences** and divisions shall file their by-laws with the Board.
- **Each ATA member** shall have equal voting rights. At present, the voting strength of a member airline is measured by the revenue ton miles it carried in the previous year. The Board said that, under this system, large carriers are in a position to dominate the selection of ATA directors.
- **All classes of carriers** shall be represented on the ATA board of directors, unless all members of any class prefer not to be so represented. Classes include: domestic trunklines, international carriers, local service airlines, scheduled helicopter operators and all-cargo carriers. In the past, all classes of carriers have not always been represented.
- **ATA and its conferences** shall file with the CAB all resolutions, contracts and agreements.
- **ATA and its conferences** shall file all minutes of all meetings within 30 days of such meetings.
- **Full statement** of public relations campaigns or programs shall be submitted to the Board within 30 days after they are adopted.
- **If any ATA member** is a party to any hearing before the Board, CAB Rules of Practice will apply to the ATA generally. Rules of Practice declare it improper " . . . to give statements to the press or radio or by paid advertisements . . . designed to influence the Board's judgment in the case."
- **ATA will give all members** an opportunity to consider the adoption and the publicizing of any broad position or program.
- **In issuing any public** statement, ATA shall disclose the extent of its representation whenever it has any reason to believe that any members may disagree with that statement.
- **Director of the ATA tariff** division and the publishing agent for the air traffic conference tariffs manual shall not be an employe or official of the ATA. The tariff publishing agent shall perform his functions independently of the ATA or the air traffic conference.

Rail Union Makes Bid for 12,700 At United; 3,000 Are Ex-members

Washington—Brotherhood of Railway Clerks is attempting to recruit 9,700 unorganized United Air Lines employes, and 3,000 others now belonging to the International Assn. of Machinists. Some 3,000 of the unorganized are former members lost by the rail union after the United-Capital Airlines merger.

The Brotherhood of Railway Clerks (BRC) has petitioned the National Mediation board for the right to hold the representation election. The recruiting drive by the railway union stems from a Civil Aeronautics Board merger order that held that United did not have to recognize BRC, which formerly represented 3,000 Capital clerical workers. The union lost a legal appeal to the CAB decision.

The balance of the 12,700 employes have not been previously organized. The employes BRC is seeking to represent perform a variety of jobs, including clerical work, ticket sales and ramp service.

W. A. Patterson, president of United, has written to Attorney General Robert F. Kennedy, Secretary of Labor Willard Wirtz and the NMB, complaining that NMB election ballots do not offer employes the choice to vote against union representation. He urged that NMB election procedures be reviewed. Groups of United employes have lodged similar complaints with members of Congress.

All of these requests have been referrred back to the NMB, which notes that, as an independent government agency, it is "not subject to pressure." NMB refused a United request that it break the customary "class and craft" determination into three separate groups for the 12,700 employes, pointing out that the recognition of clerical, sales and related workers as one "class or craft" has been fixed on the airlines since 1947. The Mediation Board also cautioned United that it could not legally participate in the representation elections for employes.

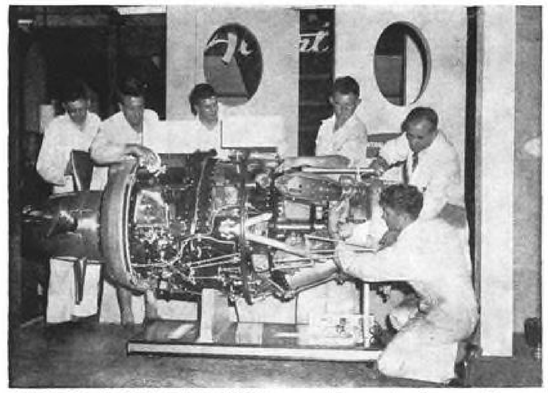
It was under the same "class and craft" ruling that the Airline Pilots Assn. won representation rights for both pilots and flight engineers on United. In the present case, United is concerned that there are too many different duties handled by the 12,700 workers to consider them as one class. Recognition of one union to represent the group could produce a costly problem of training and cross bidding for jobs, the carrier feels.

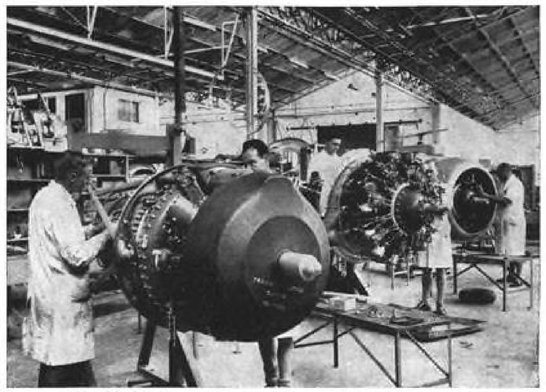
NMB is prepared to conduct the election, but is still awaiting a list of employe names involved in the representation dispute. They were first promised by United on Jan. 14, but have not yet been received. Mediation Board spokesmen indicate that if the list is not produced soon, NMB may subpoena the information rather than delay the election. They added that United's criticism of the NMB ballot form is "not justified," since employes wishing to vote against any union representation can do so merely by failing to return the ballot.

Under NMB voting procedures, at least 51% of the employes eligible must vote or the election is not considered valid.

To gain the representation rights for the group, one or more unions must receive a majority of the votes cast.

Meanwhile, the IAM has filed a union "raiding" complaint against the BRC with the AFL-CIO. Final outcome of this action could result in the BRC dropping the 3,000 IAM members from its recruiting drive.





CENTRAL AFRICAN AIRWAYS apprentice mechanics examine working model of Rolls-Royce Dart engine constructed as part of training course (left). Engine overhaul (right) is conducted at CAA's maintenance base at Salisbury. Company also handles repair of propellers and radio components for Royal Rhodesian Air Force. CAA employs a progressive maintenance system.

Airline Grows Despite Federation Unrest

By Robert H. Cook

Salisbury, Southern Rhodesia—Central African Airways is accelerating its growth plans, confident that a continued white domination of Southern Rhodesia's government will protect the company's interests if Northern Rhodesia and Nyasaland withdraw from the Central African Federation after independence (AW Jan. 14, p. 40).

A heavily subsidized operation only four years ago, the airline has elected to build revenues on an improved regional service, rather than risk a costly competitive battle on new long-haul routes.

To accomplish this, CAA has been strengthening its financial reserves toward the proposed purchase of three British Aircraft Corp. BAC 111 turbojets. It also is conducting a concentrated sales program aimed directly at Africa's largest white market—the 3,000,000 whites just across the border in the Union of South Africa.

The airline concedes that it could face many political problems if the federation is disbanded. Among these would be the continued joint financing of the airline. In addition, African hopes for an East African Federation, to include Northern Rhodesia and Nyasaland, conceivably could result in these two countries dropping their participation in CAA and granting route and traffic rights to another airline.

But the multiplicity of independence possibilities and the complexity of arguments over federation in both East and Central Africa indicate that these political complications may not arise for many years, if at all.

Depending on whether CAA can maintain the status quo, it has also suggested that it might enter into consortium with East African Airways to provide international service to Europe. CAA's sole European service now is handled under contract with British Overseas Airways Corp., which has conducted the service since 1957. Bearing a CAA flight number, the BOAC Comet flight to London is identified as the "Rhodesian Comet." This agreement will expire in 1967.

Because of its geographical location and population distribution, CAA's situation is somewhat different than that of other African carriers, most of which depend on long-haul, international traffic for profits.

Other than an occasional charter flight and the BOAC contract, CAA has no true long haul-routes, and route expansion is severely limited by competition from EAA to the north, South African Airways to the south and DETA, the flag carrier of Portuguese Mozambique, to the east. To the west, CAA would have to fly 1,200-mi. to reach Luanda, the capital of Portuguese Angola, which also has its own carrier, DTA.

Longest scheduled stage lengths on the CAA system from Salisbury are 1,200 mi. to Nairobi, Kenya, via Dar es Salaam; 600 mi. to Johannesburg, South Africa and 800 mi. to Durban.

The federation covers an area larger than the combined acreage of New York, Texas and California. More than half of the federation lies in sparsely-settled Northern Rhodesia and Nyasaland, which have a combined white population of less than 87,000, compared with Southern Rhodesia's 227,000. African population in the entire federation is about eight million.

Aside from the tourist attractions of Victoria Falls and Kariba Dam, both of which straddle the Zambeze River separating Northern and Southern Rhodesia, the only major business centers in Northern Rhodesia are Lusaka and Ndola, a rich copper mining center near the Republic of the Congo. In Nyasaland the major business center is Blantyre.

Against this background CAA feels its best promise for increased revenues lies in the development of traffic to and from the highly-developed commercial centers in South Africa.

However, the airline has long supported a policy of maintaining adequate service into remote and unprofitable areas as a necessary public benefit, and operates a daily "bush service" through the western area of Northern Rhodesia and Nyasaland.

A fleet of five de Havilland Beavers is used on two separate routes, one of which serves Sesheke, Senanga, Mongu, Kalabo, Lukulu, Balovale, Mankoya and Mumbwa in Northern Rhodesia. The other serves Zomba, Ft. Johnston, Monkey Bay, Lilongwe, Salima, Mzimba, Mzuzu, Kabonga and Ft. Hill in Nyasaland and Mbeya in Tanganyika.

One route covers 800 mi. and the other 775 mi. In more than 20 years of bush operations, the airline has never had a fatal accident, despite the fact that weather conditions are violent for five months of the year, during which there is an annual rainfall of 48 in. Most of the 3,000-ft. long landing strips are grass plots hacked out of the bush, and only a few have refueling facilities.

A few runways are gravel surfaced and can be used all year round, while the 4,800-ft. long Mungu runway is constructed of a double-layer of three million bricks on a sand base with a tar topping. Station managers on the bush system are usually the wives of local District Commissioners.



FLEET OF SIX DE HAVILLAND BEAVERS provide daily "bush service" in Northern Rhodesia and Nyasaland. One route operates near the border of Portuguese Angola and the other near Tanganyika. Typical route covers six stops in two days.

As in many areas of Africa, bush service is the only available communications link between people in the "back country" and more populated centers. As an example, Balovale is 450 mi. from the nearest railhead at Lusaka. In addition to passengers, the Beavers carry a variety of cargo, including medical supplies, mail, hides, live animals and produce, along with the week's grocery supply for bush stops. Last year the Beavers flew 425,000 mi. of the CAA system's total aircraft miles of 3.5 million.

Financially, the company is doing well. It turned in an operating profit of $700,000 last year after paying $369,000 in interest on long-term debt.

CAA also has shortened the depreciation life on its fleet of five Viscounts, which will be fully depreciated by 1965. Utilizing funds carried forward from the previous year, the airline set aside $394,000 for this purpose. Six Douglas DC-3s and five de Havilland Beavers already have been completely written down.

In preparation for the BAC 111s, which will replace the Viscounts, CAA added $560,000 to its cash reserves and expects to pay 50% of the total cost of the $9 million order from company funds. Financial terms of the purchase have not been completed and it is expected that a loan will be acquired either from the Colonial Development Corp., which financed the Viscounts, or the British Aircraft Corp.

Cash position of the airline, in terms of both cash on hand and deposits held by the federation government, approximated $8.4 million last year.

On the sales front, CAA has stepped up its advertising budget to a point where it now accounts for 3.5% of its estimated annual revenues. Last year the advertising expense was $224,000. Bulk of the program is aimed at developing a two-way movement of traffic between the federation and the Union of South Africa for vacation travel.

Because of the federation's landlocked location, CAA emphasizes beach holidays for Rhodesians at such points as Durban and Capetown, South Africa. Television is the favored medium because it is cheaper than newspapers and provides a wide exposure.

South Africans are urged to use CAA's "Flame Lilly" tours to such attractions as Victoria Falls and the Kariba Dam on the Zambeze River. Revenues from this tour increased 60% last year and reached a point where it was necessary to turn away customers in peak holiday periods because of insufficient accommodations. There is no television network in South Africa and the airline divides its advertising between newspapers and filmed commercials shown during theater intermissions.

CAA also maintains several other tour arrangements with its schedule pooling partners, BOAC, EAA and South African Airways.

Internationally, it also is exploring the feasibility of special package tours from both the U.S. and Britain. Cost of the tour would be approximately 20% above the published one-way fare. CAA contends the tours can legally be conducted from Britain under cabotage rights, but that the inclusion of the U.S. might bring a rejection from the International Air Transport Assn.

Among the carrier's most popular fares is a "Skybus" service which emphasizes the time and expense saved by flying instead of driving. As an example, advertisements for the Salisbury to Ndola flight, a distance of 379 mi., point out that the flight is made in 1 hr. 40 min. as compared with more than 10 hr. by auto. Cost of the flight is $64 round trip. DC-3 aircraft with 38 seats and African hostesses are used.

Other sales innovations being considered are the purchase of a fleet of rental autos for "Skybus" passengers' use at their destinations, and the use of a credit card system.

About 40% of CAA's pilots are recruited from the Rhodesian and South African air forces, while the balance are veterans of the Royal Air Force and British aviation experience. They are members of the Pilots Assn. of Central Africa. Maintenance technicians are organized under the Air Transport Union, and the company has never had a strike by either union.

Because of the severe flying conditions that predominate during Africa's seven-month rainy season, recurrent training and early retirement are required by CAA.

The airline has been using a Viscount simulator and plans to order a BAC 111 simulator for recurrent pilot training. Pilots are now required to undergo instrument landing system training for every field served and receive separate proficiency and instrument checks every six months. To this are added two route checks a year, plus a test whenever the pilot has returned from a leave exceeding 30 days.

Company policy requires pilots to retire at age 50. This limit can be exceeded only by permission of the airline's general manager. Originally, the pilots wanted a 45-year retirement age, then accepted the company limit of 50 and now favor retirement at age 53, the company said. Only one CAA pilot has reached retirement age and the next two will not do so until next year.

Typical Viscount schedule employs a three-man crew, with the third man serving as a combination flight engineer and radio operator. Daily crew time averages 12 hr. Last year the Viscounts averaged 13,000 flying hr. each. DC-3s averaged 14,000 and the Beavers 10,000 hr.

Using a progressive maintenance system, CAA has about 428 people employed in maintenance from a company total of 1,200 employes. Out of the 428 in the engineering division, 125 are Africans and 278 are Europeans.

All highly technical maintenance and overhaul work, such as powerplant assembly, is handled by European mechanics, most of whom are graduates of a rigid five-year apprentice program conducted by CAA and the federation government.

Candidates for the course must have the equivalent of six college credits. After selection they must undergo a six-month course in tool handling and machine shop practice. Subject matter is added in increments of six months, and after two years, a major subject is selected on the basis of the student's past record.

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ASPEN AIRWAYS, scheduled third-level type airline operating between Denver and Aspen, last year carried more than 5,000 skiers and tourists to the Rocky Mountain resort. Flight requires about 40 min., compared with about 7 hr. by surface transportation. Aero Commander shown is one of three company aircraft.

Skiers, Tourists Boost Operations Of Third-Level Colorado Carrier

Aspen, Colo. — Aspen Airways, a scheduled and charter third-level type airline operating between Denver and Aspen, carried over 5,000 passengers last year, a 30% increase over 1961, which in turn was about 35% higher than 1960.

These figures are explained by the fact that skiers from the east and south, headed for the popular slopes of Aspen, can fly here from Denver in less than 40 min., while surface transportation takes about 7 hr. When Attorney General Robert Kennedy and Sen. Ted Kennedy came here recently for a ski holiday, they flew an Aspen Airways charter.

Scheduled Service

Aspen Airways operates two twin-engine aircraft for its scheduled service, an eight-passenger Beech D-18 and a six-passenger Aero Commander 500B. Between Dec. 15 and Apr. 15, it operates one scheduled trip in each direction each day, and resumes the service from June 15 to Sept. 15 to accommodate tourists and businessmen attending Aspen seminars. During the other five months service is limited to charter operations. These often use a four-place Piper Apache with supercharger that provides sea-level performance at 21,000 ft.

Because of altitude limitations on the twin-engine aircraft, lack of instrument weather facilities at Aspen's Pitkin County Airport and the fact that a passenger usually rides the co-pilot's seat, Aspen Airways flies only during visual flight rules (VFR) weather. Despite this, and the fact that more than half its scheduled operations occur during winter months, the company completed more than 85% of its scheduled flights, according to C. B. Simons, vice president and general manager. Simons, an airline veteran with more than 16,000 hr. time, is one of two company pilots. The other is Clyde Bonham, another 16,000-hr. veteran.

Aspen is 110 air miles from Denver, but there are three mountain ranges with peaks ranging above 14,000 ft. between the two cities. Although the company has modified its D-18 to reduce its weight for operation at Colorado altitudes, normal cruise altitude is under 13,000 ft. for both the Beech and Aero Commander, Simons said. This means the pilots must thread their way through the passes, so the air distance normally runs about 130 mi. Sometimes it is necessary to take more lengthy detours to maintain VFR flight.

The planes' weight-altitude limitations are aggravated by the fact that skiers normally travel with considerably more baggage than tourists.

If the skier brings his own skis and boots, his baggage may weigh around 80 lb. or more. Aspen Airways allows 40 lb. free of charge, with another $1.50 charge for the skis.

The one-way fare between Denver and Aspen is $23.50, including tax, for the 40-min. flight. The fare by rail or bus from Denver to Glenwood Springs, and then by bus to Aspen, is about $8, but total travel time is about 7 hr.

Runway Extension

Pitkin County Airport here has a hard-surface 5,200-ft. runway, which will be extended soon to 7,800 ft., according to Simons. The airport has no runway lights, approach aids or radio—only a wind sock. The runway slopes down to the northwest direction, and all takeoffs are in this direction.

In the 10 years since he first came here as a skier and decided to set up a charter operation, Simons said, Aspen Airways has not had a single accident. About five years ago, the company obtained a license for scheduled operations from the Colorado Public Utilities Commission.

Aspen Airways receives no subsidy, Simons said, and it seeks none. In addition to the two pilots, the company has only one other full-time employe, who handles reservations. These usually are made well in advance, either directly or through one of the major airlines that serve Denver—Braniff, Continental and United. An extra section is added to the scheduled flight when passenger load warrants.

The combination of scheduled service and charter operations has given the company a modest profit for the past five years, Simons said. Corporation president is James F. Ferry, a director of Continental Motors Corp.

Aircraft Maintenance

The local airport has one mechanic for routine service. General maintenance is performed at Denver's Stapleton Airport by Combs Aircraft Co. on the Beech and by Clinton Aviation for the Aero Commander and Apache.

Aspen Airways aircraft are equipped with oxygen for passengers, but it seldom is used, Simons says. Those who come to ski will be exerting themselves far more heavily on the slopes at altitudes up to 11,300 ft. without oxygen and, therefore, usually do not require it in the more passive role of passengers at altitudes only slightly higher.

Departure time of the scheduled flight from Denver to Aspen is changed during the winter months as spring approaches. The additional daylight hours permit a later departure before darkness settles on the Pitkin County Airport.



THE FLEXIBLE MEN Never has man faced so formidable a combination of unknowns as in the exploration of space. It is a challenge that demands investigation along the entire spectrum of the scientific disciplines; it represents a compendium of scientific thought that is being revised and refined hour by hour...by men of widely diverse scientific backgrounds.

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

SHORTLINES

► **Air Transport Assn.** has named a committee of top airline executives to evaluate a proposed industry advertising campaign which may carry an annual budget as high as $5 million.

► **American Flyers Airline Corp.** has purchased three Lockheed Electra turboprop transports for use in domestic and overseas charter flights.

► **Bonanza Air Lines** has reported a 36.3% gain in revenue passenger miles in 1962 over the 1961 total. Available seat miles for the period rose 24%. Load factor in 1962 was 52.5%, contrasted to 47.8% in 1961.

► **Braniff Airways** has contracted with General Precision Systems, Ltd., of England for the purchase and installation of a BAC 111 flight simulator. The unit will be installed at Love Field, Dallas, in September, 1964.

► **British Overseas Airways Corp.** will reschedule its transpacific flights so that passengers flying from New York and San Francisco to Tokyo and Hong Kong may stop over one or more nights at Honolulu.

► **Civil Aeronautics Board** has authorized local service, Hawaiian and Alaskan carriers to meet during the next 90 days to discuss adoption of a single fare allowing unlimited transportation over a specified period for foreign visitors to the U. S. on all airlines in the group.

► **Federal Aviation Agency's** new regulation requiring installation of distance measuring equipment on all civil transport aircraft flying instrument flight rules (AW Jan. 28, p. 50) has been amended to exclude specifically foreign aircraft operating into the U. S.

► **FAA predicts** that the number of airline passengers in the Washington, D. C., area will increase annually from the present 4.9 million to 8.3 million in 1967. Passengers are expected to be divided evenly between Dulles International and Washington National.

► **United Air Lines** has adopted portable hangars for use in line maintenance work at certain airports where regular hangars are not available. The portable hangars are constructed of corrugated aluminum sheets on a structural steel frame with plywood floors. They are heated and can be moved to cover an aircraft wing for engine maintenance during inclement weather.

AIRLINE OBSERVER

► Member carriers of the International Air Transport Assn. carried 18% more passengers in 1962 than in the previous year. Load factor for the group in 1962 was 51.6%, an increase of 0.5% over the previous year. Available seat miles rose 36.7%. First-class traffic decreased by 15%, while economy class traffic increased 23.3%, accounting for 90.8% of all passengers carried.

► **Great Britain and Israel appear to be deadlocked in renegotiation of their bilateral air transport agreement. British team re-evaluating the agreement involving El Al fifth freedom rights beyond London was preparing its recommendations to the Minister of Aviation last week. Israel is seeking a 12-month extension of present rights, but British contend that the extension to New York through London is more valuable than concessions offered to British carriers at Tel Aviv. Thus, British are pressing for more freedom of routing from Tel Aviv while applying additional pressure to reduce El Al flights from London to New York, now three weekly.**

► Scandinavian Airlines System and Austrian Airlines have signed an agreement covering the pooling of air services to the Middle East. Under the plan, SAS will provide Caravelle transports and flight crews for the operation. Later, AUA will contribute Caravelles it plans to acquire to the pool. Flights will operate from Copenhagen, Dusseldorf and Vienna to Istanbul, Beirut, Damascus and Cairo.

► **Aeroflot fell far short of its 1962 passenger traffic target, according to data released by the USSR's Central Statistical Board. The Soviet airline monopoly handled 24% more passengers than last year, the report stated. This would indicate that Aeroflot flew around 27 million passengers in 1962, compared with a goal of 30 million and with the official total of 21.8 million passengers in 1961.**

► First open industry support for United Air Lines' proposal for a single class service (AW Nov. 19, p. 42) came last week from L. B. Maytag, Jr., president of National Airlines. In a surprise statement in Houston, Maytag said "I now place myself on record as being an advocate of a single class" fare. He noted that "We are coping with 16 different fares, many of them cut-throat and absurd."

► **Proposal to adopt a multilateral system of exchanging international air routes (AW Feb. 4, p. 39) appeared shelved last week. Special Paris meeting of the Commission on Air Transportation of the International Chamber of Commerce voted down a proposal to establish a special study group to explore the possibility of a multilateral air transport agreement among nations. The study, which was opposed by the U. S., was referred back to national councils of the chamber.**

► Civil Aeronautics Board last week reported that the fatality rate for U. S. certificated air carriers was 0.27 per 100 million passenger miles for 1962, compared with 0.29 in 1961. U. S. supplemental air carrier industry had a perfect safety record in 1962, compared with a fatality rate of 9.7 per 100 million passenger miles in 1961. U. S. certificated scheduled international airlines operated without a single fatal accident for the second consecutive year.

► **Proposal to grant the U. S. President authority to compel the submission of certain labor disputes to impartial third parties for decision as a means of avoiding strikes has been offered by George A. Spater, executive vice president and general counsel of American Airlines. Spater explained that collective bargaining would continue as done now, but if the parties failed to settle by voluntary agreement, "then the President could direct that it be settled by the decision of outsiders."**

► United Arab Airlines last week accepted a U. S. offer of two routes into New York. The routes, basically the same as those offered in earlier bilateral discussions (AW Jan. 28, p. 45), are New York-Cairo via London and New York-Cairo via Paris. European en route stops for both include Ireland, Germany, Switzerland and Greece.



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The BAC One-Eleven will give better than the best Viscount short haul economics and do it with quicker turn-round and a cruise speed of 540 mph.

The BAC One-Eleven will come off the production line this year. It has already been ordered by: BRITISH UNITED AIRWAYS, BRANIFF INTERNATIONAL AIRWAYS, MOHAWK AIRLINES, KUWAIT AIRWAYS, CENTRAL AFRICAN AIRWAYS and an undisclosed airline. Passenger appeal and low break-even factors make the BAC One-Eleven the first choice for all short haul operators.

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BAS29

Large Solids Feasibility Awards Due Soon

Contractors for feasibility demonstrations of the first generation of solid-propellant rocket motors beyond the 120-in.-dia. unit now under development for the Titan 3 booster may be selected by Mar. 11.

Competition winners will be named by a joint board composed of representatives from USAF Space Systems Div., the program technical manager, and National Aeronautics and Space Administration. There will be no de-briefing for unsuccessful competitors. Contract negotiations may begin May 1, following approval of company selections by Air Force Systems Command, USAF headquarters and Defense Dept.

Two sizes of motors—260- and 156-in.-dia.—will be involved in this new NASA/DOD effort. Industry proposals are due Feb. 15 for technical aspects and Feb. 25 for cost estimates of the program (AW Jan. 21, p. 37).

This procedure is one of the two-step proposal evaluation systems that have been widely discussed in industry, and is one of the first examples of its use in a major program.

Short-length motor firings of the 260-in.-dia. motors will be conducted to determine problem areas in this size of solid motor—an unexplored regime involving many unknowns. The 156-in.-dia. solid motor demonstrations will involve firings for component investigation and to evaluate advanced technology for large solids, particularly with regard to nozzles and thrust vector control. All motor cases will be steel.

Full-length Projections

In addition, projections related to full-length motors in the 260- and 156-in.-dia. sizes will have to be defined in the industry proposals, but will not be incorporated as bids. This will give SSD and NASA a preview of the propulsion industry's large-solid motor concepts, without initiating a formal study for full-scale motors.

Over-all program effort is not tied to any specific space booster, but there is a strong possibility that the program may lead to demonstration of full-scale 260-in. or larger solid motors in Fiscal 1965-66. Sizes as large as 280 and 320 in. have been discussed as possibilities.

Companies can bid for any or all of four separate packages:

• **Bid package No. 1** includes firings of two short-length 260-in.-dia. motors. First of these is to be a minimum-risk unit to be readied in a minimum time of not more than 18 months and will involve no thrust vector control. Second motor, to be fired within 24 months, will be used to investigate improvements specifically related to a full-length 260-in. configuration, and will include thrust vector control. Bidders will be expected to define a program to demonstrate two full-length, 6 million-lb.-thrust, 260-in. motors in their proposals for the short-length firings. This program outline for a full-length motor will not be considered a bid. Bid package No. 1 probably will be awarded to two contractors—one for each 260-in. short-length motor. It is possible the program may be broadened to have each contractor fire both motors.

• **Bid package No. 2** also involves a minimum-risk program in materials and fabrication techniques. It includes firing of a 156-in.-dia. motor using a fixed nozzle to develop 3 million lb. thrust for a short duration.

• **Bid package No. 3** will involve a single-segment 156-in.-dia. motor incorporating a movable nozzle for vector control of the 1 million-lb.-thrust exhaust stream.

• **Bid package No. 4** calls for two 156-in.-dia. motors to demonstrate thrust vector control using a jet tab inserted into the exhaust stream.

Design objective of the short-length 260-in. motor in the first bid package is to permit scaling to a full-length motor with minimum design change. It's estimated that this full-length motor would produce a total impulse of about 700 million lb./sec. There is a possibility that this total impulse could increase as much as 25%, depending upon technology advances.

First short-length 260-in. test motor is projected to have an average thrust of 3 million lb. and a maximum thrust of 3.5 million lb., with an average chamber pressure of about 550 psi.

Propellant with have a specific impulse of approximately 242 sec. Web action time (burning time from 75% of maximum pressure to beginning of tail-off) will be about 110 sec., to produce a total impulse of approximately 350 million lb./sec. Mass fraction should be about 0.88.

By comparison, a full-scale 260-in. motor developing about 6 million lb. thrust is expected to have a maximum thrust of about 7 million lb. Motor mass fraction is expected to increase to about 0.91, and sliver loss (propellant which remains unburned at the end of web action time) is expected to be about 7% maximum. Chamber pressure and web action time are expected to be the same as for the short-length motor. Pressure-time trace for both configurations is not expected to vary more than 10% from neutral (optimum chamber burning for the design).

Short-length 260-in. motor is expected to use a butadiene-type fuel, with ammonium perchlorate as the oxidizer and aluminum powder added for burning stabilization and increased specific impulse. Use of inert slivers will not be permitted to improve motor tail-off characteristics.

Studies will be performed for the full-length 260-in. motor to obtain an optimum grain design prior to beginning short-length design.

Nozzle for the short-length 260-in. motor will be a fixed, state-of-the-art design. A sub-scale development program will evaluate throat and exit cone materials. The sub-scale throat, about 7 in. in diameter, probably will involve use of both ablative and high-density graphite inserts.

Both pyrogenic and hypergolic types of ignition will be considered.

In addition to providing instrumentation for recording normal motor parameters, data will be required on characteristics of vibration, acoustics, infrared radiation, microwave attenuation and increase in case girth and length during firing.

Government Facilities

Maximum use of government facilities will be expected. There is a possibility that two 80-ft.-deep silos at Edwards AFB, Calif., originally constructed for Minuteman ICBM tethered tests, could serve for on-site case welding, pouring and firing of a 260-in. motor up to one-half length (60 ft.).

Second short-length 260-in. motor will be used to demonstrate advanced technology not incorporated in the first short-length version. Mass fraction of the second motor is expected to be approximately 0.90.

Choice of the thrust vector control system for the second motor will be the responsibility of the contractor. The system is expected to afford about 3 deg. of exhaust stream deflection.

Nozzle for the second motor will be evaluated initially in sub-scale tests, and designs are expected to allow scaling to nozzle configurations adaptable for 6 million-lb.-thrust motors. Design of the nozzle exit cone will be a critical factor in this evaluation.

Contractor will have to submit a preliminary design of a 6 million-lb.-thrust flight-weight nozzle which will incorporate refinements indicated by the short-length second motor and sub-scale firings.

The 156-in.-dia. motor in bid package No. 2 primarily will be a nozzle evaluation unit directly supporting the short-length 260-in.-dia. motor in bid package No. 1. Incidental objective will be to demonstrate operating characteristics of the 156-in. motor. This program probably will be conducted by one of the two contractors for the 260-in. motor tests.

Static firing of the 156-in. motor is to be accomplished in 15 months. The contractor will be able to use rocket test facilities at Edwards AFB.

Motor configuration may be segmented or monolithic and will mount a fixed nozzle which will incorporate both segmented-graphite and ablative reinforced-plastic throat inserts for successive tests. The nozzle design will have to be approved by SSD.

Propellant will be a polybutadiene type, and the grain will be configured to approximate that expected to be used for the short-length 260-in. motor. The igniter also will form the basis for the type to be used in the 260-in. motor.

The 156-in. motor will contain approximately 700,000 lb. of propellant. Average thrust will be about 3 million lb., and web action time about 50 to 60 sec. Total impulse is expected to run about 165 million lb./sec.

Bid package No. 3's 156-in. motor will be a single-segment, flight-weight configuration using a polybutadiene-type, cylindrical-grain propellant. Case material will be 18% nickel steel.

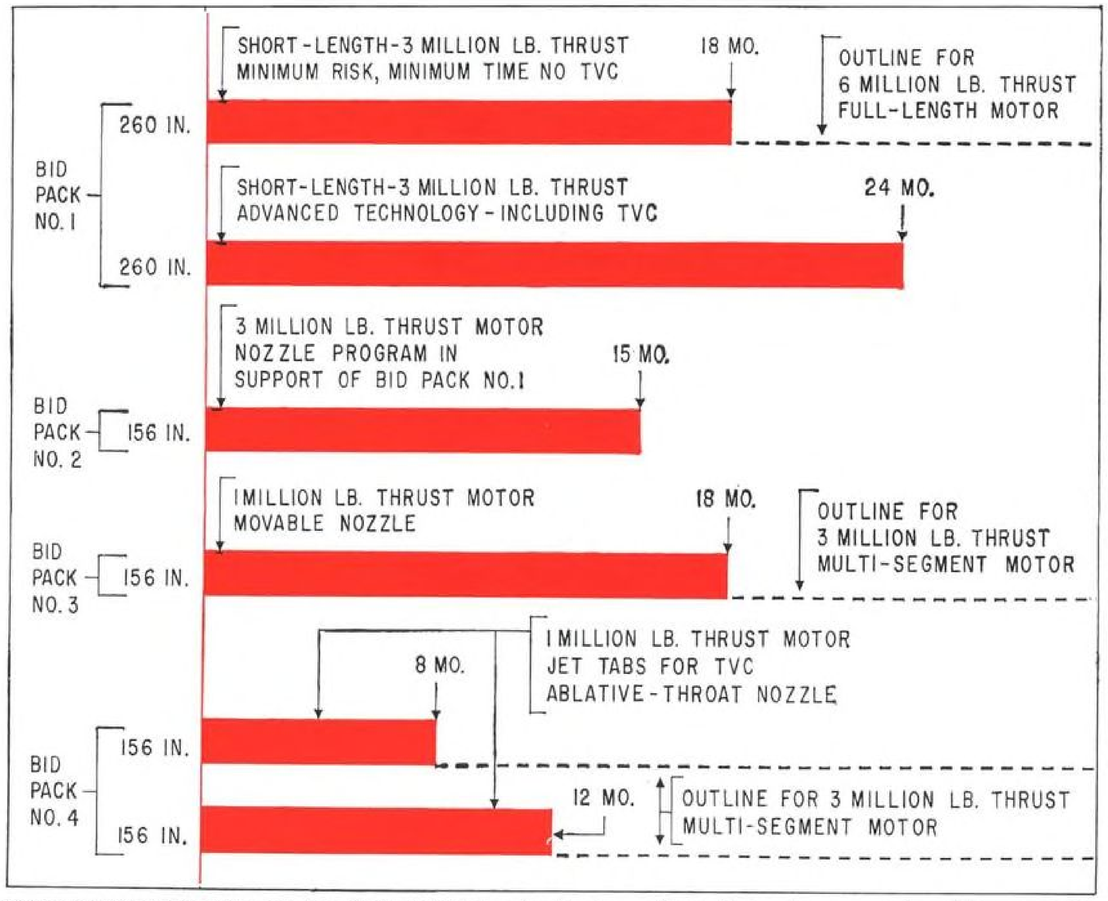
Design of the aft-closure section of the single-segment motor must permit adaption for use with a multi-segment motor nozzle, without changing the configuration of the section.

Prime purpose of this motor test is to demonstrate a movable (gimbaled) nozzle and its actuation system for thrust vector control. The demonstration is to be completed within 18 months. Nozzle design probably will be projected to have a throat diameter of about 38 in., which may approximate the nozzle throat diameter on the 120-in.-dia. solid motor now under development for the Titan 3 booster. Nozzle should have a vectoring capability of approximately 8 deg. from center, which is roughly equivalent to the capability of Minuteman first-stage nozzles. The gimbal cycle response rate necessarily will be very rapid.

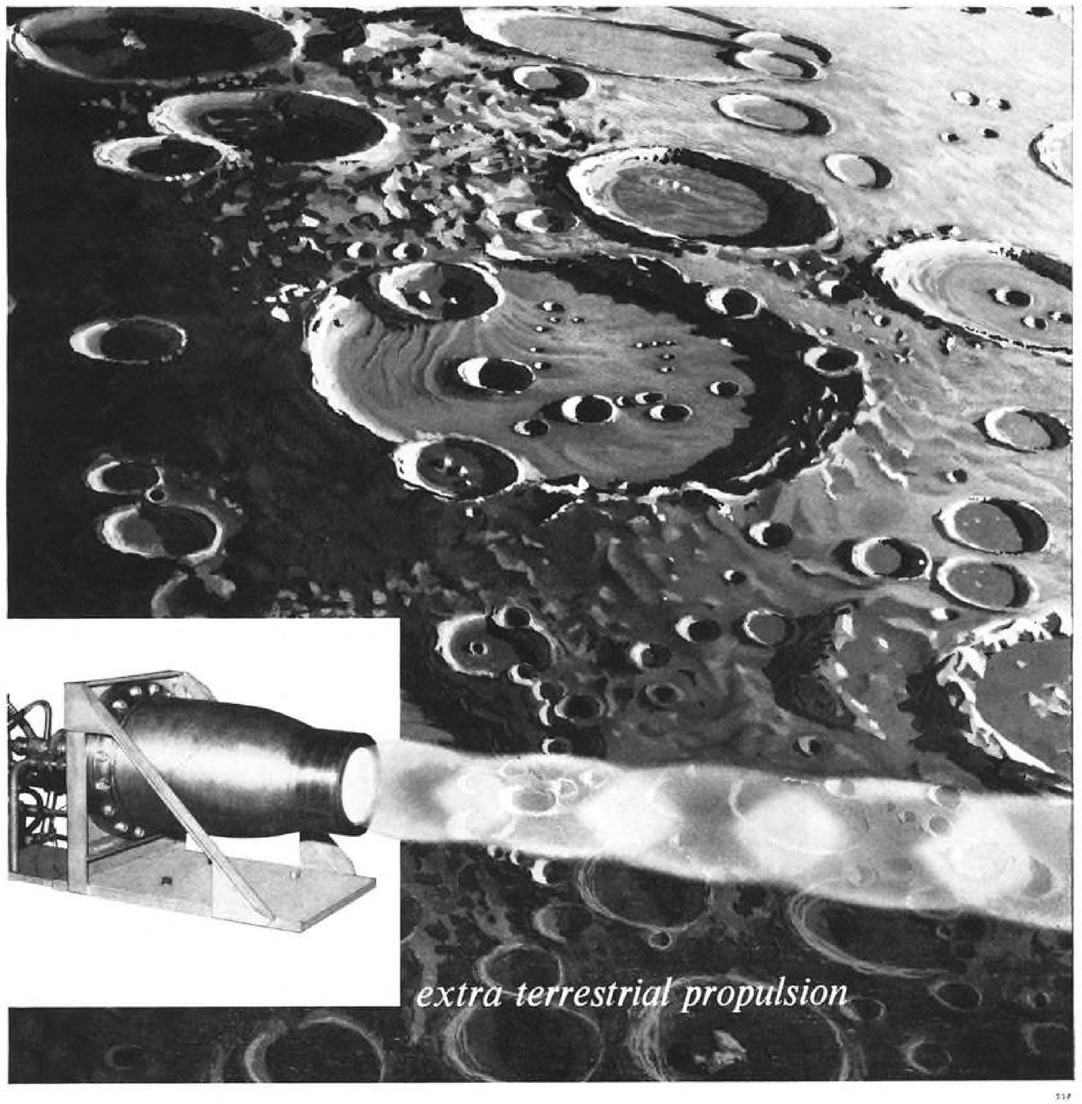
Sub-scale tests to verify the nozzle design will be conducted before building the full-scale nozzle, which will have to accommodate about 1 million lb. thrust with the single-segment motor. Sub-scale motor tests will use a nozzle with a throat diameter of about 15 in., and a firing duration of about 2 min.

Program for this motor is expected to include rail transportation of a loaded unit from the contractor's plant to Edwards AFB to record physical details in transit, such as impact forces, vibration, temperature changes, etc.

Proposal for this motor also will be required to contain plans for develop-



GRAPH ILLUSTRATES TASKS and time limits established under the large solid-propellant motor program, for which requests for proposals in the form of four bid packages have been issued to industry. Motor sizes include both 260- and 156-in.-dia. Contractors for feasibility demonstrations will be required to submit outlines for possible follow-on efforts. Program represents Air Force and National Aeronautics and Space Administration interest beyond the 120-in.-dia. units already under development.



Many space missions require rocket engines whose thrust level can be accurately controlled over a wide range. STL scientists and engineers are developing a family of such engines, including the 5000 pound bipropellant rocket engine shown above. These engines can vary their thrust across a throttle range greater than 40 to 1 while maintaining high combustion efficiency and limiting propellant residuals. With each test firing of the 5000 pound engine (and its 500 pound counterpart), the insight of STL scientists and engineers grows keener in areas of extra terrestrial propulsion. New positions have been created by this project, by STL's work as prime contractor for NASA's OGO, by its prime contractor assignment on a new series of Air Force-ARPA spacecraft, by its Systems Management activities for the Air Force's Atlas, Titan and Minuteman programs, and by other space responsibilities. Openings are in: Space Physics, Radar Systems, Applied Mathematics, Space Communications, Antennas and Microwaves, Analog Computers, Computer Design, Digital Computers, Guidance and Navigation, Electromechanical Devices, Engineering Mechanics, Propulsion Systems, Materials Research. For Southern Calif., or Cape Canaveral positions, write Dr. R. C. Potter, Dept. A-2-3, One Space Park, Redondo Beach, Calif., or P.O. Box 4277, Patrick AFB, Fla. STL is an equal opportunity employer.

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1962 USAF Space Vehicle Launches

Date	International Designation	Perigee-Apogee (Mi.)	Incl. (Deg.)	Launch Vehicle	Decay
Feb. 21	1962 Delta	104–232	81.97	Thor Agena B	3/4/62
Feb. 27	1962 Epsilon (Disc. 38)	207–377	82.23	Thor Agena B	3/21/62
Mar. 7	1962 Eta	146–427	90.93	Atlas Agena B	
Apr. 9	1962 Kappa	1,727–2,111	86.65	Atlas Agena B	
Apr. 18	1962 Lambda	98–332	73.53	Thor Agena B	5/28/62
Apr. 26	1962 Pi	*		Atlas Agena B	4/28/62
Apr. 29	1962 Rho	97–306	73.23	Thor Agena B	5/26/62
May 15	1962 Sigma	184–394	82.32	Thor Agena B	
May 30	1962 Phi	121–211	74.10	Thor Agena B	6/11/62
May 31	Blue Scout Probe				
June 2	1962 Chi (w/Oscar 2)	117–217	74.25	Thor Agena B	6/28/62
June 17	1962 Psi			Atlas Agena B	6/18/62
June 18	1962 Omega	227–253	82.11	Thor Agena B	
June 23	1962 Alpha Beta	130–149	75.09	Thor Agena B	7/7/62
June 28	1962 Alpha Gamma	130–397	76.04	Thor Agena D	9/14/62
July 18	1962 Alpha Zeta			Atlas Agena B	7/25/62
July 21	1962 Alpha Eta	122–217	70.29	Thor Agena B	8/14/62
July 24	Blue Scout Probe				
July 28	1962 Alpha Theta	129–250	71.06	Thor Agena B	8/24/62
Aug. 2	1962 Alpha Kappa	120–218	82.25	Thor Agena D	8/26/62
Aug. 5	1962 Alpha Lambda			Atlas Agena B	8/6/62
Aug. 23	1962 Alpha Omicron	388–524	98.62	Blue Scout	
Aug. 29	1962 Alpha Sigma	114–250	65.16	Thor Agena D	9/10/62
Sept. 1	1962 Alpha Upsilon	188–417	82.81	Thor Agena B	
Sept. 17	1962 Alpha Chi	123–382	81.85	Thor Agena B	11/19/62
Sept. 29	1962 Beta Beta	118–240	65.41	Thor Agena D	10/14/62
Oct. 9	1962 Beta Epsilon	131–262	81.99	Thor Agena B	11/16/62
Oct. 26	1962 Beta Kappa	120–3,452	71.41	Thor Agena D	
Nov. 5	1962 Beta Omicron	122–251	75.02	Thor Agena B	12/3/62
Nov. 11	1962 Beta Pi			Atlas Agena B	11/12/62
Nov. 21	Blue Scout Probe				
Nov. 24	1962 Beta Rho	128–202	65.15	Thor Agena B	12/13/62
Dec. 4	1962 Beta Sigma	119–174	65.00	Thor Agena	12/8/62
Dec. 13	1962 Beta Tau (with Injun and 3 unspecified piggybacks)	152–1,720	70.37	Thor Agena	
Dec. 14	1962 Beta Phi	126–241	70.00	Thor Agena	
Dec. 18	Blue Scout Probe				
	TRS-1 (radiation sensors)			Thor Agena B	

* Leader lines indicate information was not available.

ment and preliminary flight rating tests for a multi-segment configuration developing approximately 3 million lb. thrust. Although part of the proposal, this plan will be only a projection and will not be a specified task for the potential contractor in the initial feasibility program.

Two single-segment, 156-in. motors built under bid package No. 4 will have single fixed nozzles. Prime objective will be to demonstrate thrust vector control using a jet tab system. The jet tab will have to be mounted on the motor, and the basic motor will be designed to be transportable.

Motor cases will be flight-weight and designed for reuse. Propellant will be a polybutadiene type.

Nozzle for the first of the two engines will be supplied by the Air Force and will have an ablative reinforced-plastic insert for the 38-in.-dia. throat. Nozzle for the second engine also will have an ablative throat, but will be designed and supplied by the contractor. Jet tabs will be designed and manufactured by the contractor. Although the jet tab for engine No. 2 will be evaluated on a single-segment motor, it will be designed for use on a multi-segment engine.

This probably will be an approximation of conditions which would be encountered in the 120-in.-dia. solid motor for Titan 3.

Tab vectoring capability will be about a 5-deg. angle of stream deflection. Tab motion rate will be rapid, perhaps 1½ cps.

Performance requirements for the first motor are expected to include a thrust capability of about 875,000 lb. Duration will be about 105 sec. for burning about 400,000 lb. of propellant.

Motor No. 2 will burn for about 120 sec. and have a corresponding increase in propellant weight.

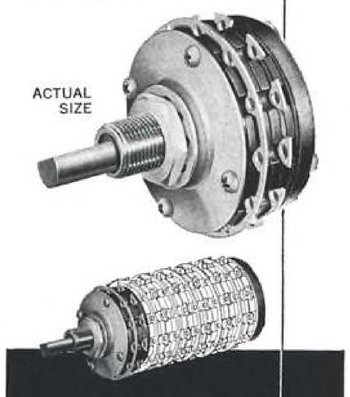
As part of the proposal, an outline will be submitted for follow-on development and test of a multi-segment 156-in. motor. This multi-segment motor may contain about 1.5 million lb. of propellant and incorporate as many as six segments.

Mass fraction figure is expected to be slightly greater than bid package No. 4's demonstration motor, probably about 0.90.

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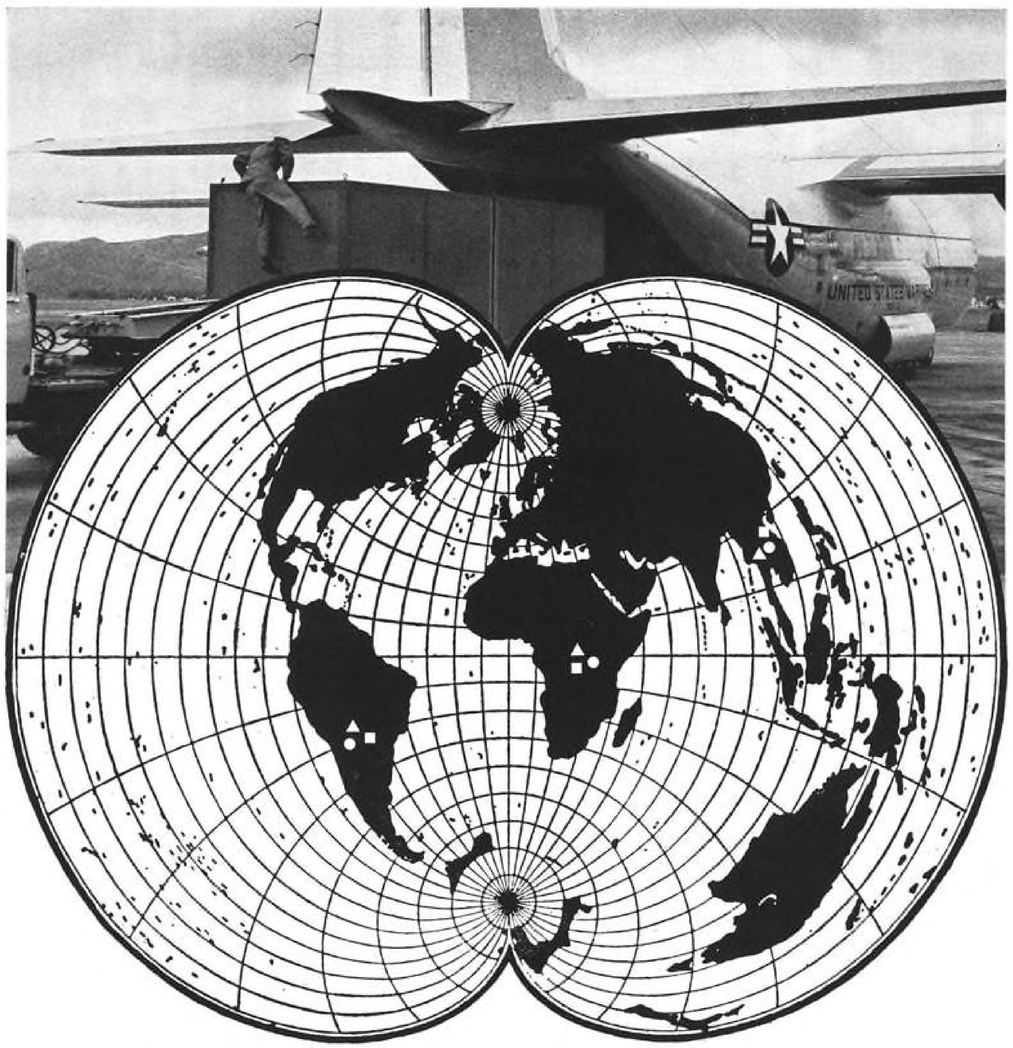


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Schirra Reports on MA-8 Flight Success

(Navy Cdr. Walter M. Schirra, Jr., made the third manned U. S. orbital flight last Oct. 3 in the Sigma 7 spacecraft (AW Oct. 8, p. 26; Oct. 15, p. 28). Aviation Week & Space Technology is publishing Cdr. Schirra's pilot report on the six-orbit flight.)

One of the main objectives of this flight was an engineering evaluation of the spacecraft systems to determine their capabilities for an extended mission. In line with this objective, we wanted to demonstrate that the consumable supplies could be conserved sufficiently to permit longer duration flights in the future using the Mercury spacecraft. Of course, most of the consumables, such as water, electrical power, and contaminant filters, will have to be increased, but it is still important to determine the long-term consumption rates.

Since this was to be an engineering evaluation, the name chosen for my spacecraft was that of the mathematical symbol for summation, sigma, with the number 7 added to it for the seven-member Mercury astronaut team. Thus was derived the name and symbol that was painted on the spacecraft, Sigma 7.

The camaraderie of everyone concerned with the flight preparations and equipment meant a great deal to me. For example, it was certainly a thrill while entering the spacecraft on launch day to see a dummy "ignition key" on the control stick safety pin. This and other small gestures really helped to make me realize that there were many other people who were interested in what I was doing. We know this inherently, but these visible examples of it mean quite a bit. Here again, sigma symbolizes the summation of the great efforts exerted by each and every man in the vast Mercury team.

The following comments are my observations and impressions of the flight from the countdown to recovery. In the period since the flight, I have taken the opportunity to refine and analyze my flight experiences. In many instances, I will submit comparisons of my observations with those of astronauts who preceded me into space. It was their pioneering efforts which helped so much to make my flight a success.

Countdown and Boost

The countdown was conducted very successfully; there were absolutely no problems. The only delay was that resulting from a temporary loss of signal from the Canary Islands' radar system, but waiting for what proved to be a rapid repair was worthwhile since they had good radar acquisition during the first orbital pass. The tracking task is critical at this time, because it provides early definition of the spacecraft trajectory.

The boosted flight itself was disappointingly short. Considerable training was conducted to prepare me for emergencies which might occur during powered flight. We so often practice system failures and aborts, either in the procedures trainer or by coordinating the trainer with the Mercury Control Center and Bermuda stations, that this practice made a very pronounced impression upon me.

This launch, in contrast, was a successful, normal flight where I encountered many new experiences. I still believe that the amount of practice we had for the period prior to insertion is important, in that here the pilot must be prepared for reaction to an emergency, rather than thinking one out.

There is no doubt about when lift-off occurred. If anything, I was somewhat surprised because it occurred earlier than I had anticipated. I heard the vernier engines start, felt them thrusting, and then heard the main engines start. During ascent, the communications with the Cape Capsule Communicator (Cape Cap Com) were perfect except for the few seconds when the noise of maximum dynamic pressure triggered the voice-operated relay and prevented the ground transmissions from reaching me. I never felt rushed, and all the events during launch were in order.

I had more than anticipated time available to me to make my system checks. My scan pattern of the instrumentation panel was developed to where it was instinctive. I thought from my training that I might have missed on making a good electrical check prior to 3 min. but subsequent to tower jettison; however, I found that I had completed that in time. There was absolutely no question as to when booster engine cutoff (BECO) occurred. The change in acceleration was quite obvious; whereas in the trainer, I could only wait for the accelerometer indication to decrease. There is no doubt, whatsoever, when these forces decrease in actual flight. Since beginning this mission, I had become familiar with check-off points for various emergencies; for example, a no-BECO abort, a no-staging abort, and an abort at 3 min. and 50 sec. after lift-off. It was a very pleasant feeling to check each of these off and put them behind me.

I knew that the launch vehicle staged without having to wait for confirmation from the Cape Cap Com, which, by the way, did come in rapid order. You can see the flashback of smoke from the booster engines as they part from the sustainer stage, and you can see the escape rocket when it is jettisoned. Unfortunately, the escape rocket blast left a light film on the window.



CDR. WALTER M. SCHIRRA, JR.

It did seem that the buildup of acceleration during the sustainer period was rather slow. As I look back, the forces I experienced while being accelerated in boosted flight seemed to be much less than the later forces of re-entry. This comparison, I am sure, is best explained by the fact that you have a breathing point at BECO, in between the accelerations, while at re-entry there is a long continuous buildup of accelerations which are equally as exciting as those during boosted flight.

Orbital Flight

At sustainer engine cutoff (SECO), the sequence panel light did not seem to help very much. All the lights were somewhat dim, and I was made aware of these events better by the feel and sound than by the sequence light itself drawing my eye to it. After SECO, I immediately selected the auxiliary damping mode, knowing from my previous training that there was no rush, selected fly-by-wire, low, on the thrust select switch, and commenced turn-around. I resisted every impulse to look out of the window at this point, as I wanted to make this a fuel-minimum turnaround by strictly monitoring the gyro instruments. I was pleased to note that I got exactly the turnaround I wanted in the fly-by-wire low control mode, including approximately 4 deg. per second left yaw. I had no trouble with any of the low thrusters at this time or at subsequent times during the flight. I attained retroattitude at about 6 min. and 50 sec. after lift-off and then selected Automatic Stabilization Control System (ASCS) dropping into this automatic-pilot mode without any high thruster action.

After turnaround, I observed the sustainer stage right where it had been predicted to be, and I was very intrigued. I was somewhat surprised to see the sustainer engine pointing toward me. By this, I mean that it was basically in an attitude where it must have turned lengthwise 180 deg. It was moving very, very slowly in relation to its insertion attitude, although it had managed to make a 180 deg. turnaround during the time I had made mine.

I was also impressed with the fact that it was almost black in appearance, rather than the shiny silvery vehicle that Astronauts Glenn and Carpenter had seen at this time and that I had observed on the launching pad. The white belly band of condensed moisture, the frost itself, was apparent to me. The sustainer followed the path that was predicted, and this knowledge helped to satisfy me that the attitude gyros and horizon scanners were operating properly.

I did not see any crystalline material exhausting from the sustainer engine, which Scott Carpenter had described. The sustainer, in retrospect, appeared slightly to the right of the predicted position which indicated a slight error to the left in my indicated attitude about the yaw axis.

It was a very real satisfaction to receive



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Resistance (kilohms)	0-0.1, 0-1, 0-10, 0-100, 0-1,000, 0-10,000
Frequency	0-2 Mc
Period and Time Interval	1 μsec to 10^6 sec
Ratio	1 to 10^6 sec from 1 cps to 2 Mc
ACCURACIES	
ac volts	±0.5% from 30 cps to 50 kc ±1% from 20 cps to 100 kc
dc volts	±0.1%
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the statement from the Cape Cap Com that I had at least a seven-orbit capability. As I proceeded on to the Canary Islands, the flight was textbook already. I never did feel rushed; in fact I could send a blood pressure, for example, and have little else to do. I got a good 10-min. check when the tower jettison and cap sep lights indicating spacecraft separation went out. I had loss of voice transmission with the Cape Cap Com just prior to 10 min. Although I had everything under control, I did store away all events and switch positions to transmit to the Canary Islands Station, since their relaying of these data would, in turn, update the flight director and the flight controllers back at the Cape.

At about 10 min. 30 sec., I went back to fly-by-wire, low, and tracked the sustainer as it traversed down through the window, and it was a thrill to realize the delicate touch that it is possible to have with fly-by-wire, low. This touch is an art that a pilot hopes to acquire in air-to-air gunnery for getting hits. In this case the control system was so effective that it just amounted to a light touch and maybe a few pulses in either axis to get the response I wanted. I could point the spacecraft at anything I wanted to.

Relative Motion

I could see the sustainer and track it, but I do not believe the relative motion problem would be so easy to solve that I would be able to steam along and join up with it. Although the relative velocity was on the order of 20 to 30 fps., it was enough to cause a problem, particularly at a time when one is becoming acclimated to a new environment. These problems would be difficult to solve by one's own inherent trajectory analysis, since there were no systems aboard to aid the pilot in solving the problem.

I think that when we build up to the rendezvous technique, one will need more time than that just at the point of insertion to effect this rendezvous, even with proper training. The use of time while orbiting in space is only earth relative—therefore, if a rendezvous is not hurried, the task should be relatively simple.

At the Canaries, the flight itself had settled into a very normal pattern. I was content with the autopilot function, although I was convinced by this time that I had a small discrepancy between indicated and actual yaw attitude. During the sustainer tracking exercise, I had disabled the yaw reference system, and I knew that I had to wait for it to precess out the errors before I misjudged it. Having pitched up with manual proportional control, I was content that the system was exactly as I felt it would be.

The greatest effect I did notice in manual proportional control was the tail-off in thrust, rather than the response to control input. As a result, you have a tendency to overshoot, and you cannot park the spacecraft in the attitude you want without having to counteract and then recounteract a tail-off. As a result of this effect, almost every time I went from manual proportional back to automatic mode, I switched to fly-by-wire, low, to reduce these small rates to a level at which I could effect this transition without using high thrusters.

I did not have much chance to assess Africa as a viewing sight; I was much more engrossed in what was happening within the spacecraft. I did, of course, notice the color of Africa's desert terrain; it was difficult not to notice it. The country itself was exactly as I had anticipated from the orbital charts.

At this time, I was well aware of the fact that we were working up to a slight suit-system cooling problem. I decided then to devote my primary attention to solving this situation before it became necessary to end the flight prematurely. I was well aware of the fact that people on the ground were probably quite concerned and were thinking in terms of previous missions when cooling problems had persisted. Therefore, I decided I had better solve this one.

Suit Valve Increase

I did not want to increase the valve setting for the suit circuit too rapidly. I had said before the flight that I wanted to increase the flow settings about half a mark every 10 min. and this technique had been agreed upon by the system specialists. I had to go from a setting of 4 to 8, which represents about eight half marks. This procedure would therefore take about 80 min.

At a setting of about 7, I had arrested the increase in the suit and dome temperatures, and I needed about another 10 or 15 min. to get the cooling I wanted. I did not want to increase the setting too rapidly and freeze the system. I had everything monitored closely, and while I saw the temperature was still going up as I increased flow, the rate of change of the temperature was decreasing.

Even though it seemed to me that the Mercury Control Center did not have as much information as I did on this temperature problem, their request that I decrease the suit setting back to 3 was valid. I later decided that they might have made an analysis that I had not and subsequently backed down to the number 3 position as requested.

I gave the system about 10 min. to respond and saw that both the dome temperature and the suit inlet temperature were increasing again, so I immediately went from there up to about 7.5, which again arrested the temperature increases.

Once the suit circuit temperature was under control, no other problems demanded such careful attention. Continually, I metered the attitude control fuel and attempted to conserve its use. Electrical power, which is stored in six batteries, is another consumable that I wanted to conserve. There were scheduled periods during the flight where I powered down electrical systems. In addition, I conserved electrical power by recording my observations with a voice-operated relay "record-only" mode, rather than transmitting out of range of the Mercury tracking stations. Although we don't have a system for measuring the actual power remaining, battery voltage readings are a good indication, and I was very impressed that the voltage readings did not drop during the flight.

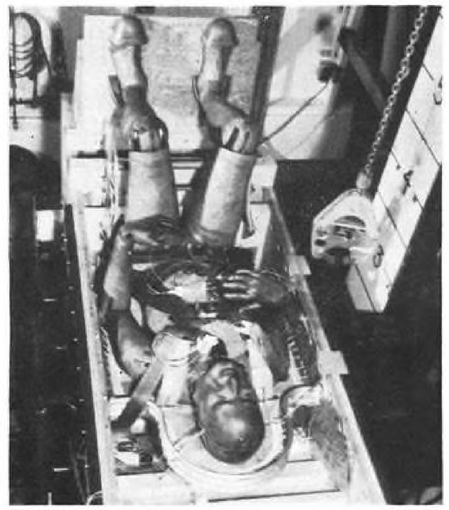
I do not believe I need to discuss the weather, the sun, or the stars. It seems more appropriate to discuss the events within the spacecraft. Each network station got as much information as I had available to give them. Once we had



Gemini Food, Waste Tests Completed

Two contractor technicians from Whirlpool Corp. emerge from full-scale mockup of Gemini spacecraft after spending two days in the capsule in a test run of experimental food and waste systems under evaluation for National Aeronautics and Space Administration. Tests conducted at Manned Spacecraft Center, Houston, included consumption of freeze-dried food, reconstituted by test subjects through addition of water, and equipment for disposal of body waste through storage or jettisoning from spacecraft.





Photos Show Couch Originally Proposed for MA-9

Close-meshed nylon net couch, originally proposed for the Mercury Atlas-9 spacecraft (AW Jan. 21, p. 55), has been eliminated from the scheduled Apr. 2 mission because of failures in cord materials (AW Feb. 4, p. 34). NASA described the problem as minor, but decided to use the standard molded couch used on previous Mercury flights. Nylon net couch consists of cross-woven strands about 1/16- to 1/20-in. dia. Strands expand under loading, undergoing a low hysteresis reaction in the process, and are differentially pre-loaded to correspond to relative mass of the pilot's body resting on each section of the couch. Net couch may be qualified in time for use on backup capsule to MA-9 for a possible longer-duration space mission, which would be designated MA-10.

solved the suit circuit problem and I had begun to feel cool, I knew we were in a "go" status and I had achieved my goal of using minimum fuel up to this point.

I had stated long ago that I wanted to do some control maneuvers other than in fully automatic mode. I also had stated that I wanted to use the automatic mode when I did not need to employ manual modes or when I was too busy to fly the spacecraft, since this is why we have an auto-pilot. Admittedly, we have taken a system that was designed to be completely automatic and then tried to build some versatility into it and give the pilot the capability of controlling the vehicle as he desires. I had become satisfied with my capability of controlling the spacecraft before I got to the Canaries, a fact which I reported to the ground. From that time on, I merely wanted to make observations that seemed to have merit and to use the control system only during those periods when I had to re-establish the attitude within the limits required to drop back into the automatic mode.

Cloud Coverage

I was discouraged by the tremendous quantity of cloud coverage around the earth and realized that it may always be a problem for certain space flight requirements. Africa, on the first and second passes, was ceiling and visibility unlimited (CAVU). The southwestern United States was also CAVU after I crossed over the ridge along the Baja California peninsula. I had a very good view, and I could easily determine yaw attitude by reference to the ground.

When I re-established orbital attitude as I came over Muchea on the third pass, I was very pleased when I talked to the Muchea Cap Com, and he and I agreed on yaw attitude exactly except for a possible 4 deg. error in left yaw, which was also indicated by my instruments. The telemetered scanner readings were coincident with the spacecraft attitudes, and I had just acquired these attitudes shortly prior to Muchea by using the moon and the planet Venus adjacent to it for visual references. They actually showed up over the Indian Ocean Ship and were very easy to work with. They both lined up to give me a roll, pitch, and yaw reference.

A smog-appearing layer was evident during the fourth pass while I was in drifting flight on the night side, almost at 32 deg. S. lat. I would say that this layer represented about a quarter of the field of view out of the window, and this surprised me. I thought I was looking at clouds all the time until I saw stars down at the bottom or underneath the glowing layer.

Seeing the stars below the glowing layer was probably the biggest surprise I had during the flight. I expect that future flights may help to clarify the nature of this band of light, which appeared to be thicker than that reported by Scott Carpenter.

It was a real treat to pass over each station and realize that they were as excited as I was and as envious as anyone could ever be. I saw the particles that John Glenn reported, and I also saw what Scott Carpenter reported as having seen. I believe that both phenomena are varied in appearance because of lighting conditions at sunrise and during bright daylight.

I checked the high thrusters in fly-by-wire prior to retro sequence, and on the first demand for each high thruster in all three axes, they worked and reacted beautifully. It was a tremendous feeling to know that I had no problem with the high thrusters becoming cool. At the nominal retro sequence, the Pacific Ocean Ship Cap Com gave a perfect count. Sequence and attitude lights actuated on time. I was sitting there ready to punch the retro sequence button. I did have the safety cover off the button and put it back on again.

At the time of retrofire, the delay by a fraction of a second in firing the first rocket seemed agonizingly long. This time is probably the most critical of the flight, at least subsequent to insertion; and you know that these rockets have to work. Again, I was poised to punch off the retrofire button to back up the automatic system. I had its safety cover off, and I guess I put it back on again sometime later. The rocket ignition was crisp, clean, and each one actuated with a definite sound. There was no doubt as to when each rocket was firing.

Retrofire Stability

The spacecraft did not seem to vary as much as half a degree in attitude during the period of retrofire. I was also cross-checking out the window and had plenty of visual cues in case things did go wrong with the automatic mode. I could see stars that did not even quiver.

Because of these cross-checks, I was aware that the ASCS was working well throughout this period and did not require any manual control inputs.

Subsequent to the retrofire maneuver, I controlled the spacecraft with fly-by-wire. I had the retro-jettison switch armed in time, and the retro package subsequently jettisoned. Control seemed somewhat loose. I guess I was probably excited about the fact that the retrorocket did ignite and did not have the cool head that I should have had. Therefore, I allowed the attitudes to drift off by perhaps 10 or 15 deg. in roll and probably the same amount yaw and pitch. The flying was not really of poor quality, but it was not up to my usual standards. I then brought



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Apollo Life Raft Tested

Experimental inflatable life raft with detachable canopy, designed and built at National Aeronautics and Space Administration's Manned Spacecraft Center, Houston, has been water-tested in development program for Apollo three-man spacecraft survival gear.

Sigma 7 up to re-entry attitude on fly-by-wire and intentionally actuated some of the high thrusters to see what it felt like. They reacted very well. At this time, I did not want to stay in the rate command mode and use a large quantity of fuel needlessly. I have always believed, with regard to fuel consumption, that the rate stabilization control system (RSCS) was the most expensive mode of the spacecraft. I came into retro sequence with 80% of fuel in each tank, which was higher than any mark, and I was quite pleased that I had that much.

After retrofire, the automatic fuel was somewhere around 52 or 53%. I easily got into re-entry attitude and felt very comfortable with it. The periscope retracted on time. I noticed that my control of the spacecraft was still loose, so I tightened it up and then went into ASCS orbit mode. I wanted to see if the logic had picked up for re-entry, and it dropped right in and held beautifully. Then, I set up rate command to give it a small check. It responded very well, and I was satisfied that the system was working.

The beginning of the actual entry into the sensible atmosphere, with the attendant cues, was a very thrilling experience. Because my vision was somewhat obscured by perspiration on the inside surface of the visor, the cue for occurrence of the important event, 0.05g, was my visual sensing of the roll rate that was automatically induced by the control system rather than by the 0.05g event light on the panel.

The spacecraft with a roll rate is something you just cannot effectively visualize in your mind. It is a very nice series of slow rolls, and you really feel as if you are back in the old fighter seat, just playing games. Looking out at the sky and at the surface of the earth which was starting to brighten up, I observed that the roll pattern was very slow and deliberate. You could integrate your attitude out of this very easily, and I knew that the spacecraft was as stable as an airplane.

The accelerations during re-entry were not severe in the sense of bothering me, but it seemed to take much longer than I had anticipated. This was predictable, but it is just one of those things that you cannot seem to approximate in real time, even on the centrifuge which I had trained in just before the flight. It is difficult to store all these cues and inputs into your mind and just pull them out quickly. Physiologically, I never felt any strain as far as the re-entry went. Each event came into place as closely as I could have wished.

As the acceleration buildup began, I could see external cues which were of great interest. I missed the hissing that John Glenn and Scott Carpenter described, possibly because I was concentrating so much on how the RSCS system was performing. I was prepared at any time to throw it into the auxiliary damping mode. As expected, an enormous amount of fuel was consumed during re-entry before the drogue parachute was deployed. After drogue parachute deployment, of course, the fuel was jettisoned normally. But before the drogue parachute was deployed, that system must have been down to approximately the 20% level. This level corresponds to a total fuel consumption from the manual tank during re-entry of some 60%, or approximately 14 lb.

There were two occasions when I nearly switched from RSCS to the auxiliary damping mode. One was while I was monitoring the fuel gage; it looked just like a flowmeter. The indicator for the manual tank was visibly dropping. Yet, I continued with RSCS because I wanted to give it every chance to complete the re-entry control task in order to evaluate it sufficiently. The second time that I thought about going to the auxiliary damping mode was when the yaw rate left the nominal 2.5 to 3 deg. per second and went off-scale (6 deg./sec.) to the left. Soon after this occurrence, it held to about 5 deg. per second and then did the typical needle fanning that we have seen in the re-entry training at Langley. Since it had started to hold again, I did not switch to auxiliary damping because I still wanted to allow the RSCS a full demonstration. However, I was perfectly content that the ASCS was working properly and it was good to know I had this powerful system ready to be switched on if needed.

I did see the green glow from the cylindrical section. It was a very pretty color, probably best described as a shade similar to limeade (a little green and chartreuse mixed together). This shade included a slightly stronger yellow cast than I had anticipated from earlier descriptions. One opinion which was ventured that might explain the green-yellow color is the copper treatment on the beryllium shingles. In fact, burning copper in a Bunsen burner flame is a good approximation to the effect that I saw. I did not see any distinctive color differences resulting from the different ablation panels that had been bonded to the beryllium shingles. There were no variances in color, such as a chromatic or a rainbow effect.

The altimeter came off the peg very nicely. I manually deployed the drogue parachute at 40,000 ft. There was a definite, strong thrumming accompanied by the drogue deployment, somewhat like being on a bumpy road. Although it is of no consequence, I was probably about 10 or 15 sec. slow in turning the hydrogen peroxide jettison fuse switch on, and this I can only blame on the intrigue and interest in looking at the drogue parachute up there straining and pulsating.

The window definitely was further occluded during re-entry.

I armed the recovery arm switch at about 15,000 ft. The main parachute opened at about 10,500 ft., and it was just as pretty as astronauts of previous flights had described it. It sort of puts the cap on the whole thing. I prepared for landing but did not hook up the survival raft to the suit.

On landing, Sigma 7 seemed to sink way down in the water. It also seemed as if I were horizontal for a while. I allowed the main parachute to be jettisoned by punching in the main-parachute disconnect fuse. Then, I actuated the recovery aids switch to the manual position. The spacecraft seemed to take a long time to right itself, but again time is merely relative, and in actuality, the spacecraft righted itself in less than 1 min. When Sigma 7 had finally started to right itself, it was a very, very pleasant feeling, and at this point I knew I could stay in there forever, if necessary. The suit temperature was 75F or 76F, and the highest point reached prior to egress was 78F.

I had very good communications with the Cap Com at Hawaii. The recovery carrier, which was probably the nearest thing other than the recovery helicopter, was really "down in the mud" as far as communications are concerned. Communications from the carrier were very weak, but legible, as evidenced by the fact that my request for permission to come aboard was immediately granted.

Sigma 7 deserves some non-engineering closing remarks. Aviators are known to acquire an affection for their aircraft when it performs well, and now, in the space age, an astronaut should convey his personal thoughts about his spacecraft. I definitely fell in love with Sigma 7, and it is the first vehicle in my history of flight that finally replaced the F8F, a Navy propeller-type fighter, as the one on the top of the list. This spacecraft, the crew that prepared her, and the flight itself, truly combine to make this MA-8 experience the high point in my life.

Ground Station Difficulty Delays Syncom

By George Alexander

Cape Canaveral—Launch of the Syncom communication satellite, originally scheduled for Feb. 6 was postponed to Feb. 13 by the National Aeronautics and Space Administration. Reason for the postponement was that the USNS Kingsport, one of the earth-based transmitting and receiving stations for the satellite, reported problems in its instrumentation. Problems, however, were not severe and the ship is expected to be ready this week.

Syncom (AW Aug. 20, p. 80; Dec. 12, 1960, p. 52), built for NASA's Goddard Space Flight Center by Hughes Aircraft Co., will be the first U. S. attempt to place a satellite in a synchronous 24-hr. orbit around the earth. The satellite is the third U. S. active repeater communications satellite—following American Telephone & Telegraph's Telstar and Radio Corp. of America's Relay.

Achievement of the programed synchronous orbit, if successful, is regarded here as having as much significance as the operation of the satellite itself. At an altitude of 22,300 stat. mi. and an orbital velocity of about 6,875 mph., Syncom's track should closely approximate the 15 deg./hr. angular rotation of the earth. It should remain fairly steady over a longitude of about 25 deg. west, but—because its orbital plane will be inclined 30-33 deg. to the earth's equator—will appear to trace out an elongated figure 8 between 30 deg. north and 30 deg. south of the equator.

Launch Vehicle

Syncom will be launched by a three-stage Douglas Delta vehicle. The Delta has successfully orbited 14 consecutive payloads in 15 attempts. Flight plan calls for Goddard's Field Projects Branch here to launch Delta 16 and its Syncom payload on an azimuth of 108 deg. down the Atlantic Missile Range.

Thor first stage, developing about 168,000 lb. thrust, will be programed to burn for about 146 sec. Second stage, developing about 7,500 lb. thrust, should burn for about 167 sec. and, with third stage and payload still attached, coast for another 40.5 sec.

Shroud surrounding Syncom will be jettisoned 30 sec. after second stage ignition. After separation from the second stage, third stage and payload will coast for an additional 13.5 sec. before ignition of the third stage solid propellant motor. Third stage will burn for about 42 sec. and then coast for about another 118 sec. before separating the Syncom payload. During this final coast period, the third stage and payload will be spin-stabilized at 150 rpm. by small solid propellant rockets. Third stage motor should place Syncom at the perigee of a highly elliptical orbit. The satellite is expected to be at an altitude of about 150 mi. and about 1,000 mi. downrange at this point.

Syncom then will coast upward along the steep trajectory of this transitional orbit for more than 5 hr. At an altitude of approximately 22,300 mi. above the earth, and at a point over the Mozambique channel between Madagascar and the eastern coast of Africa, a timer will command ignition of the solid propellant kicker motor carried inside the spacecraft.

This motor will burn for about 18 sec. and transfer the satellite from its temporary orbit into the desired circular orbit. Injection into synchronous orbit is expected to occur about 315 min. after liftoff.

Launch Target

Desired location in space for Syncom is a point over the South Atlantic Ocean between Africa and South America—a difficult target for a launch vehicle to achieve from Cape Canaveral because of relative proximity of the launch site and the point in relation to the altitude. Once in orbit, the satellite's velocity will be calculated. If the earth's angular velocity is slightly greater than that of Syncom, the desired earth reference point will gradually move under the satellite, and when coincidence occurs, a small burst from one of the spacecraft's two gas control systems will bring the two in phase.

If, however, the satellite is moving at the same or greater angular velocity than that of the earth, some of this forward speed will have to be bled off. This will be accomplished by the control systems.

Control System

Control system consists of two separate gas supplies—one hydrogen peroxide and the other gaseous nitrogen—and four nozzles, two to each gas reservoir. Nozzles are positioned in opposition from each other, parallel to and perpendicular to the satellite's spin axis.

Peroxide and nitrogen jets perpendicular to the spin axis—i.e., mounted in the cylindrical walls of Syncom, 180 deg. apart—are to be used for orientation control.

If Syncom is traveling at a velocity equal to, or greater than, the earth's angular speed, then the velocity control jets would be used. As the nozzles rotate with the spacecraft, they would be pulse-fired every time they face in the direction of motion. The peroxide jet, capable of a 300 fps. correction, would be used for major retro-effect; the nitrogen jet, capable of a 60 fps. correction, would be used for small velocity trimming.

Once the correct position over the South Atlantic Ocean has been achieved, the peroxide and nitrogen jets parallel to the spin axis would be used to correct orientation deviations, the former for large scale errors and the latter for minor changes.

Syncom itself is a 28-in. dia., 15.5-in. tall cylinder weighing 150 lb. at liftoff. After the apogee motor has been fired, the orbital weight of the NASA-Hughes satellite is about 86 lb. The satellite consists of two structures:

- **Outer unit**, covered with 3,480 silicon solar cells, includes the 2.5-lb. gaseous nitrogen sphere and the 5-lb. peroxide sphere and most of the satellite's electronics.
- **Inner unit** includes the apogee motor, antennas and other electronics.

Syncom will be able to transmit one two-way telephone call or several teletype messages. Satellite-to-ground transmissions will be on a frequency of 1,814-1,816 mc. and from ground to Syncom at 7,316-7,363 mc. Satellite's transmitting antenna is a coaxial slot array and radiates a pancake-shaped beam.

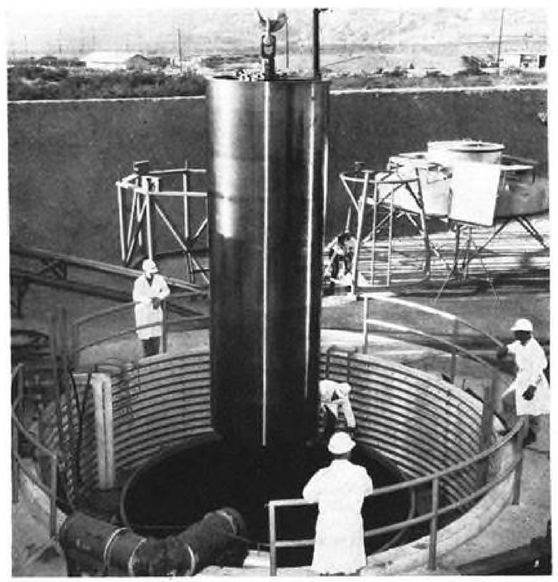
Ground Terminals

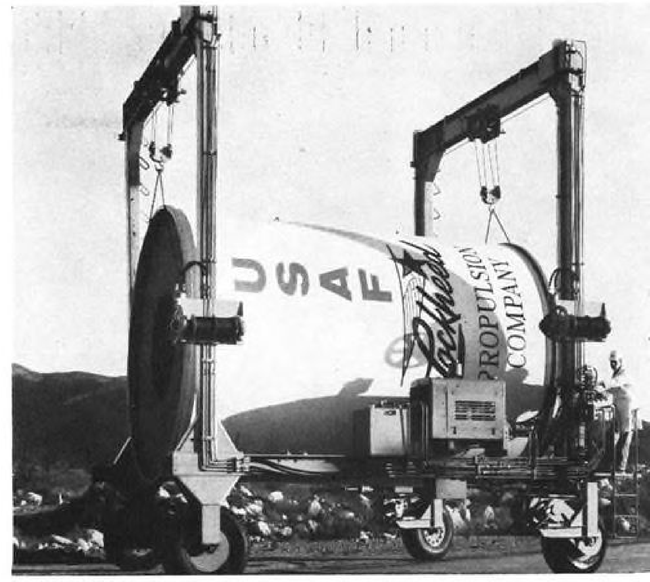
Ground terminals will be located at Lakehurst, N. J., and aboard the Kingsport in Lagos Harbor, Nigeria, and will feature 30-ft. dia. parabolic antennas (AW Jan. 21, p. 95). U. S. Army Satellite Communications Agency will conduct experiments with the satellite and the ground stations for NASA.

A 60-ft. dish at Army's Ft. Dix, N. J., installation also will be used in the tests. Lakehurst station consists of 11 transportable, van-mounted units and was developed under Army contract by Bendix Radio Div. and Goodyear Aircraft Corp.

Bendix Systems Div. and General Electric's Ordnance Div. developed the shipboard systems for the USNS Kingsport. Sylvania Electric Products built the 60-ft. antenna at Ft. Dix; Bendix installed the communications equipment at the second New Jersey transmitting-receiving station.

Syncom mission will be controlled from the NASA Communications Spacecraft Control Center at Goddard's Greenbelt, Md., center. Actual exercise of the satellite and ground stations will be executed for NASA by the Army at the latter's satellite communications test operations center at Ft. Monmouth, N. J.



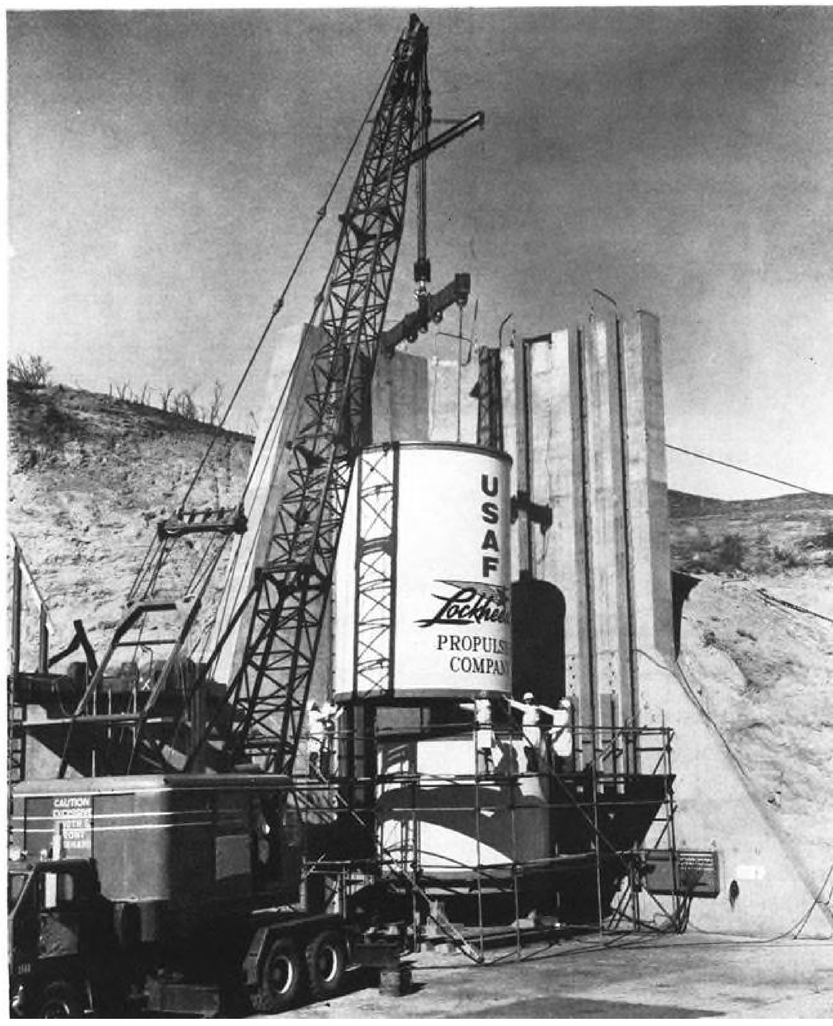


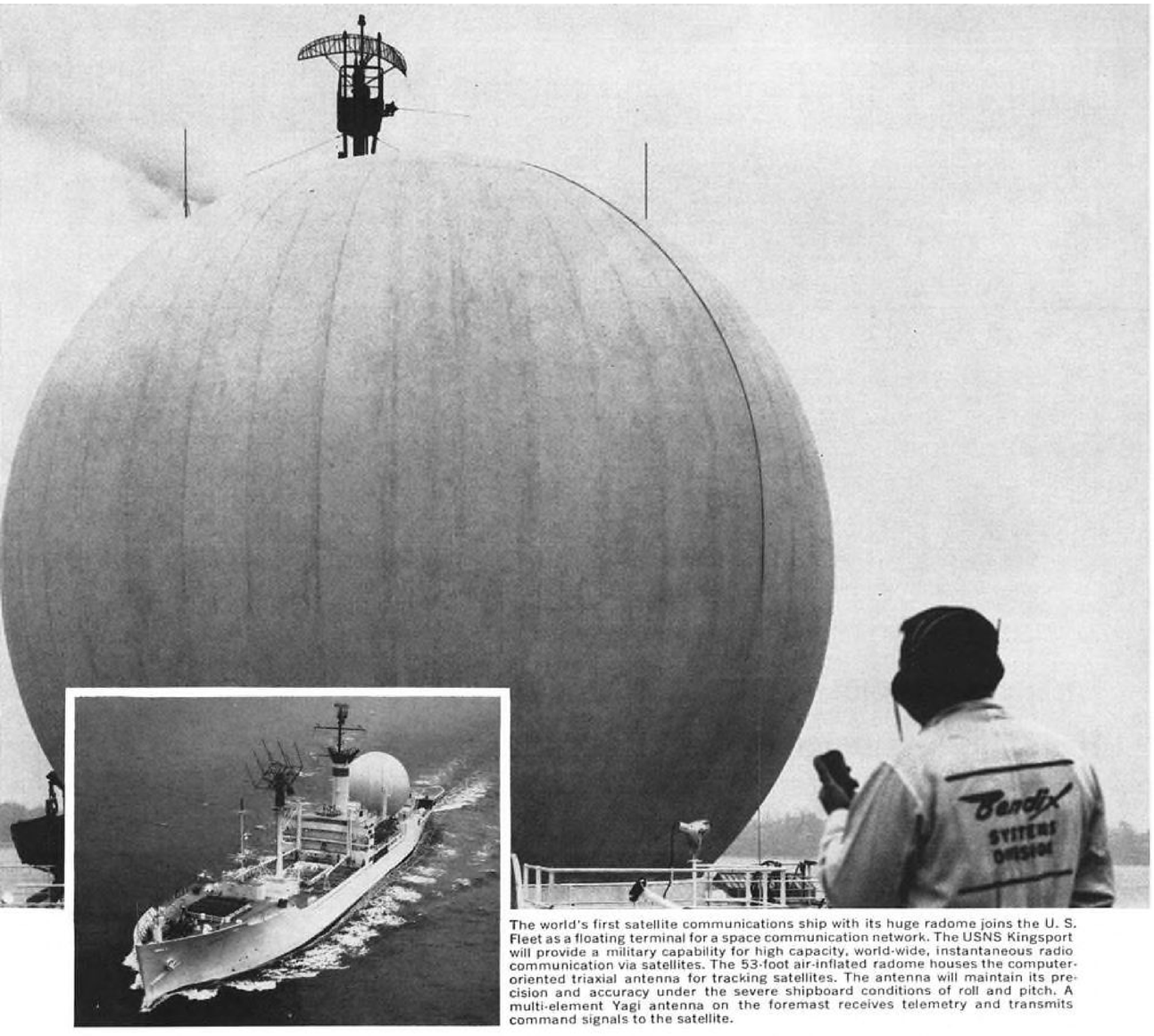
Technicians at Lockheed Propulsion's Redlands, Calif., facility check mandrel of 156-in. mockup (upper left) as crane removes it from casting and curing oven. Crane hoisted center segment onto lowboy trailer (upper right) to move segment around facility. Following shipment by truck to company's Potrero facility (lower left), center segment and forward segment were mated in test bay (lower right).

Lockheed Studies Handling Techniques For 156-in. Motor

Lockheed Propulsion Co. has evaluated the capability of its Redlands and Potrero, Calif., facilities to handle a 156-in.-dia. solid-propellant rocket engine, using a mockup of the case and mandrel full-scale in all specifications except weight. Test bay used for mating the forward and center segments of the mockup, (lower right) is the same one used in firing the company's 120-in.-dia. thrust vector control research motor last year (AW May 21, p. 34).







The world's first satellite communications ship with its huge radome joins the U. S. Fleet as a floating terminal for a space communication network. The USNS Kingsport will provide a military capability for high capacity, world-wide, instantaneous radio communication via satellites. The 53-foot air-inflated radome houses the computer-oriented triaxial antenna for tracking satellites. The antenna will maintain its precision and accuracy under the severe shipboard conditions of roll and pitch. A multi-element Yagi antenna on the foremast receives telemetry and transmits command signals to the satellite.

SHIPBOARD SATELLITE COMMUNICATIONS TERMINAL—The USNS Kingsport, working in conjunction with land based terminals, will allow communication relay through satellites to many world locations. Developed for use by the U. S. Army Satellite Communications Agency, the first mission of the USNS Kingsport will be to support NASA in the development of civil and commercial communications satellites. As prime contractor for the U. S. Navy Bureau of Ships, the Bendix Systems Division managed the systems engineering and integration of the system, including communication and related equipment from 23 companies and three Bendix divisions. System design and integration engineers in these space technologies can learn of exciting challenges by contacting our Personnel Director, Bendix Systems Division, Ann Arbor, Michigan—an equal opportunity employer.

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WHERE IDEAS UNLOCK THE FUTURE

McNamara Views Strategic Aircraft Role

(Defense Dept.'s cancellation of development of the Skybolt air-launched ballistic missile and its reluctance to develop the B-70 Mach 3 bomber have put the future of manned strategic aircraft in doubt. Defense Secretary Robert S. McNamara made what he called "a most detailed and exhaustive review" of this question and presented his findings to the House Armed Services Committee last Jan. 30. AVIATION WEEK & SPACE TECHNOLOGY *is publishing below the portion of his public testimony which concerns the future of this type of aircraft.)*

I know that this committee is concerned over the question of the future of manned strategic aircraft. As I promised last year, we have made a most detailed and exhaustive review of the entire problem of the future role of these systems. I would like to review some of the recent history of this issue and to report to you on our findings at this time.

The first bomber procurement issue I faced was the question of whether or not to procure another wing of B-52s in 1961. At that time, we had a force of some 1,500 intercontinental bombers, soft based and concentrated on about 60 bases. We had very few ICBMs, and those that we did have were also soft and concentrated. By mid-1961, as you will recall, we had five Polaris submarines operational; a very small force. The most urgent problem at that time, and the problem was urgent, was to acquire rapidly a large force of protected nuclear firepower that could not be knocked out in a surprise missile attack.

Manned bombers on the ground are quite vulnerable to surprise ballistic missile attack. Minuteman, however, because it is installed in hard and dispersed sites, is far less vulnerable. An attacker would have to use several of his missiles in order to be reasonably confident that he had knocked out one Minuteman. And Polaris missiles in submarines at sea cannot be targeted for ballistic missile attack at all. Therefore, we decided to concentrate our procurement dollars on the accelerated production of Minuteman and Polaris. This decision did not mean that we did not want manned bombers. We already had many bombers but very few ballistic missiles. What we needed to do was to build a more balanced force of bombers and missiles, and to do that, we had to buy more missiles.

The next issue I had to face was the development of the B-70, or the RS-70 as it was later called. The issue here was not the future of manned strategic aircraft in general. Rather, it was whether this particular aircraft, in either of its configurations, could add enough to our already programed capabilities to make it worth its very cost.

Many of the arguments that have been advanced in support of the RS-70 actually support the case for post-attack reconnaissance in combination with an improved ICBM force. We believe that there are more promising ways of performing this mission than the RS-70, when both cost and effectiveness are considered. Other than this, the RS-70 is said to have distinct capabilities: (1) trans-attack reconnaissance; that is reconnaissance during our missile attack, and (2) the ability to examine targets and attack them on the spot with strike missiles, if required. Quite apart from the technical feasibility of developing, producing and deploying such a system within the time frame proposed by the Air Force (which we do not think possible), there are better ways, when one considers both cost and effectiveness, to obtain both of these capabilities.

The principal advantage of having a "reconnaissance" and a "strike" capability in an aircraft is one of timeliness. That is, it may be possible to process and interpret enough of the "recon" data in the few minutes the aircraft is still within range of the target to permit an effective air-to-surface missile strike, keeping in mind that the aircraft would be moving at a speed of over 30 mi. per min. and that the missile would have a relatively short range —i.e., a few hundred miles. If this can be done "effectively" there is the advantage of being able to deal with the target within minutes instead of an hour (or more) if the "strike" had to be accomplished by some other weapon system. Quick attack is not always important, but to the extent that it is and can be accomplished effectively, a "strike" capability in the aircraft is an advantage. However, post-attack reconnaissance and subsequent strike—whether by air-to-surface missiles or ICBMs—is important in two principal cases:



ROBERT S. MCNAMARA

- **Where fixed targets** whose location was not known precisely must be attacked.
- **In "mop-up" operations** against fixed targets of known location that have been programed for initial attack by ballistic missiles, but which may not have been destroyed.

Initial attack on targets of known location can be accomplished effectively with ICBMs, which have the important advantages of shorter time-to-target, lower cost, and higher survival potential. Mobile targets simply cannot be successfully attacked with an RS-70 and, in fact, such a role has not been proposed for that aircraft.

The issue, therefore, resolves itself to the question: How much could we gain from a capability to attack the two types of targets I referred to earlier, with air-to-surface missiles instead of ICBMs?

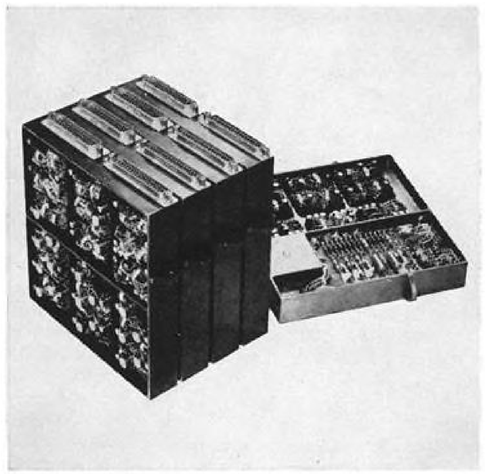
With regard to the first case, if a target is known to be somewhere within a relatively small area, usually its exact location can eventually be established. Moreover, such targets can be attacked by ICBMs after post-attack reconnaissance. With regard to the second case, other means are expected to be available to determine whether targets previously attacked by ICBMs have been destroyed. These targets, too, once it is known that they have not been destroyed, could be attacked again with ICBMs.

The RS-70, by carrying air-to-surface missiles, would provide only a very small increase in over-all effectiveness. In my judgment, this increase is not worth the large additional outlay of funds estimated at more than $10 billion above the $1.35 billion already approved.

Accordingly, we proposed to complete the presently-approved $1.3 billion B-70 development program of three aircraft and, in addition, continue the development of selected sensor components using, in the current fiscal year, $50 million of the extra $192 mil-

Computer Control Company performs successfully on Mariner II Program

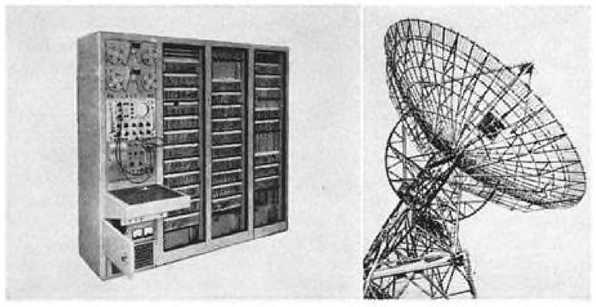
Spaceborne Data Conditioning System handles over 5 million bits of scientific information on 109 day flight to Venus



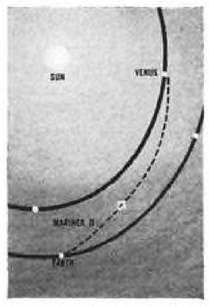
Spaceborne Data Conditioning System aboard Mariner II typifies Computer Control's ability to satisfy stringent size, power, reliability and delivery specifications for logic design, circuit and module development, fabrication and packaging. This fast real-time sampling, processing and control system gathered information from scientific instruments aboard the spacecraft and prepared data for transmission to earth. In addition, it controlled: (1) the scan of instruments sweeping Venus' surface, (2) calibration operation checkout, and (3), time sharing of scientific and engineering data in the telemetry system. Design to delivery: three months.

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Coordinate Conversion Computer at Goldstone positions antennas tracking Mariner II and other space vehicles



3C real-time Coordinate Conversion Computer at West Coast site continually positions 85-foot parabolic antennas to track orbiting satellites, as well as Mariner and other space probe vehicles. The antennas, computer and a microwave link form the closed loop system that tracked Mariner's 182-million mile journey through space. A similar system has been developed by 3C as part of an airborne tracking system designed to photograph missiles during re-entry.



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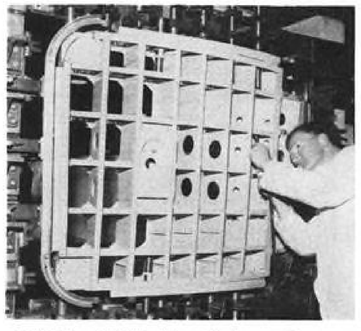
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lion provided by the Congress last year for the RS-70 program. The Air Force has not yet completed its analysis of the effect on development costs of the three-month delay already encountered in the flight testing of the first B-70.

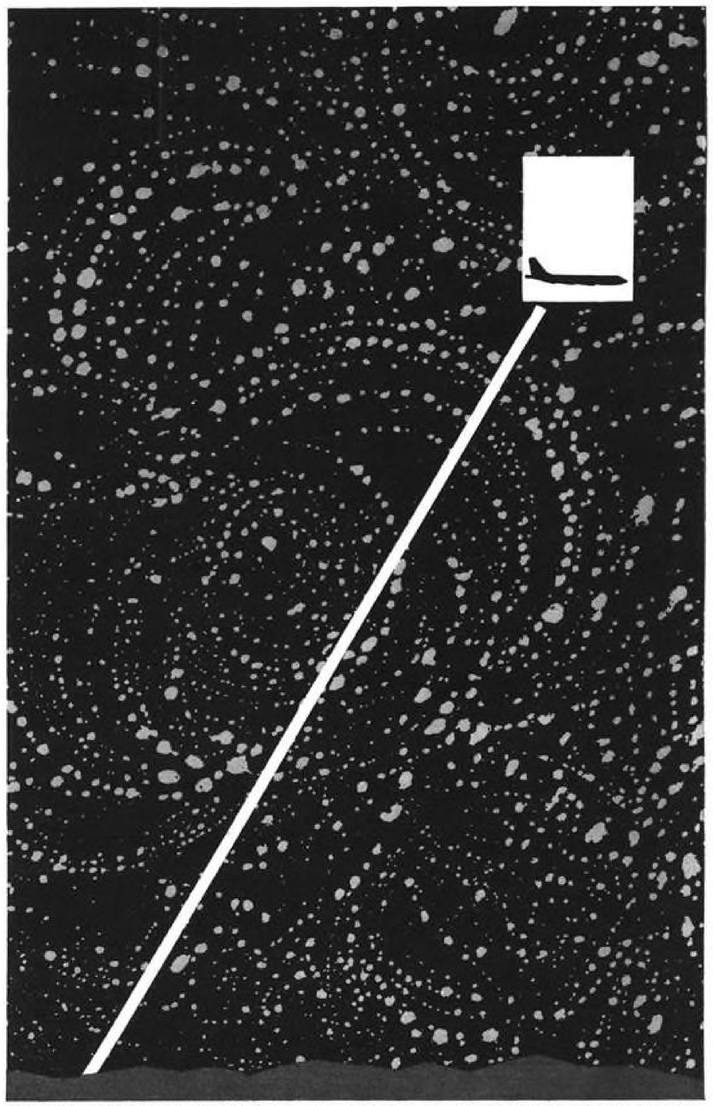
The final issue related to the future of manned bombers is the cancellation of Skybolt. It has been argued that Skybolt would be able to extend the life of the B-52 force in an era of increasingly sophisticated enemy air defenses. That is, even if the B-52 were to have trouble penetrating enemy defenses, it could stand off at a distance and fire Skybolt. Viewed in this role, it was clear that Skybolt could not make a worthwhile contribution to our strategic capability since it would combine the disadvantages of the bomber with those of the missile. It would have the bomber's disadvantages of being soft and concentrated and relatively vulnerable on the ground and the bomber's slow time to target. But it would not have the bomber's advantageous payload and accuracy, nor would it have the advantages usually associated with a manned system. It would have the lower payload and poorer accuracy of the missile—indeed, as designed it would have had the lowest accuracy, reliability and yield of any of our strategic missiles—without the relative invulnerability and short time-to-target of a Minuteman or a Polaris.

These characteristics make Skybolt unsuited to either category of primary strategic targets. On the one hand, Skybolt would not have been a good weapon to use against Soviet strategic airbases, missile sites or other high-priority military targets because it would take hours to reach its target, while a Minuteman could reach it in 30 min. On the other hand, Skybolt would not have been a good weapon for controlled, counter-city retaliation. Aside from its



BAC 111 Freight Door

Worker at British Aircraft Corp.'s Cardiff factory inspects the door frame for one of the cargo holds aboard first BAC 111 short-haul jet transport. For a photo of wing-fuselage mating on the first BAC 111, see AW Feb. 4, p. 47.



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relative vulnerability to anti-ballistic missile defenses, it has the important disadvantage that its carrier, the B-52, must be committed to its targets, if at all, early in the war because it would be vulnerable on the ground to enemy missile attack. Common sense requires that we not let ourselves be inflexibly locked in on such a matter. And being "locked in" is unnecessary when we have systems like Polaris whose missiles can be withheld for days, if desired, and used at times and against targets chosen by the President. The Skybolt therefore, cannot be, and is not, justified as a weapon to be used against primary targets.

Skybolt's value, then, would depend upon its effectiveness in the only remaining important target category, "defense suppression" that is, the destruction of the enemy's defenses in order to permit the bombers to penetrate. But in this role Skybolt offered no unique capability. Several other missiles could also be used to attack enemy defense: Minuteman and Hound Dog in particular. Skybolt offered a special advantage in this role as long as it was expected to be significantly cheaper than alternative systems. Unfortunately, this advantage disappeared.

The cost history of Skybolt is particularly poor. Although originally estimated to be less, the Air Force early in 1960 estimated that Skybolt would cost $214 million to develop and $679 million to procure. By early 1961, the estimated development cost had increased to $391 million. By December 1961, the estimated development cost had risen to $492.6 million and the procurement costs to $1.424 billion. In its July, 1962, program submission, the Air Force increased the estimated procurement cost to $1.771 billion. Thus, the latest Air Force estimate to develop and procure Skybolt exclusive of warheads was $2,263,600,000.

In fact, there are compelling reasons for believing that even these latest estimates are still very unrealistic, and that the actual costs would be much higher. For example, the Skybolt development program was far behind schedule on the program that was supposed to be completed for $492.6 million. According to that program, there were supposed to be 28 test flights by the end of 1962, when, in fact, there were only six.

Moreover, the amount of flight time allowed in the Skybolt test program was less than half the amount which was actually required for Hound Dog, a much less complex development.

Just how much more would have been required to complete Skybolt is uncertain. I am sure that the full development and engineering test program would have ultimately cost at least $600 million and might have cost substantially more. As for procurement, it is difficult to see how the cost could have been less than $2 billion. Thus, the Skybolt would very likely have become nearly a $3 billion program, not counting the additional cost of warheads. And even then, there was no assurance that the Skybolt development would result in a reliable and accurate missile.

In effect, this meant that Skybolt had lost whatever cost advantage it once promised. The cost per missile aboard an alert bomber—and that is the most realistic way to reckon the cost—would approximate $4 million per missile, very close to the incremental initial investment cost for a Minuteman missile, complete with its blast resistant silo. In view of Minuteman's greater flexibility, reliability, accuracy, its much lower vulnerability and faster time to target, it clearly makes sense to meet our extra missile requirements by buying Minuteman rather than Skybolt.

We propose, then, that to the extent ballistic missiles are required for defense suppression, they be Minuteman. I can assure you that the missile program I am recommending is fully adequate to the defense suppression task.



First Coast Guard S-62s Delivered

Five of 28 Sikorsky HH-52A (company designation S-62) single-turbine, boat-hulled helicopters have been delivered to Coast Guard to replace older piston helicopters and equip new search-rescue units. Coast Guard pilots are now completing familiarization flights.

Penetrate Defenses

Finally, I want to emphasize that we are doing many other things to help our bombers to penetrate enemy defenses. We have equipped the B-52s with jamming equipment and with air-launched Quail decoy missiles to confuse the defenses. Nearly $315 million for a wide range of measures to enhance the overall effectiveness of the B-52 fleet was included in the 1963 budget, and about $210 million more is included in the 1964 budget request.

Lest there be any impression to the contrary, the cancellation of Skybolt has had no effect whatsoever on our plans for retention of the B-52 fleet. However, that decision will result in a net saving of about $2 billion, even after providing for the extra Minuteman (missiles) for the defense suppression task.

We plan to continue a mixed force of missiles and manned bombers throughout the entire planning period—1964-1968. Although most of the aiming points in the Soviet target system can be best attacked by missiles, the long-range bombers will still be useful in follow-up attack, particularly on certain hardened targets. Accordingly, all 14 of the B-52 wings will be maintained in the force. Advance attrition aircraft have been procured with prior-year funds to support this force.

The B-47 subsonic medium bombers will be gradually phased out of the forces over the next several years. Some of these aircraft could be continued in operation for a longer period of time than now planned if the need should arise over the next year or two. Two wings of the B-58 supersonic medium bombers will be continued in the force throughout the program period.

Bomber Alert

Since July, 1961, we have maintained approximately 50% of the manned bomber force on a 15-min. ground alert. Because this measure is essential to the survival of the force in a ballistic missile attack, we plan to continue it throughout the program period. But I should caution that a 15-min. ground alert may not be sufficient to safeguard the bomber force—particularly during the later part of this decade. By that time the Soviet Union could have a large number of missile-firing submarines on station within reach of most of our bomber bases. The increasing missile threat underscores the importance of maintaining our on-the-shelf airborne alert capability and the value of the special provisions contained in Section 512b of the Fiscal Year 1963 Defense Appropriation Act. This is the section which authorizes the Secretary of Defense, upon determination by the President that such action is necessary, to provide for the cost of an airborne alert as an excepted expense. This provision should be retained in the law.

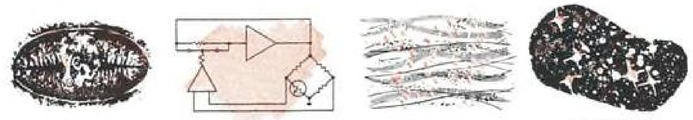
Although we are planning to continue the present airborne alert training program and the maintenance of an on-the-shelf capability to fly one-eighth of the force for one year, we must always be ready to increase promptly the scale of this operation. Indeed, during the early phases of the Cuban crisis last year, we did just that. We may be able to finance the additional cost of that action from our current year's appropriations, in which case we may not have to resort to Section 512b this year, provided, of course, that no new crisis again forces us to expand our airborne alert operations.

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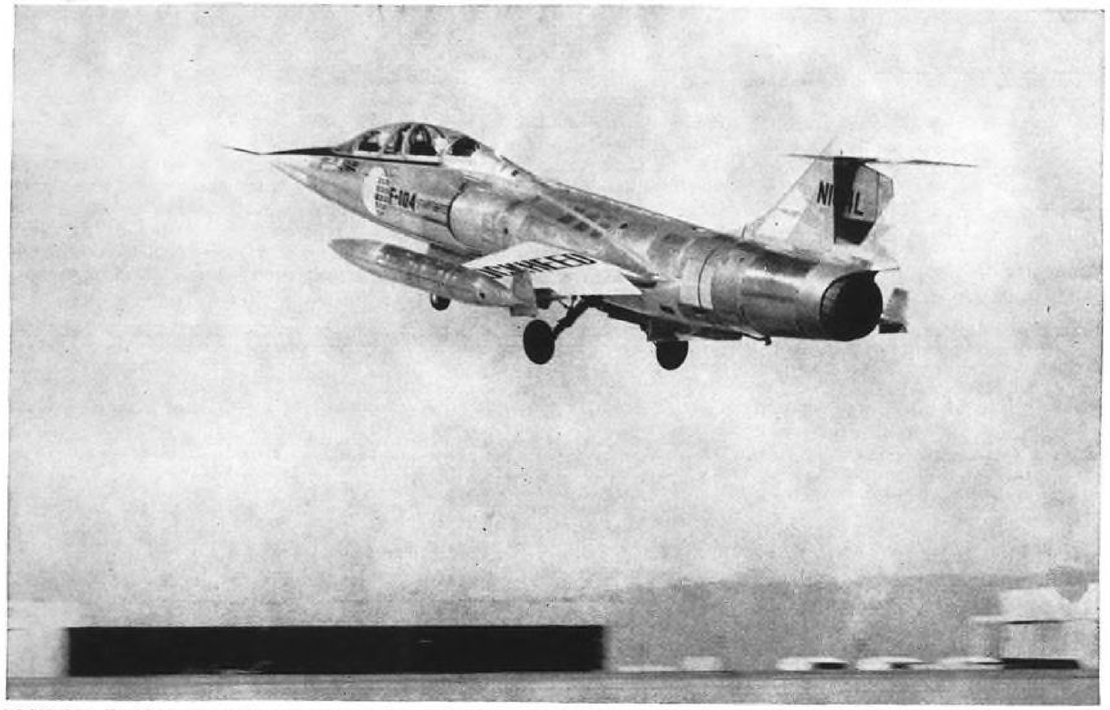


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LOCKHEED TF-104G TRAINER VERSION of the strike-intercept-reconnaissance aircraft lifts off on demonstration flight at Lockheed's Palmdale, Calif., facility. Stub-winged aircraft is powered by a 15,800-lb.-thrust General Electric J79-11A engine with afterburner and has fully blown flaps to provide boundary layer control in landing configuration.

Aviation Week Pilot Report:

Mission Variety Demonstrated by F-104G

By C. M. Plattner

Palmdale, Calif.—Effectiveness of the Lockheed F-104G in two divergent missions—air superiority and defense and low-level strike-reconnaissance—was demonstrated to this AVIATION WEEK & SPACE TECHNOLOGY pilot during a flight in the two-seat TF-104G trainer version.

Terrain avoidance and navigation systems proved reliable and accurate during the first phase of the mission, a simulated low-level strike over the rugged Sierra Nevada mountains, which included maintaining a predetermined altitude over an assigned course followed by a dive-bombing strike.

Second part of the mission, a climb and acceleration for a simulated intercept, showed the F-104G's ability to perform air defense and air superiority missions. TF-104G accelerated from subsonic cruise to Mach 2 in 3¼ min. in level flight at 35,000 ft.

Prior to the flight, a complete briefing on the Super Starfighter's capabilities was given by Lockheed Engineering Test Pilot Ed Brown, who flew the plane during the demonstration. Brown pointed out that little difference existed between the TF-104G, which was flown here, and the F-104G, now in production in Western Europe (AW Aug. 6, p. 54; Aug. 13, p. 92).

To provide for the additional seat in the TF-104G, the autopilot and 20-mm. M61 Vulcan cannon have been eliminated to provide room for relocated electronics equipment and fuel tanks. The centerline rack, capable of carrying nuclear weapons, also has been removed.

In outlining emergency escape procedures, Brown pointed out that successful ejection was possible on the ground at speeds over 110 kt. if the zero-delay lanyard was connected to the D-ring on the parachute. The zero-delay lanyard bypasses a timed, one-second delay and deploys the chute immediately after leaving the ejection seat.

Metal spurs, which are fitted to the flight boots, are slipped over steel fittings near the bottom of the seat in the aircraft. The fittings are attached to cables which play out as the feet are moved forward to the rudder pedals. In flight, the light tension of the cables is hardly noticeable.

In case of ejection, a large D-ring located near the front of the bucket seat is pulled and cables are automatically snubbed-up, positioning feet and legs tightly against seat. The cables are severed as the Lockheed-developed C-2 rocket-assisted seat leaves the aircraft.

The mission chosen for the flight deviated from the four standard alternatives proposed by Lockheed, so that both low altitude capabilities as well as Mach 2 performance of the aircraft could be demonstrated. A 400-naut.-mi. round robin with four en route checkpoints was planned.

Major portion of the flight was to be flown at an altitude 1,000 ft. above the terrain using radar and navigational equipment and verifying position and altitude visually.

Up to 12 checkpoints may be set into the navigation system but the settings must be pre-determined on the ground in terms of X and Y coordinates relative to the point of takeoff. Values of the coordinates, based on longitude and latitude of the checkpoint, can be worked out by hand using formulas, or determined with a computer.

The flight plan called for a climb to 35,000 ft. on the last leg of the flight, with acceleration to Mach 2, followed by an idle descent and minimum roll landing. A full load of 700 gal. JP-4 fuel was to be carried internally and 170 gal. in each of the tip tanks.

All external tanks have capacitance-type probes, so fuel quantity can be read out in the cockpit. Two 195-gal. tanks can be hung on wing pylons.

Aircraft cockpit was entered via a ladder up from the ground. It was necessary to step down onto the seat to ease into a sitting position. Survival pack, located under the seat cushion, was strapped to the parachute harness, safety pin of ejection seat D-ring was removed, shoulder harness, parachute lanyard and lap belt secured.

After a quick check of the 13 emergency warning lights located on the right forward console, Brown gave the signal for engine turnup. The pneumatic unit cranked up the General Electric J79-11A, which has a maximum 15,800-lb. thrust with afterburner, and the igniters were actuated at about 8% rotation speed. After light-off, the starter unit was disconnected at 40% rpm. Engine was stabilized at idle between 66% and 67% rpm., at 450C exhaust gas temperature (EGT).

Taxi permission was given to 104-Lima (FAA-assigned identification number) to procede to runway 25—winds were calm. After tower clearance for takeoff, brakes were released and power eased up to 100.5%. Afterburner was cut in and the plane rapidly accelerated to 170 kt. takeoff speed. Aircraft lifted off after using about 4,500 ft. of runway. Variable tailpipe nozzle automatically maintains tailpipe temperature at 540C at 100% power without afterburner and 588C with afterburner.

A right-hand turn was initiated to a northerly heading to intercept the course to the first checkpoint 63 mi. away. Since the first part of the mission was low-level navigation and terrain-following afterburner was cut and throttle retarded to 92% power at 8,000 ft. Airspeed stabilized at 370 kt. indicated airspeed (IAS) at the selected power setting and altitude with a fuel flow of 3,700 lb./hr.

Heading and distance to the selected checkpoints were read on the position and homing indicator (PHI) which has three modes of operation—inertial, dead reckoning (DR) and Tacan. The inertial navigator, which requires a 10-15 min. warmup prior to flight, is a four-gimbal platform with two two-degree-of-freedom gyros and three mutually perpendicular accelerometers mounted on the innermost gimbal.

The platform senses all accelerations, including wind, and integrates them twice to find distances, relaying this information to the PHI computer as X and Y coordinates.

In the DR mode, the PHI computer monitors true airspeed information from the air-data computer, as well as time and magnetic heading. Wind direction and velocity, which must be set in by the pilot, were disregarded during the flight, since they were forecast to be light and variable. Wind direction and velocity may be determined in flight by cross-checking the DR readout against visual or radar reference to known checkpoints.

Shortly after leveling off at 8,000 ft., the F15A NASARR (North American Search and Ranging Radar) was actuated and the contour mapping function of the air-to-ground mode was selected. Contour mapping may be done with either the 20- or 40-mi. range scale and may be used to maintain a desired clearance above the terrain, in this case 1,000 ft. Only the terrain features projecting above a horizontal plane at the pre-selected altitude below the aircraft are displayed on the scope, a standard plan position indicator (PPI) presentation with a 30-sweep per minute, 90-deg.-sector scan.

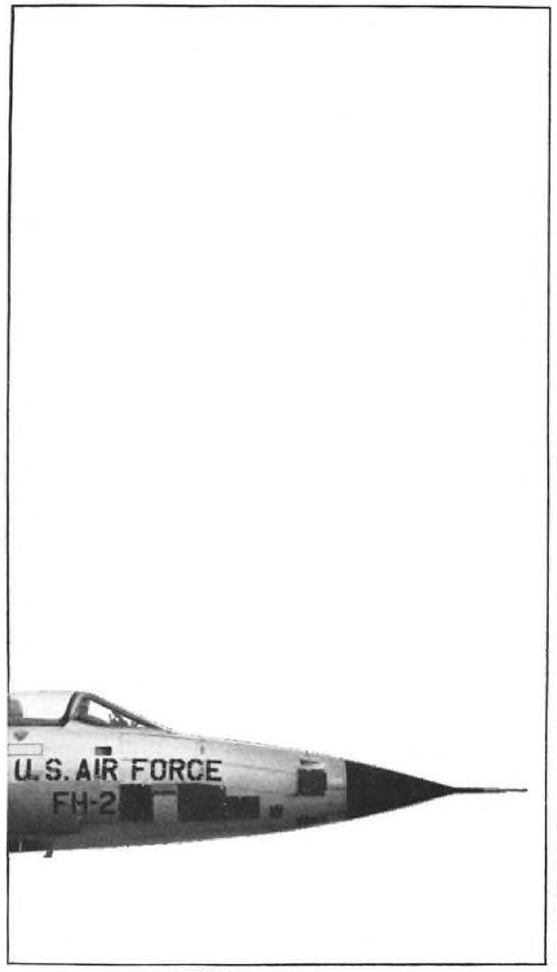
Only tips of mountains or more prominent terrain features are seen on the scope when proper clearance is maintained. During the flight promi-



CENTERLINE WEAPONS RACK and M61 Vulcan cannon have been removed from TF-104G version of the Super Starfighter to accommodate second seat. Relocation of some internal plumbing results in internal pressure surges in transonic speed regime. Aircraft is speed limited to Mach 2 by critical compressor inlet temperature.



LADDER PROVIDES ENTRANCE to cockpit for pilots, including Aviation Week's C. M. Plattner, entering rear cockpit, prior to demonstration flight. F-104G is wired to carry and launch Bullpup missiles, but control panel has not been put into place in cockpits.



6500 man-hours to assemble



6500 man-hours to assemble

During the past two years, we have halved the cost of assembling the nose section of the F-105 fighter-bomber. (That's 5,500 major parts, excluding fasteners.)

This saving of 3250 man-hours is just a small part of the nearly $900,000 we have chopped off the total unit flyaway cost of the F-105. And when we say "flyaway," we mean with all systems and equipment in and tested and operating.

Not that we've done it all by ourselves. F-105 costs have been reduced (1) at the Republic plant; (2) by the thousands of small business firms who have received over 82% of our sub-contract purchase orders; and (3) by the suppliers of government furnished aircraft equipment, to whom we have given cost-control assistance with full Air Force cooperation.

In its first two years of operation, Republic's cost-management program saved the Air Force $226,300,000. Today we are still working to reduce continuously the total cost of the F-105 weapon system, without impairing function or reliability.

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nent terrain features along the flight path were kept at nominal blip size (about the size of an aircraft blip on a standard ground-radar set). Brown declared he had used the system with confidence down to several hundred feet above the ground. This is the altitude that would be required for avoidance of radar detection on combat missions.

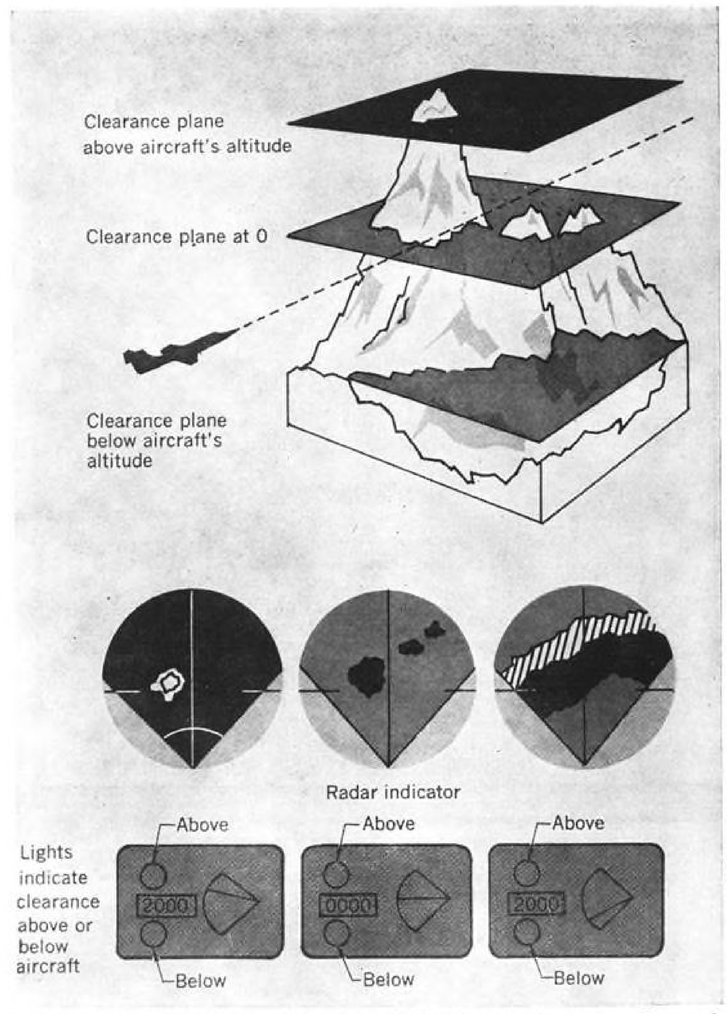
The contour map display showed valleys and mountains effectively. Maintaining the pre-selected clearance of 1,000 ft. proved to be no difficulty to this AVIATION WEEK pilot, who flew the plane about 50% of the time. The route—north and east of Palmdale—was over terrain ranging from 2,000 to 12,000 ft., and frequent altitude changes were required to maintain the planned clearance altitude.

Terrain Avoidance

After the first checkpoint (the small town of Isabella, Calif.) was passed, terrain avoidance was used for a short time rather than contour mapping. Terrain avoidance differs from contour mapping in that the 1,000 ft. (or any other pre-selected number) clearance plane parallels the aircraft flight path rather than remaining fixed relative to the horizon.

If the aircraft is pitched up or down using terrain avoidance, the clearance plane also pitches up or down. Flying in this mode proved somewhat troublesome at the 1,000-ft. clearance level selected, since after each climb or descent the aircraft had to be leveled in order to determine if it had gone far enough.

Thus, more maneuvering was necessary to adhere to the 1,000-ft. clearance than was required for contour mapping in which it is possible to ease up or down, watching the radar blips, and to stop at the correct altitude without having to check several times by leveling the aircraft.



CONTOUR MAPPING MODE of the F15A NASARR navigation system shows pilot obstructions above a predetermined altitude regardless of aircraft attitude. Top level in drawing shows terrain 2,000 ft. above aircraft altitude, center level shows terrain at aircraft flight path and bottom level is terrain 2,000 ft. below aircraft.

Bomb Run

Aircraft passed over the second checkpoint (Lone Pine airstrip) about 18 min. after takeoff, and a check of the inertial navigation readout showed zero miles to go, indicating negligible gyro drift. The DR mode was about 1½ mi. off, indicating an effective wind of about 4 mph.

Over the one checkpoint (the small town of Pahrump, Nev.) a simulated, low-angle, dive-bombing run from 11,000 ft. was demonstrated. Airspeed built up quickly without the use of flaps, which are often used for close air-support work, since they provide more lift during pull-out. When the electrically actuated flaps are used, they are placed in the takeoff position—15 deg. leading edge and 15 deg. trailing edge. Although flaps may not be extended above 370 kt., speed restriction after extension is 500 kt.

After passing Pahrump, a climb to 35,000 ft. at military power of 100% without afterburner was initiated. During the Mach 0.9 climb—Mach .92 is used with afterburner—several aileron rolls were tried.

The fast rate of roll and ease of control indicated excellent maneuverability at high subsonic speeds.

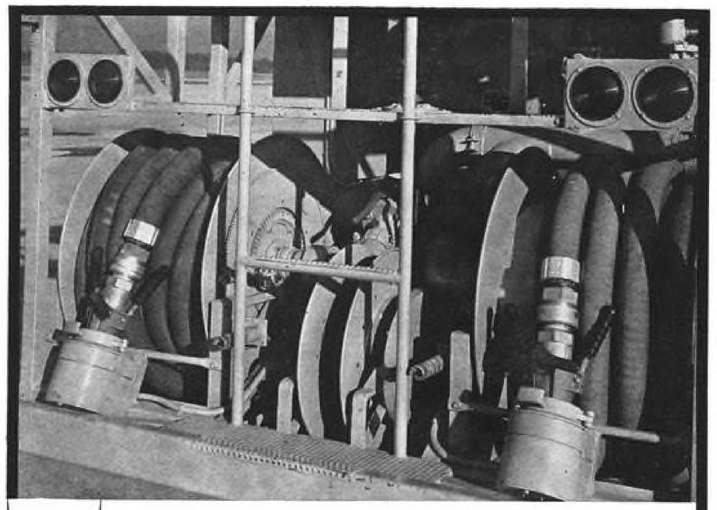
After the 6½-min. climb from 5,500 ft. to 35,000 ft., a turn was made over the final checkpoint (the town of Baker, Calif.) and the aircraft was headed west toward the supersonic corridor east of Edwards AFB. Over Baker, the inertial readout was still zero.

When permission was received to use the corridor, afterburner was lighted and level acceleration to Mach 2 began. While passing through Mach 1, a cabin pressure surge of about 1,000 ft. was noticed as the shock wave passed over the static inlet port located on the forward part of the fuselage.

Location of the static port farther aft on the single place F-104 prevents this pressure surge.

While waiting for speed to build up, Brown demonstrated ground mapping in the air-to-ground mode, using the radar to pick out the large hangars at Edwards AFB. These were easily seen on the scope after the gain was turned down to remove most of background clutter.

At Mach 1.8, the fuel control automatically went into total inlet temperature reset, providing an increase in engine rpm. to 103.5% and additional fuel to compensate for the higher en-



HOW ARE REELS USED AT DULLES?

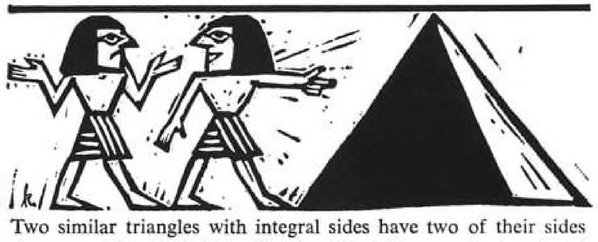
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PROBLEMATICAL RECREATIONS 157



Two similar triangles with integral sides have two of their sides the same. The third sides differ by 387. What are the lengths of the sides? —*Contributed*

Dual deflection, high resolution and high light output may be expected from a new cathode ray tube developed by our Electron Tube Division. With a 21" rectangular screen, the large area display tube proves useful for computer read-out, traffic control, message display and other applications. Inquire after the C21C4 and other display devices and microwave tubes from the Marketing Department. They're located in San Carlos, California.

ANSWER TO LAST WEEK'S PROBLEM: Let A and B be the extremities of the diameter. Construct the line through P and A intersecting the circle at C, and let D be the corresponding point on the circle by considering the line through P and B. The intersection of the lines through A and D, B and C, yields a point E with the line through P and E perpendicular to the line through A and B.

LITTON INDUSTRIES, INC.
Beverly Hills, California

F-104G Missions

Primary missions of the various advanced F-104s now under licensed production or being built by Lockheed and the optimized modes of their respective NASARR (North American Search and Ranging Radar) systems include the following:

- CF-104 manufactured in Canada has primary mission of strike and reconnaissance. Its R24A NASARR is optimized in air-to-ground mode.
- F-104G (MAP) is manufactured by Lockheed Aircraft Corp. for U. S. Air Force which delivers the aircraft to Mutual Aid Program countries such as Norway, Denmark, Greece and Turkey. F15AM-11 NASARR is optimized in air-to-air and air-to-ground modes for strike, reconnaissance and intercept missions capability.
- F-104G manufactured in Western Europe must perform intercept, strike and reconnaissance missions. The F15A-41B radar is optimized in both air-to-ground and air-to-air.
- F-104J manufactured in Japan is limited by U. S. treaty agreements to intercept missions, but has essentially the same air-to-ground capability as the F-104G. The F15J-31 NASARR manufactured by North American Aviation's Autonetics Div. is optimized in the air-to-air mode.

gine speed. Maximum allowable engine rpm. is 107%.

A noticeable boost in acceleration resulted from the increase in rpm. and fuel flow, but except for the pressure surge passing through Mach 1, supersonic flight was vibrationless and only the Mach needle indicated that the aircraft now was flying at supersonic speed.

When Mach 2 was reached, 3½ min. after starting the run at Mach .92, a red, speed-limit warning light reading "slow" came on, and afterburner was cut out manually. The unexpected deceleration approximated a catapult-shot in reverse, and the plane slowed quickly to subsonic speed as the throttle was reduced to about 86%—roughly idle rpm. at 35,000 ft.

Top speed of all F-104s is about Mach 2, which is an imposed rather than a performance restriction. The primary limitation is high air temperature at the compressor inlet, since speeds up to Mach 2.4 (with a longer inlet spike) have been attained during record-breaking attempts when the restriction was temporarily lifted. The compressor inlet air temperature restriction of 121C (reached at about Mach 2) has been imposed to protect the compressor frame from critical heating.

An idle descent was made to Palmdale at 500 kt., which Brown said was optimum for best range. With no power, 275 kt. is best speed in a clean configuration and yields a 5 to 1 glide ratio. Over Palmdale, a final check on the inertial navigation system showed no noticeable error in the readout.

An overhead approach with gear down at 280 kt. followed by landing flaps of 30 deg. leading edge and 45 deg. trailing edge brought the plane abeam of the runway at a speed of about 220 kt.

Trailing edge flaps are fully blown in landing configuration, providing boundary layer control.

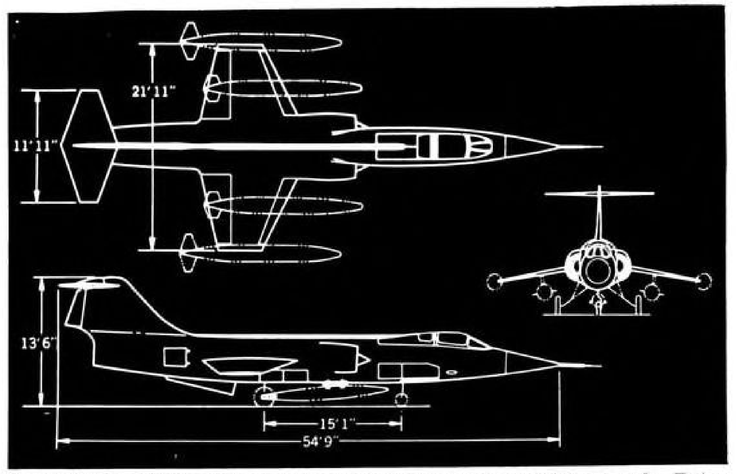
Turn into final approach was at about 190 kt. Power was gradually reduced and speed fell off to about 160 kt. over the end of the runway.

Drag Chute Deployed

Touchdown was 200 to 300 ft. from the end of the runway and the 18-ft. drag chute was deployed to slow to braking speed. The anti-skid braking system, used in intermittent, long-duration applications, brought the aircraft to a stop about 3,400 ft. from the end of the runway, after a 3,200 ft. roll.

Chute was released on one side of the runway and the plane was taxied to the line, with about 950 lb. of fuel remaining.

Flight time from takeoff to touchdown was 57½ min.



THREE-VIEW SHOWS variety of external stores which can be carried by F-104G. Trainer version carries same stores, except for centerline pod and M61 Vulcan cannon.

Features of the NASARR F15A radar system, covered in a post-flight briefing but not demonstrated in flight, include:

- **Air-to-air search** for airborne targets, which uses a two-bar scan sweeping a 4-deg. by 90-deg. sector. The antenna may be tilted up or down through a range of +20 to −40 deg. to provide full radar coverage at 20-, 40- or 80-mi. range.
- **Air-to-air tracking,** for use after locating the target in air-to-air search. The pilot presses an action/reject button on his control stick when the sweep passes over the target, causing the antenna to restrict its sweep to a small elliptical pattern, 10 deg. wide and 4 deg. deep, about the target. A variable range-gate is positioned over the target and the pilot again depresses the action/reject button which locks the radar on the target.
- **Air-to-air attack,** which takes place,

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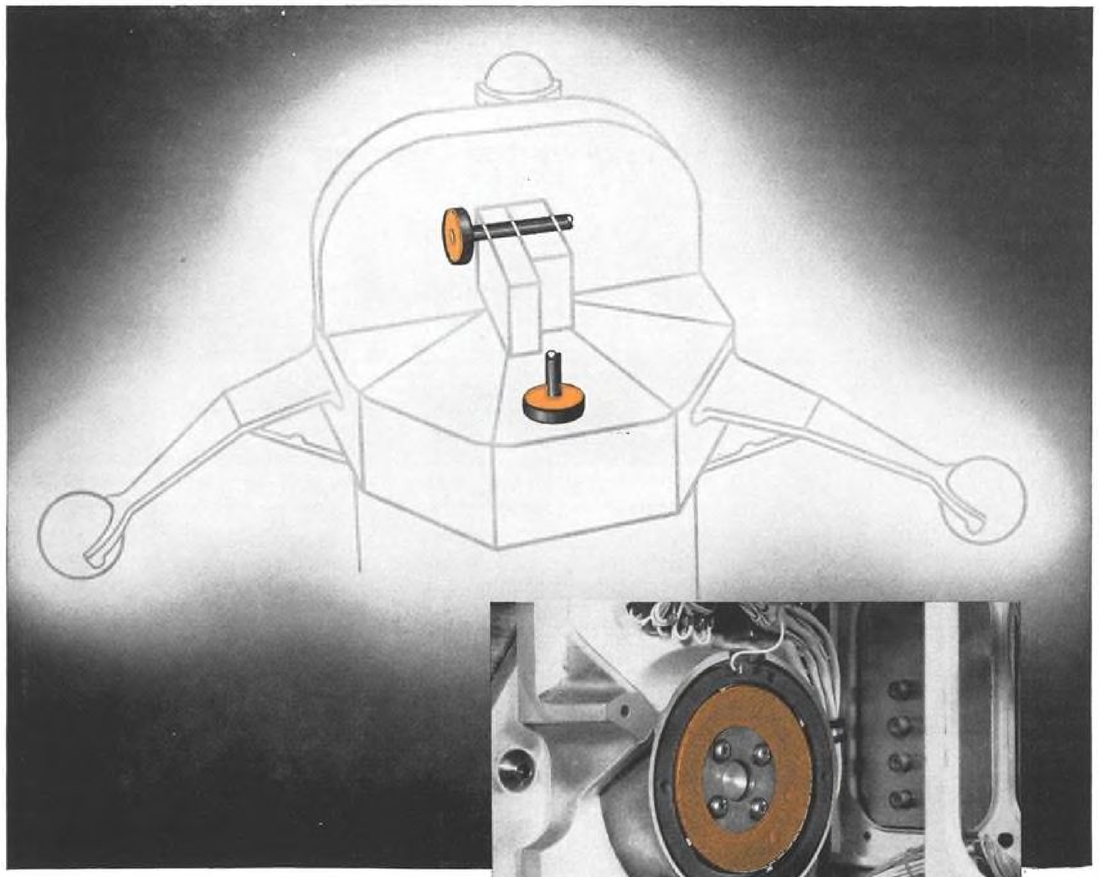


Photo — Courtesy of Ball Brothers Research Corporation

Inland Gearless Torquers help keep "OSO" instruments locked on the sun

Orbiting Solar Observatory satellites —designed, developed and built by Ball Brothers Research Corporation for NASA to conduct as many as 16 separate studies of the sun's radiation. Success depends on pointing scientific instruments at the center of the sun with accuracy approximating one minute of arc.

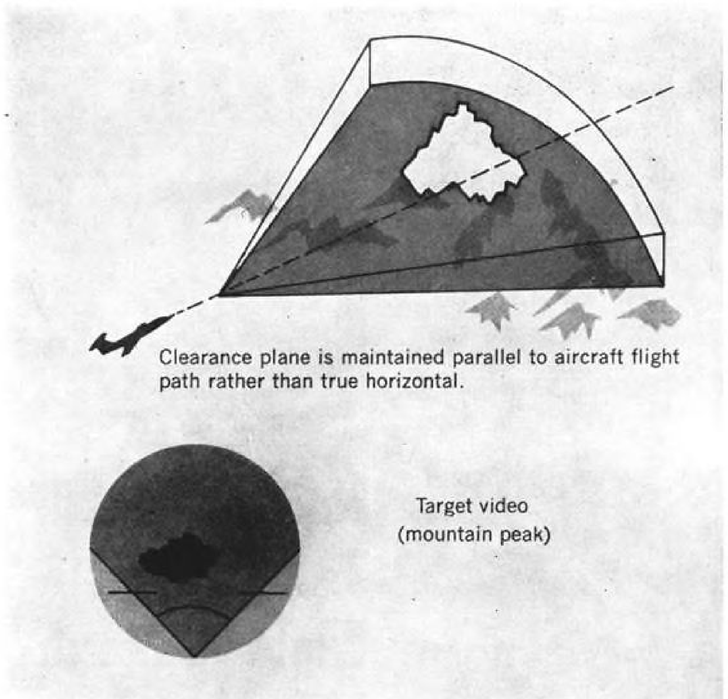
Two Inland Gearless Torque Motors play major roles in "OSO" servo-positioning systems. One motor keeps the instruments pointed toward the sun in azimuth; the second provides fine control in elevation. Both motors are controlled by photovoltaic sun sensors.

Fast, accurate response to servo-position error signals is one reason why Inland Gearless Torquers win so many missile and space-vehicle assignments. Their high-resolution performance comes from torque-to-inertia ratios 10 times higher than equivalent gear-train servo motors. Moreover, the compact pancake configuration of Inland Direct-Drive Torque Motors overcomes stringent weight and space limitations.

What's your problem? If you're currently working on a servo system calling for output torque between 0.04 and 3,000 pound-feet*, compare Inland Gearless Torquers with any alternative. Write for facts.

**Even higher torque output levels can be provided.*

INLAND MOTOR CORPORATION
A SUBSIDIARY OF
KOLLMORGEN CORP.
NORTHAMPTON, MASS.



TERRAIN AVOIDANCE MODE of NASARR system shows obstacles in front of aircraft and in line with its flight path regardless of attitude to true horizontal. Radar sweep is represented by gray area in front of airplane silhouette and radar presentation is shown below.

after lock-on, within a 20-mi. range. Prior to starting the intercept, the pilot must select a lead-pursuit, lead-collision or pure pursuit course and the weapon —homing rocket, unguided missile or cannon. This information is set into the armament control panel, which relays it on to the armament control computer. Necessary elevation and course corrections are indicated on the scope by the position of a small circle used for approximate alignment and a dot used for fine alignment.

After steering so as to center the small circle in the scope, the pilot centers the dot inside the circle to maintain proper course.

Rotation of a single, fixed-gap in the perimeter of a large circle around the edge of the scope indicates rate of closure or opening. With the gap at the 12 o'clock position, the aircraft has a zero rate-of-closure. A clockwise rotation of the gap to 6 o'clock indicates a rate-of-closure 1,800-kt. or above. Counterclockwise rotation to 10:30 indicates opening rate of 300 kt.

When the target is within range, the gapped circle collapses to half size, and continues to reduce in size until breakaway range, when a large X appears on the scope. Pilot may fire anytime when within range. A faint azimuth line and dot represent the target's actual position during the intercept. During air-to-air attack, an artificial horizon line superimposed on the scope indicates pitch and roll, allowing the pilot to use the scope as a single primary flight instrument.

The NASARR F15A is augmented by both a visual and an infrared sight, both displayed on a combining glass in front of the pilot. Tracking may be accomplished with the visual site by positioning a circle and dot combination (which remain fixed in relation to each other) in the center of the reticle image. An infrared system may be used in clear weather to track jet aircraft or differentiate between propeller and jet planes. The infrared display appears in the form of a large X on the combining glass.

Investment Curbs

Paris—French intentions seeking some sort of curb on U. S. investment in the six Common Market nations probably won't have much effect on U. S. aerospace companies.

The French insist their concern isn't aimed at the U. S. aerospace investment in France. What the French are worried about is U. S. investment taking dominant position in any sector. Investments by U. S. aerospace companies have generally been on a minority basis.



PUMP PRIMERS

ARTHUR A. NICHOLS

Special Purpose Pumps For Special Problems

► In over thirty years experience in the design and manufacture of special pumps, we have solved numerous pumping problems where the design and production of a suitable pump was considered almost impossible, either because of the material to be pumped, or because of the precise manufacture necessary to obtain satisfactory performance.

► **Nichols pumps are standard for example, in the man made fibre industry for pumping rayon, acetate, celanese, nylon and other fibres spun in fibre plants throughout the world.**

► Some interesting new applications for Gerotor pumps have been developed in recent times involving specialized problems in hydraulic servo systems.

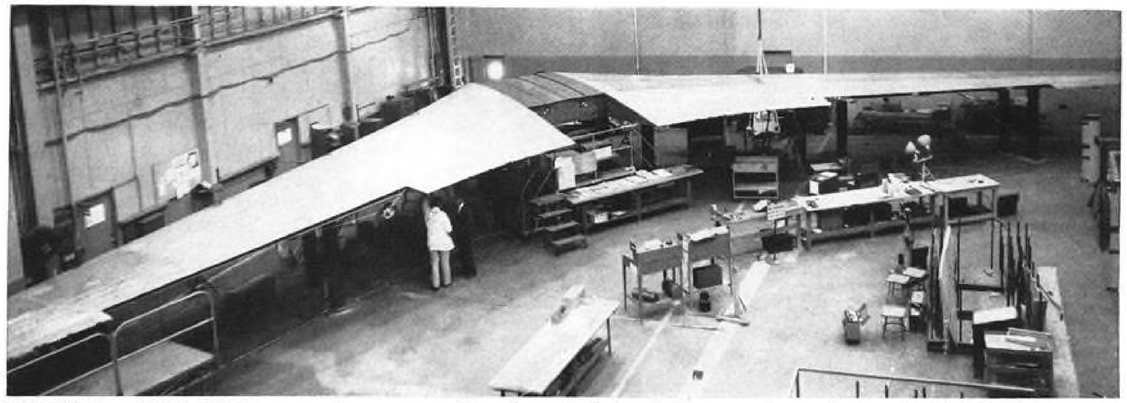
► **Important advantages are offered by the Gerotor pump for servo control applications. It is a positive displacement pump and provides a smooth power flow from one end of the pumping cycle to the other. Unlike other types of pumps which tend to quit work at the low end of the speed range,** *Gerotors stay right on the job and provide positive power to the extremely low range.* **Thus, they are exceptionally responsive in servo systems.**

► For electronic equipment operating at high altitudes, air cooling of high input components becomes troublesome because lower air density limits cooling fan efficiency. Liquid cooling systems are therefore frequently preferred for this type of service. Our extensive experience over the years in the production of high performance aircraft engine pumps has been of great value in developing electronic coolant circulators that provide maximum weight and space savings with efficient heat transfer capabilities.

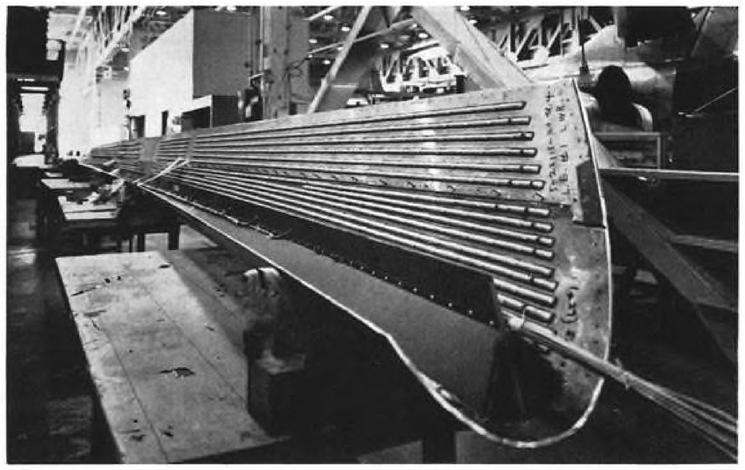
► **Special pumps have been designed and manufactured for applications as varied as metering pumps in vending machines and conveying molten solder in production equipment. This long and varied experience in industry-wide pumping applications, combined with years of specialized development and production of pumps for the aircraft engine, super-charger, missile, helicopter and electronic field is available to today's designer faced with new and unusual pumping applications and problems.**

► *Technical data is available and your inquiry is invited. Write:*

W. H. NICHOLS CO.
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USAF/Northrop X-21's 30 deg.-sweep wing represents that of a typical subsonic, long-range, long-endurance aircraft. Wing has an aspect ratio of 7, taper ratio of 0.3. Spanwise distributions of thickness, camber and twist are based on wind tunnel and other studies.



Northrop X-21 To Make First Flight in March

First of two Northrop X-21 laminar flow control demonstration aircraft, built by the company's Norair Div., Hawthorne, Calif., under USAF contract, is scheduled to make its first flight in late March. X-21 is a converted Douglas WB-66D twin-jet weather reconnaissance plane. New wing has spanwise slots in the outer skin to draw off small portions of air flowing over the wing, thereby reducing friction drag.

Inside of wing leading edge, center shows rows of tributary ducts under surface slots. Below, workmen complete one wing panel.



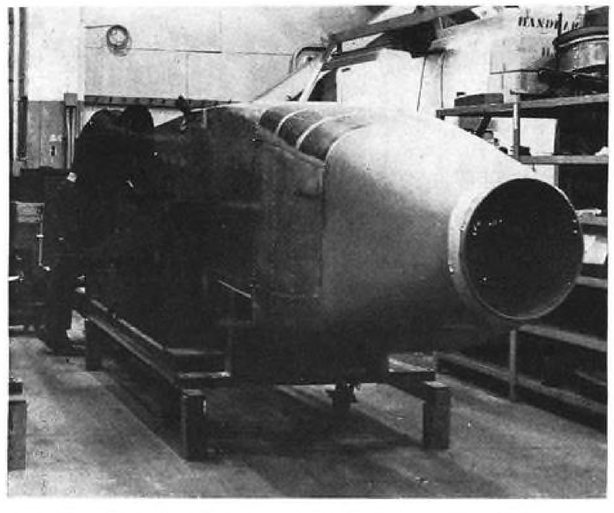


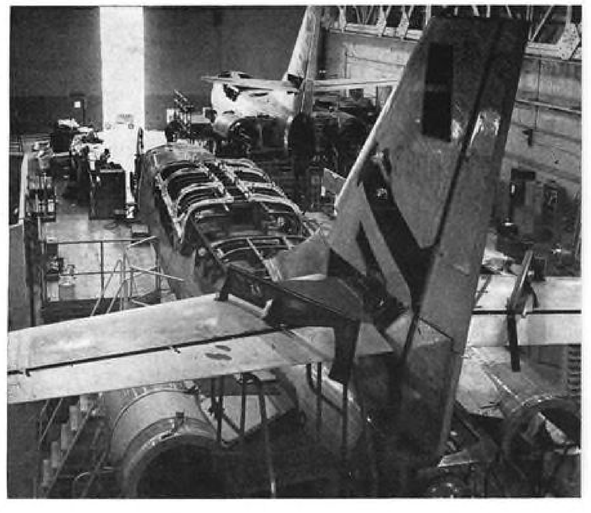
Above, wing is mated to the fuselage of the first X-21. Other changes from WB-66D configuration include location of the engines on the fuselage. Powerplants are two General Electric J79 turbojets producing 9,400 lb. thrust each.

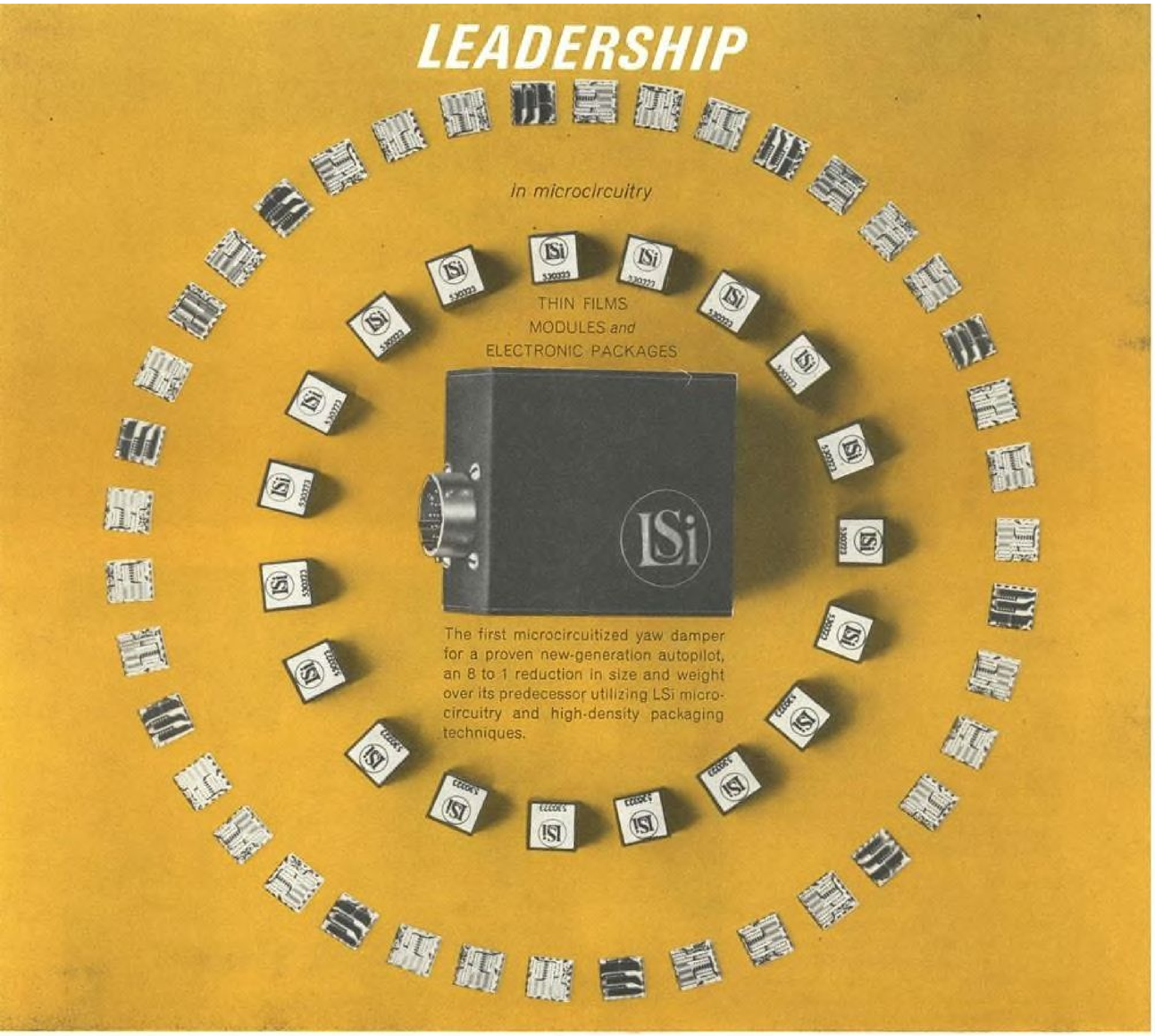


Center, engineer checks automatic slotting machine on X-21 wing surface. Device is used to cut surface span slots, plenum chambers within slots and metering holes below plenum chambers. Air drawn off the wing surface feeds through the metering holes into tributary ducts inside the wing, then spills through a box structure into compressors under the wings and is exhausted behind the plane.

Below left, one of two compressor pods to exhaust air drawn from the wing surface, contains both a high-and low-pressure compressor (AW June 4, p. 94). Below right, frames atop fuselage support a fairing to redirect air flow over the wing for optimum pressure distribution. No. 2 airplane in background will fly in May.







LSi ASTRONICS ENCIRCLES MICROCIRCUIT TECHNOLOGY



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A total capability in microcircuitry...the achieved goal of LSi Astronics. Already recognized as a leader in the development and production of thin films for micro-electronics, the Astronics Division is producing thin film modules and electronic packages resulting in extremely small and light weight systems which possess high degrees of reliability and ruggedness. Whether your requirement is for thin films, modules or completely packaged products, Astronics has unmatched design and production capability to meet your special microcircuitry requirements. Inquire about our standard off-the-shelf circuits and modules suitable for use in a variety of system applications. Learn more of Astronics' complete capability in thin film technology by writing for Data File AW-1994-1.

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DOD Research Awards Total $6.1 Billion

Washington—Defense Dept. awarded $6.129 billion in Fiscal 1962 in contracts of $10,000 or more for experimental, developmental, test and research work (EDTR), an increase of $104 million over Fiscal 1961. Five hundred contractors accounted for $6.04 billion, or 98.5% of the total spent.

Almost one contractor in every four on the Fiscal 1962 list—134 out of 500—did not appear on the Fiscal 1961 list. Defense Dept. broke the Fiscal 1962 list into two categories—388 U. S. business firms and 112 educational institutions, government agencies, other non-profit institutions and foreign firms. Approximately one-third of the business firms, or 136 out of 388, were small businesses.

Although the top 500 contractors accounted for all but 1.5% of the total Fiscal 1962 contracting, 1,542 other businesses and non-profit firms received prime contract awards of $10,000 or more for EDTR work. Of these, 452 were government, non-profit or foreign organizations; 582 were large companies and 1,008, or 63.4%, were small businesses. Eighty-nine per cent of the awards was for work connected with missiles, aircraft, ships and electronic programs.

AVIATION WEEK & SPACE TECHNOLOGY is publishing below the 500 contractors by rank and amount of awards, with the 388 business firms listed first:

Business Firms

Rank	Name of Company	Thousands of Dollars
1.	General Dynamics Corp. San Diego, Calif.	$508,097
2.	Lockheed Aircraft Corp. Sunnyvale, Calif.	499,596
3.	Boeing Co. Seattle, Wash.	497,038
4.	North American Aviation, Inc. Los Angeles, Calif.	401,159
5.	General Electric Co. Philadelphia, Pa.	383,456
6.	Martin Marietta Corp. Littleton, Colo.	333,012
7.	Western Electric Co. New York, N. Y.	268,411
8.	Aerojet-General Corp. Sacramento, Calif.	202,037
9.	Douglas Aircraft Co. Santa Monica, Calif.	181,331
10.	Sperry Rand Corp. Syosset, N. Y.	152,888
11.	International Telephone & Telegraph Co. Paramus, N. J.	140,249
12.	Pan American World Airways, Inc. Cocoa, Fla.	106,791
13.	Hercules Powder Co. Rocket Center, W. Va.	102,507
14.	Radio Corp. of America Moorestown, N. J.	100,656
15.	Thiokol Chemical Corp. Brigham City, Utah	91,868
16.	Philco Corp. Palo Alto, Calif.	85,593
17.	Westinghouse Electric Corp. Sunnyvale, Calif.	84,553
18.	General Motors Corp. Milwaukee, Wisc.	80,769
19.	Bendix Corp. Ann Arbor, Mich.	80,315
20.	Avco Corp. Wilmington, Mass.	78,830
21.	Space Technology Laboratories, Inc. Los Angeles, Calif.	59,257
22.	Sylvania Electric Products, Inc. Mountain View, Calif.	56,552
23.	United Aircraft Corp. East Hartford, Conn.	52,668
24.	Raytheon Co. Waltham, Mass.	48,648
25.	Goodyear Aircraft Corp. Akron, Ohio	46,077
26.	Ford Motor Co. Newport Beach, Calif.	46,017
27.	Hughes Aircraft Co. Culver City, Calif.	33,473
28.	Northrop Corp. Hawthorne, Calif.	32,789
29.	ARO, Inc. Tullahoma, Tenn.	32,751
30.	Vitro Corp. of America Silver Springs, Md.	24,657
31.	Minneapolis-Honeywell Regulator Co. St. Petersburg, Fla.	24,038
32.	Ling-Temco-Vought, Inc. Dallas, Tex.	22,218
33.	American Bosch Arma Corp. Garden City, N. Y.	22,131
34.	American Machine & Foundry Co. Lompoc, Calif.	21,070
35.	Fairchild Stratos Corp. Hagerstown, Md.	20,673
36.	Bell Aerospace Corp. Buffalo, N. Y.	19,602
37.	Cutler-Hammer, Inc. Deer Park, N. Y.	17,640
38.	Burroughs Corp. Paoli, Pa.	16,712
39.	International Business Machines Corp. Owego, N. Y.	15,468
40.	Eastman Kodak Co. Rochester, N. Y.	14,096
41.	Litton Systems, Inc. Canoga Park, Calif.	13,590
42.	Marquardt Corp. Van Nuys, Calif.	12,923
43.	Collins Radio Co. Richardson, Tex.	12,673
44.	Control Data Corp. Minneapolis, Minn.	11,793
45.	General Precision, Inc. Little Falls, N. J.	10,548
46.	Parsons (Ralph M.) Co. Los Angeles, Calif.	10,268

(Continued on page 85)



Hiller L4 Automatic Stabilization Helicopter Shown

Hiller L4 is being displayed with new automatic stabilization system while final certification by Federal Aviation Agency is completed. Auto stabilization model is equipped with a new rotor system package including automatic stabilization unit, hydraulic power controls and high lift rotor blades. System was tested last year on various helicopter models (AW June 25, p. 91). Stabilization unit contains rate gyro, solid state electronic control package and an electric actuator for each cyclic control axis.



The consolidation of electro and fluid mechanic engineering and manufacturing facilities at Bendix-Pacific provides a unique and truly integrated approach to the research, design, development and manufacture of actuation and control, servos, components and sub-systems. Research capabilities include analog and digital computers and complete environmental laboratories.

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Broad experience... demonstrated by a continuing list of important advanced components and sub-systems... illustrates the ability of Bendix-Pacific to solve complex actuation and control system problems... including trade-off and interface compatibility studies using electro-mechanical, pneumatic and / or hydraulic sub-system approaches.

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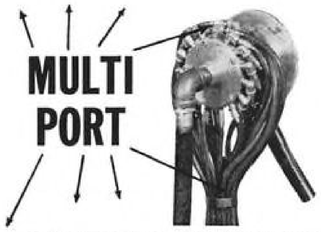
Total Defense R & D Funding

(In thousands)

	Program Cost (Total Obligational Authority)			Contract Commitments (Direct Obligations)		
	1962 Actual	1963 Estimate	1964 Estimate	1962 Actual	1963 Estimate	1964 Estimate
Military sciences	$817,375	$936,443	$978,029	$765,517	$936,183	$978,424
Aircraft and related equipment	656,621	744,430	690,317	614,542	688,583	753,421
Missiles and related equipment	2,689,807	2,445,560	2,226,866	2,752,566	2,445,587	2,233,494
Military astronautics and related equipment	817,455	1,243,704	1,284,270	784,803	1,247,153	1,277,233
Ships, small craft, and related equipment	188,810	217,250	294,208	204,640	211,983	294,190
Ordnance, combat vehicles, and related equipment	206,815	252,511	303,975	202,886	255,985	303,279
Other equipment	516,842	796,081	911,176	525,989	806,218	905,942
Program-wide management and support	452,998	482,309	531,159	495,471	480,904	531,017
Emergency fund	.....	120,380	150,000	.....	120,380	150,000
Total	$6,346,723	$7,238,668	$7,370,000	$6,346,414	$7,192,976	$7,427,000

47. Thompson Ramo Wooldridge, Inc. Cleveland, Ohio 10,018
48. Curtiss-Wright Corp. Paterson, N. J. 9,283
49. McDonnell Aircraft Corp. St. Louis, Mo. 8,750
50. Texas Instruments, Inc. Dallas, Tex. 8,631
51. Atlantic Research Corp. Alexandria, Va. 8,525
52. Hughes Tool Co. Culver City, Calif. 7,942
53. Cubic Corp. San Diego, Calif. 7,801
54. Electro Optical Systems, Inc. (5) Pasadena, Calif. 7,353
55. United Electro-dynamics, Inc. Pasadena, Calif. 7,350
56. Gilfillan Corp. Los Angeles, Calif. 7,314
57. Sanders Associates, Inc. Nashua, N. H. 7,277
58. Motorola, Inc. Scottsdale, Ariz. 7,117
59. Bliss (E. W.) Co. Canton, Ohio 6,607
60. Hiller Aircraft Corp. Palo Alto, Calif. 6,579
61. Little (Arthur D.), Inc. Cambridge, Mass. 6,332
62. Land Air, Inc. Alamogordo, N. M. 6,162
63. Fairchild Camera & Instrument Corp. Syosset, N. Y. 6,092
64. Melpar, Inc. Falls Church, Va. 6,086
65. Union Carbide Corp. New York, N. Y. 5,728
66. A C F Industries, Inc. Riverdale, Md. 5,634
67. General Instrument Corp. Westwood, Mass. 5,417
68. Cook Electric Co. Morton Grove, Ill. 5,397
69. Geotechnical Corp. (The) Garland, Tex. 5,166
70. Edgerton, Germeshausen & Grier, Inc. Boston, Mass. 5,028
71. Chrysler Corp. Detroit, Mich. 5,005
72. Garrett Corp. Phoenix, Ariz. 4,802
73. Continental Aviation & Engineering Detroit, Mich. 4,563
74. General Mills, Inc. Minneapolis, Minn. 4,473
75. Federal Electric Corp. Point Mugu, Calif. 4,369
76. Magnavox Co. Fort Wayne, Ind. 4,304
77. Holmes & Narver, Inc. Los Angeles, Calif. 3,996
78. All American Engineering Co. (5) Wilmington, Del. 3,842
79. Aerojet-General Nucleonics San Ramon, Calif. 3,822
80. H R B Singer, Inc. State College, Pa. 3,730
81. Lockheed Propulsion Co. Redlands, Calif. 3,663

(Continued on page 86)



MULTI PORT

ROPER PUMPS for aircraft

Roper flow divider pumps are ideal for systems requiring many small, controlled flows . . . such as lubricating many points in a gear box. This type of pump utilizes two special Gerotor gear sets and a simple integral valving arrangement to port each pump chamber independently. The design completely eliminates clogging, which is inherent in conventional orificing systems. There are only two moving parts for simplicity and dependability.

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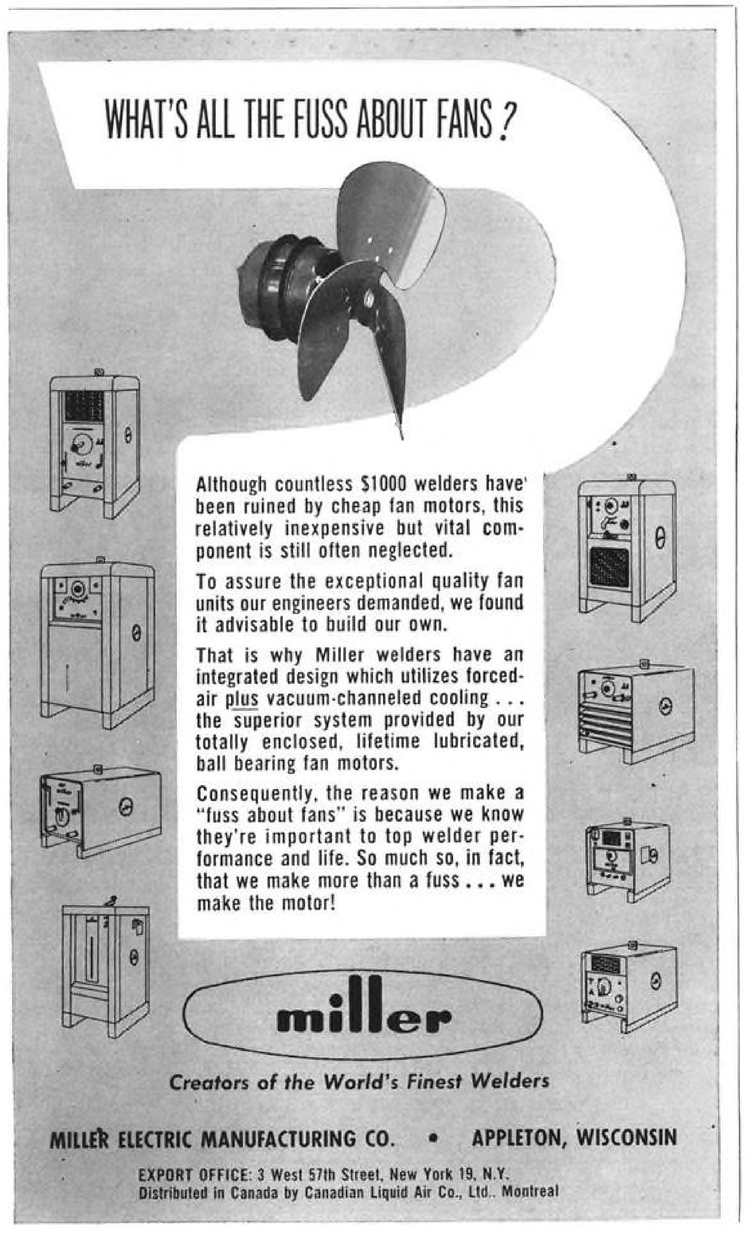


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82. T R G, Inc. (S) Syosset, N. Y. 3,593
83. Dupont (E. I.) de Nemours & Co. Wilmington, Del. 3,572
84. American Science & Engineering, Inc. Cambridge, Mass. 3,518
85. Hoffman Electronics Corp. Los Angeles, Calif. 3,483
86. Varian Associates Palo Alto, Calif. 3,445
87. Aircraft Armaments, Inc. Cockeysville, Md. 3,441
88. Hallicrafters Co. Chicago, Ill. 3,295
89. Radiation, Inc. Melbourne, Fla. 3,258
90. Callery Chemical Co. Muskogee, Okla. 3,122
91. Operations Research, Inc. (S) Santa Monica, Calif. 3,093
92. Daca Electronics, Inc. (S) Leesburg, Va. 2,985
93. Lear Siegler, Inc. Santa Monica, Calif. 2,921
94. Aero Geo Astro Corp. (S) Alexandria, Va. 2,835
95. Space-General Corp. Glendale, Calif. 2,800
96. Acoustica Associates, Inc. Los Angeles, Calif. 2,759
97. Rohm & Haas Co. Huntsville, Ala. 2,701
98. Technical Operations, Inc. (S) Washington, D. C. 2,548
99. Geophysics Corp. of America (S) Bedford, Mass. 2,542
100. Hazeltine Corp. Little Neck, N. Y. 2,459
101. Minnesota Mining & Manufacturing Co. St. Paul, Minn. 2,434
102. American Electronic Laboratories (S) Philadelphia, Pa. 2,407
103. Esso Research & Engineering Co. Linden, N. J. 2,384
104. Telecomputing Corp. Alamogordo, N. M. 2,360
105. Litton Industries, Inc. San Carlos, Calif. 2,309
106. Ryan Aeronautical Co. San Diego, Calif. 2,300
107. Eda Corp. College Point, N. Y. 2,252
108. Itek Corp. Lexington, Mass. 2,241
109. Ampex Corp. Redwood City, Calif. 2,209
110. Dow Chemical Co. Midland, Mich. 2,077
111. Clevite Corp. Cleveland, Ohio 2,043
112. Houston Fearless Corp. Los Angeles, Calif. 2,038
113. F M C Corp. San Jose, Calif. 2,000
114. Perkin-Elmer Corp. Norwalk, Conn. 1,966
115. Chamberlain Corp. Waterloo, Iowa 1,961
116. Interstate Electronics Corp. Anaheim, Calif. 1,952
117. Borg-Warner Corp. Kalamazoo, Mich. 1,889
118. Kaman Aircraft Corp. Colorado Springs, Colo. 1,872
119. Grumman Aircraft Engineering Corp. Bethpage, N. Y. 1,842
120. Planning Research Corp. (S) Los Angeles, Calif. 1,838
121. Northern Ordnance, Inc. Minneapolis, Minn. 1,764
122. Wyle Laboratories (S) El Segundo, Calif. 1,716
123. Pacific Car & Foundry Co. Renton, Wash. 1,701
124. CEIR, Inc. Arlington, Va. 1,662
125. Dynatronics, Inc. (S) San Nicolas Island, Cal. 1,632
126. United Technology Corp. Sunnyvale, Calif. 1,617
127. N T W Missile Engineering, Inc. (S) Los Angeles, Calif. 1,513
128. Barnes Engineering Co. (S) Stamford, Conn. 1,493
129. Richardson Merrell, Inc. Philadelphia, Pa. 1,494
130. American Optical Co. Pittsburgh, Pa. 1,410
131. Aeronca Manufacturing Corp. Middletown, Ohio 1,330
132. Microwave Associates, Inc. Burlington, Mass. 1,300
133. Beech Aircraft Corp. Wichita, Kan. 1,294
134. Texaco, Inc. Beacon, N. Y. 1,279
135. General Applied Science Laboratories (S) Westbury, N. Y. 1,268
136. Textron, Inc. Belmont, Calif. 1,245
137. S-F-D Laboratories, Inc. Union, N. J. 1,229
138. Olin Mathieson Chemical Corp. New Haven, Conn. 1,226
139. Packard-Bell Electronics Corp. Santa Monica, Calif. 1,222
140. Beckman Instruments, Inc. Fullerton, Calif. 1,221
141. Columbia Broadcasting System, Inc. Stamford, Conn. 1,213
142. Mayflower Trailer Co. (S) Torrance, Calif. 1,199
143. Amphend-Borg Electronics Corp. Chicago, Ill. 1,187
144. Daystrom, Inc. Poughkeepsie, N. Y. 1,185
145. P R D Electronics, Inc. Brooklyn, N. Y. 1,183
146. Bolt, Beranek & Newman, Inc. (S) Cambridge, Mass. 1,176
147. Monsanto Chemical Co. Dayton, Ohio 1,162
148. Dewey (G. C.) Corp. (S) New York, N. Y. 1,147
149. Conductron Corp. Ann Arbor, Mich. 1,145
150. Nuclear Metals, Inc. Concord, Mass. 1,143
151. Sangamo Electric Co. Springfield, Ill. 1,140
152. Allied Research Associates, Inc. Boston, Mass. 1,138
153. Defense Electronics, Inc. (S) Rockville, Md. 1,123
154. International Harvester Co. Melrose Park, Ill. 1,116
155. Sundstrand Corp. Denver, Colo. 1,112
156. Fenestra, Inc. Holmesburg, Pa. 1,099
157. Hayes International Corp. Birmingham, Ala. 1,098
158. National Cash Register Co. Dayton, Ohio 1,093
159. Belock Instrument Corp. College Point, N. Y. 1,086
160. Budd Co. Philadelphia, Pa. 1,082
161. Radiation at Stanford Palo Alto, Calif. 1,076
162. Ball Brothers Research Corp. Boulder, Colo. 1,050
163. Harvey Aluminum Torrance, Calif. 1,049

(Continued on page 87)



164. Le Tourneau-Westinghouse Co. Peoria, Ill. 1,040
165. Defense Research Corp. (S) Santa Barbara, Calif. 1,012
166. Power Generators, Inc. (S) Trenton, N. J. 1,008
167. Armour & Co. Chicago, Ill. 1,003
168. American Cyanamid Co. New York, N. Y. 999
169. Arinc Research Corp. Washington, D. C. 988
170. Electronic Associates, Inc. Long Branch, N. Y. 983
171. Emerson, Inc. Silver Spring, Md. 981
172. General Telephone & Electronics Labs, Inc. Bayside, N. Y. 976
173. Dunlap & Associates (S) Stamford, Conn. 969
174. Firestone Tire & Rubber Co. Akron, Ohio 954
175. Loral Electronics Corp. New York, N. Y. 930
176. Whirlpool Corp. St. Joseph, Mich. 910
177. Melabs, Inc. (S) Palo Alto, Calif. 908
178. National Co., Inc. Melrose, Mass. 900
179. Teague (Walter Dorwin) Associates (S) New York, N. Y. 896
180. Computer Control Co., Inc. (S) Framingham, Mass. 879
181. Howard Research Corp. (S) Arlington, Va. 877
182. Pennsalt Chemicals Corp. Wyndmoor, Pa. 872
183. Caterpillar Tractor Co. Peoria, Ill. 861
184. Mobile Holdings Corp. (S) Cypress, Calif. 859
185. M H D Research, Inc. (S) Newport Beach, Calif. 856
186. Eitel-McCullough, Inc. San Carlos, Calif. 852
187. Associated Aero Science Labs., Inc. (S) Hawthorne, Calif. 847
188. Field Emission Corp. (S) McMinnville, Ore. 841
189. Auerbach Electronics Corp. (S) Philadelphia, Pa. 838
190. United States Rubber Co. Wayne, N. J. 837
191. Stelma, Inc. (S) Stamford, Conn. 813
192. F M A, Inc. (S) El Segundo, Calif. 812
193. Systems Research Laboratories, Inc. (S) Dayton, Ohio 799
194. Adler Electronics, Inc. New Rochelle, N. Y. 793
195. Corning Glass Works Corning, N. Y. 784
196. Watkins-Johnson Co. (S) Palo Alto, Calif. 781
197. Laboratory for Electronics, Inc. Richmond, Calif. 765
198. United States Undersea Cable Corp. Washington, D. C. 763
199. Dresser Industries, Inc. Houston, Tex. 755
200. Admiral Corp. Chicago, Ill. 750
201. Raymond Engineering Laboratories, Inc. (S) Middletown, Conn. 730
202. Maxson Electronics Corp. New York, N. Y. 723
203. Hansen Brothers (S) Whittier, Calif. 719
204. Allied Chemical Corp. Morristown, N. J. 711
205. Technical Appliance Corp. (S) Sherburne, N. Y. 707
206. Horizons, Inc. (S) Cleveland, Ohio 703
207. Reeves Instrument Corp. Garden City, N. Y. 702
208. Milgo Electronic Corp. (S) Miami, Fla. 698
209. Solar Aircraft Co. San Diego, Calif. 697
210. General Atronics Corp. (S) Conshohocken, Pa. 692
211. Sanders & Thomas Inc. (S) Pottstown, Pa. 675
212. Texaco Experiment, Inc. Richmond, Va. 673
213. Intercontinental Engine-Welex Electronics (joint venture) Brownsville, Tex. 670
214. Consolidated Systems Corp. Monrovia, Calif. 665
215. Scope, Inc. (S) Falls Church, Va. 659
216. Comstock & Westcott, Inc. (S) Cambridge, Mass. 647
217. Lyon, Inc. (S) Detroit, Mich. 646
218. Ethyl Corp. Baton Rouge, La. 641
219. McKiernan-Terry Corp. Dover, N. J. 633
220. Bechtel Corp. San Francisco, Calif. 626
221. Allis-Chalmers Manufacturing Co. West Allis, Wisc. 626
222. General Electronic Laboratories, Inc. (S) Cambridge, Mass. 622
223. Genisco, Inc. (S) Alamogordo, N. M. 620
224. Servo Corp. of America (S) Hicksville, N. Y. 612
225. Bell & Howell Co. Pasadena, Calif. 609
226. Hewlett-Packard Co. Palo Alto, Calif. 607
227. Kallsman Instrument Corp. Elmhurst, N. Y. 601
228. Zenith Radio Corp. Chicago, Ill. 594
229. Goodrich (B. F.) Co. Akron, Ohio 593
230. Hycon Manufacturing Co. (S) Monrovia, Calif. 593
231. Universal Match Corp. St. Louis, Mo. 580
232. Giannini Controls Corp. Duarte, Calif. 576
233. United Industrial Corp. Cockeysville, Md. 575
234. Chesapeake Instrument Corp. (S) Shadyside, Md. 575
235. M & T Co. (S) San Clemente Island, Cal. 573
236. Ewen-Knight Corp. (S) East Natick, Mass. 571
237. Republic Aviation Corp. Farmingdale, N. Y. 556
238. Hydronautics, Inc. (S) Rockville, Md. 553
239. Kollett Aircraft Corp. (S) Willow Grove, Pa. 550
240. Technology, Inc. (S) Dayton, Ohio 544
241. Chu Associates (S) Littleton, Mass. 542
242. Magna Products, Inc. Anaheim, Calif. 535
243. Polarad Electronics Corp. Long Island City, N Y. 529
244. Tasker Instrument Corp. (S) Van Nuys, Calif. 525
245. Quantatron, Inc. Santa Monica, Calif. 521
246. National Scientific Laboratories, Inc. Washington, D. C. 515

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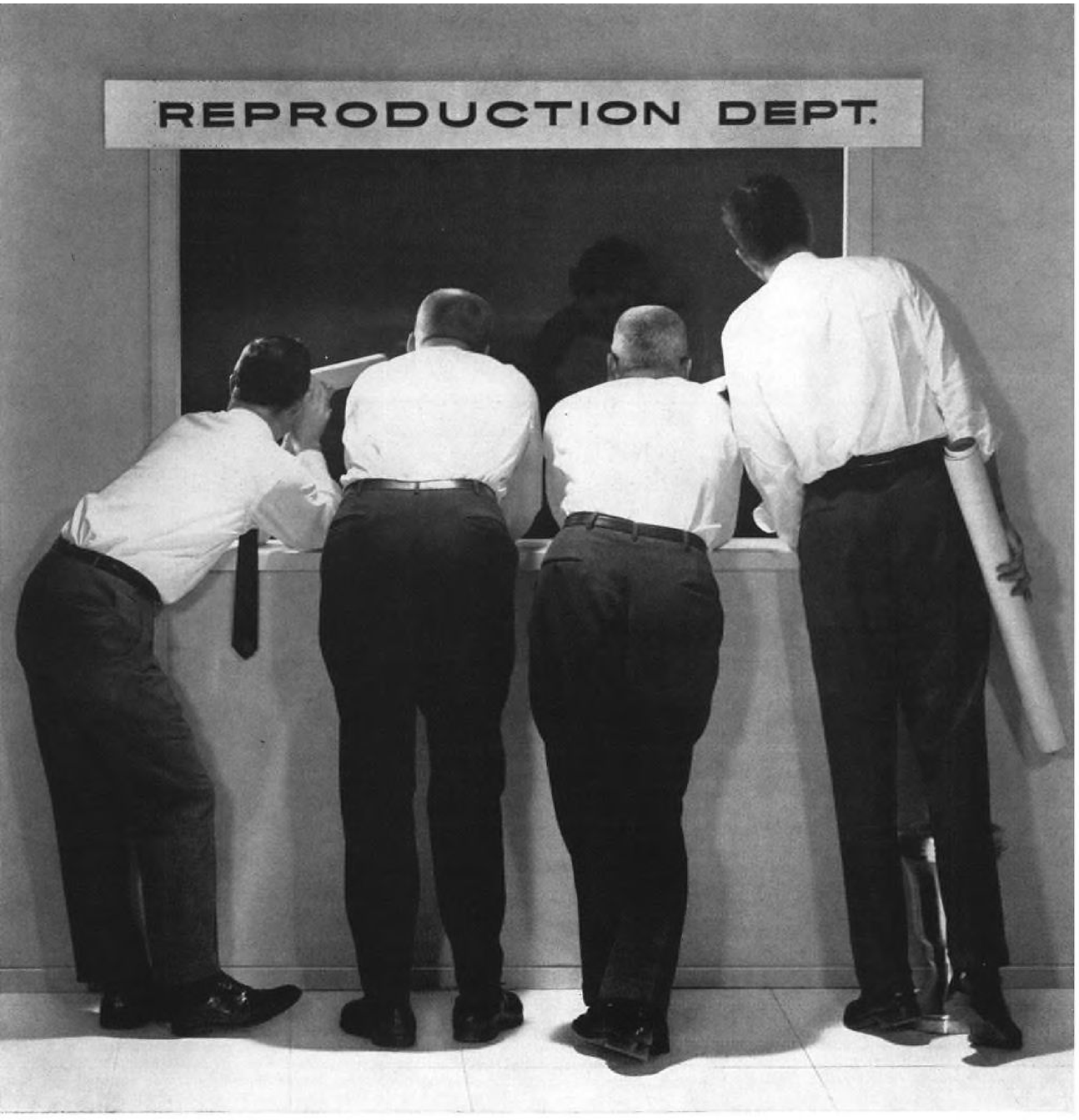




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247. Tecnifax Corp. (S) Holyoke, Mass. 511
248. Vocaline Co. of America, Inc. (S) Old Saybrook, Conn. 503
249. Brown Engineering Co., Inc. Huntsville, Ala. 502
250. Tyco, Inc. (S) Waltham, Mass. 501
251. Dynamics Research Corp. (S) Stoneham, Mass. 500
252. Booz-Allen Applied Research, Inc. Bethesda, Md. 498
253. Victor Manufacturing Co., Inc. (S) Southampton, Pa. 496
254. Monsanto Research Corp. Dayton, Ohio 494
255. Isotopes, Inc. (S) Westwood, N. J. 488
256. Manson Laboratories, Inc. (S) Stamford, Conn. 481
257. Dynatech Corp. (S) Cambridge, Mass. 472
258. Systems Technology, Inc. (S) Inglewood, Calif. 471
259. Consolidated Electrodynamics Corp. Pasadena, Calif. 471
260. Clark (David) Co. Worcester, Mass. 471
261. Arde, Inc. Paramus, N. J. 468
262. National Engineering Science Co. (S) Pasadena, Calif. 468
263. Sichak Associates (S) Nutley, N. J. 458
264. Varo, Inc. Garland, Tex. 456
265. Electronic Communications, Inc. Timonium, Md. 451
266. Allis (Louis) Co. Milwaukee, Wisc. 447
267. Manufacturing Laboratories, Inc. (S) Cambridge, Mass. 443
268. Emerson Electric Manufacturing Co. St. Louis, Mo. 429
269. Smyth Research Associates (S) San Diego, Calif. 429
270. Vare Industries, Inc. (S) Newark, N. J. 426
271. Air Reduction Co. Murray Hill, N. J. 426
272. Servomechanisms, Inc. Goleta, Calif. 424
273. International Resistance Co. Philadelphia, Pa. 423
274. Data Corp. (S) Dayton, Ohio 422
275. Pneumodynamics Corp. El Segundo, Calif. 422
276. Revere Copper & Brass, Inc. New York, N. Y. 421
277. Electro International, Inc. (S) Annapolis, Md. 418
278. Capehart Corp. (S) Richmond Hill, N. Y. 418
279. Goodrich-High Voltage Astronautics, Inc. Burlington, Mass. 417
280. Applied Research, Inc. (S) Port Washington, N. Y. 416
281. Bjorksten Research Labs, Inc. (S) Madison, Wisc. 415
282. Thermo Electron Engineering Corp. Waltham, Mass. 415
283. Microwave Electronics Corp. (S) Palo Alto, Calif. 415
284. Bermite Powder Co., Inc. (S) Saugus, Calif. 414
285. Ametco, Inc. (S) Los Angeles, Calif. 414
286. National Research Corp. (S) Cambridge, Mass. 411
287. Autometric Corp. New York, N. Y. 409
288. Bulova Watch Co., Inc. Woodside, N. Y. 409
289. Shell Oil Co. Emeryville, Calif. 408
290. Electro-Mechanics Co. (S) Austin, Tex. 407
291. Instrument Corp. of Florida (S) Melbourne, Fla. 403
292. Black Associates, Inc. (S) Cambridge, Mass. 402
293. Manlabs, Inc. (S) Cambridge, Mass. 394
294. Data-Control Systems, Inc. (S) Danbury, Conn. 394
295. Bergen Research Engineering Corp. (S) Peterboro, N. J. 393
296. Bausch & Lomb, Inc. Rochester, N. Y. 390
297. Farrand Optical Co., Inc. (S) New York, N. Y. 389
298. Aluminum Co. of America New Kensington, Pa. 389
299. M S A Research Corp. Callery, Pa. 387
300. Rucker Co. (S) Oakland, Calif. 383
301. High Temperature Materials, Inc. (S) Boston, Mass. 383
302. Victor Comptometer Corp. Chicago, Ill. 377
303. Texas Research Associates (S) Austin, Tex. 377
304. Letourneau (R. G.) Inc. Longview, Tex. 375
305. Meteorology Research, Inc. (S) Altadena, Calif. 373
306. Rixon Electronics, Inc. (S) Silver Spring, Md. 366
307. Waddell Dynamics, Inc. (S) San Diego, Calif. 365
308. Huyck Co. Huntington Station, N. Y. 364
309. Advanced Communications, Inc. (S) Canoga Park, Calif. 364
310. Stencel Aero Engineering Corp. Asheville, N. C. 363
311. Infrared Industries, Inc. (S) Waltham, Mass. 361
312. Tridea Electronics, Inc. (S) Pasadena, Calif. 361
313. Astrosystems, Inc. (S) Livingston, N. J. 354
314. Eagle-Picher Co. Joplin, Mo. 350
315. American Chain & Cable Co. Wilkes-Barre, Pa. 347
316. Device Development Corp. (S) Weston, Mass. 343
317. Audiger, Inc. (S) Roselle, N. J. 343
318. Adcole Corp. (S) Cambridge, Mass. 343
319. Piasecki Aircraft Corp. (S) Mayfield, Pa. 340
320. Raven Industries, Inc. (S) Sioux Falls, S. D. 336
321. K P T Manufacturing Co. (S) Roseland, N. J. 335
322. Plasmadyne Corp. (S) Santa Ana, Calif. 333
323. Materials Research Corp. (S) Orangeburg, N. Y. 333
324. Alvey-Fergusan Co. (S) Cincinnati, Ohio 332
325. Conaga Electronics Corp. (S) Van Nuys, Calif. 329
326. Schiller-Pfeiffer Machine Works (S) Southampton, Pa. 325
327. Pfaudler Permutit ,Inc. Rochester, N. Y. 325
328. American Air Filter Co. St. Louis, Mo. 325
329. Cooper MacDonald Co. (S) Baltimore, Md. 323
330. A R T Electronics, Inc. Little Rock, Ark. 323
331. Baldwin-Lima-Hamilton Corp. Lima, Ohio 320
332. Telephonics Corp. Huntington, N. Y. 319
333. Austin Co. (The) New York, N. Y. 316
334. Management Systems Corp. (S) Cambridge, Mass. 315
335. Morse Instrument Co. (S) Hudson, Ohio 314
336. American Power Jet Co. (S) Ridgefield, N. J. 314
337. Antenna Systems, Inc. (S) Hingham, Mass. 313
338. Astrodata, Inc. (S) Anaheim, Calif. 312
339. Elgin National Watch Co. Chatsworth Calif. 311
340. Xerox Corp. Rochester, N. Y. 310
341. Thompson (John I.) & Co. (S) Washington, D. C. 310
342. Wolf Research & Development Corp (S) Boston, Mass. 307
343. Celanese Corp. of America Asheville, N. C. 307
344. Keuffel & Esser Co. Hoboken, N. J. 304
345. Polacoat, Inc. (S) Blue Ash, Ohio 301
346. Gabriel Co. Pasadena, Calif. 301
347. Lummus Co. New York, N. Y. 299
348. Stoddard Aircraft Radio Co. (S) Hollywood, Calif. 297
349. Vought Industries, Inc. Downey, Calif. 295
350. Air Products & Chemicals, Inc. Allentown, Pa. 294
351. E.D.P. Corp. (S) Orlando, Fla. 293
352. Mechanical Technology Co. Inc. (S) Latham, N. Y. 291
353. American Systems, Inc. Hawthorne, Calif. 289
354. Federal Scientific Corp. New York, N. Y. 288
355. Leesona Corp. Jamaica, N. Y. 288
356 Baird-Atomic, Inc. Cambridge, Mass. 286
357. Page Communications Engineers, Inc. Washington, D. C. 285
358. Weinzen Research, Inc. (S) Minneapolis, Minn. 282
359. Washington Technological Associates, Inc. (S) Rockville, Md. 281
360. Systems Research Group, Inc. Mineola, N. Y. 280
361. Worthington Corp. Harrison, N. J. 280
362. United Nuclear Corp. White Plains, N. Y. 280
363. Electro-Mechanical Research, Inc. Sarasota, Fla. 280
364. Ingersoll-Rand Co. Phillipsburg, N. J. 279
365. Oxford Corp. (S) Buffalo, N. Y. 279
366. Astropower, Inc. Costa Mesa, Calif. 278
367. Flightex-Fabrics, Inc. Falmouth, Mass. 278
368. Aerochem Research Laboratories, Inc. (S) Princeton, N. J. 277
369. Cooke Engineering Co. (S) Alexandria, Va. 275
370. Steinthal (M) & Co., Inc. (S) New York, N. Y. 275
371. Aerolab Development Co. Pasadena, Calif. 274
372. Hazleton Laboratories, Inc. (S) Falls Church, Va. 274
373. Continental Electronics Mfg. Co. Dallas, Tex. 273
374. Radiation Dynamics, Inc. (S) Westbury, N. Y. 273
375. Broadview Research Corp. (S) Burlingame, Calif. 271
376. Royal Industries, Inc. Alhambra, Calif. 270
377. Electro Nuclear Systems Corp. (S) Minneapolis, Minn. 268
378. Clauser Technology Corp. (S) Torrance, Calif. 268
379. Ellicott Machine Corp. Baltimore, Md. 266
380. Rauland Borg Corp. (S) Chicago, Ill. 263
381. Wah Chang Corp. Albany, Ore. 261
382. Matrix Corp. (S) Arlington, Va. 260
383. Newport News Shipbuilding & Dry Dock Co. Newport News, Va. 260
384. Catalyst Research Corp. Baltimore, Md. 259
385. American Oil Co. Chicago, Ill. 258
386. Dynamic Science Corp. (S) South Pasadena, Calif. 257
387. Metric Systems Corp. (S) Ft. Walton Beach, Fla. 252
388. Radiation Systems, Inc. (S) Alexandria, Va. 252

Government agencies, foreign firms and non-profit institutions

Rank	Agency, Firm or Institution	Thousands of Dollars
1.	Massachusetts Institute of Technology Lexington, Mass.	74,956
2.	Aerospace Corp. El Segundo, Calif.	59,125
3.	Johns Hopkins University Silver Spring, Md.	43,988

(Continued on page 92)

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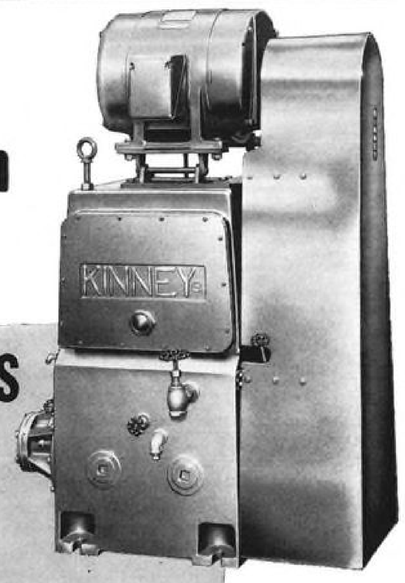


F-104 Heaters

Anti-icing heaters are being installed to give NATO's F-104 fleet all-weather capability. The heaters, built by Sierracin Corp., are fitted onto intake leading edges and intake cone tips of the aircraft.

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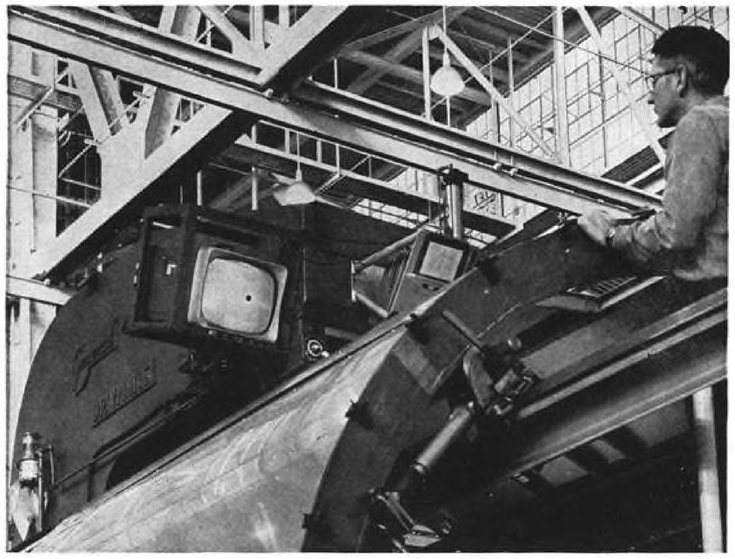
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4. Mitre Corp. Bedford, Mass.	29,481	Evanston, Ill.	2,892	61. U. S. Atomic Energy Commission Albuquerque, N. M.	1,007
5. Stanford Research Institute Menlo Park, Calif.	18,936	33. Institute For Defense Analysis Washington, D. C.	2,860	62. Analytic Services, Inc. Alexandria, Va.	960
6. Rand Corp. Santa Monica, Calif.	16,662	34. Princeton University Princeton, N. J.	2,774	63. Virginia, University of Charlottesville, Va.	953
7. Columbia University New York, N. Y.	11,555	35. Southwest Research Institute San Antonio, Tex.	2,534	64. Stevens Institute of Technology Hoboken, N. J.	897
8. California, University of La Jolla, Calif.	10,766	36. U. S. Department of Commerce Washington, D. C.	2,437	65. Purdue Research Foundation Lafayette, Ind.	874
9. Armour Research Foundation Chicago, Ill.	10,763	37. Brown University Providence, R. I.	2,118	66. New Mexico State University of Agriculture, Engineering & Science University Park, N. M.	842
10. Michigan, University of Ann Arbor, Mich.	10,596	38. Minnesota, University of Minneapolis, Minn.	2,104	67. Lowell Technological Institute Lowell, Mass.	833
11. U. S. National Aeronautics & Space Agcy. Dallas, Tex.	10,212	39. Brooklyn, Polytechnic Institute of Brooklyn, N. Y.	2,035	68. Georgia Tech Research Institute Atlanta, Ga.	798
12. Stanford University Stanford, Calif.	10,142	40. New Mexico, University of Albuquerque, N. M.	2,022	69. Texas College of Agriculture & Mechanics Research Foundation College Station, Tex.	796
13. Illinois, University of Urbana, Ill.	9,764	41. North Carolina, University of Chapel Hill, N. C.	1,948	70. American University Washington, D. C.	786
14. System Development Corp. Santa Monica, Calif.	9,024	42. Dayton, University of Dayton, Ohio	1,843	71. Cincinnati, University of Cincinnati, Ohio	635
15. Cornell Aeronautical Laboratory, Inc. Buffalo, N. Y.	8,708	43. National Academy of Sciences Washington, D. C.	1,746	72. Imperial Chemical Industries Scotland	625
16. Cornell University Ithaca, N. Y.	7,143	44. United Kingdom of Great Britain and Northern Ireland United Kingdom	1,683	73. Logistics Management Institute Washington, D. C.	600
17. Research Analysis Corp. Bethesda, Md.	6,038	45. California Institute of Technology Pasadena, Calif.	1,679	74. Yale University New Haven, Conn.	588
18. Franklin Institute of Pennsylvania Philadelphia, Pa.	5,311	46. Illinois Institute of Technology Chicago, Ill.	1,665	75. New Mexico Institute of Mining and Technology Socorro, N. M.	575
19. Pennsylvania, University of Philadelphia, Pa.	5,225	47. Southern California, University of Point Mugu, Calif.	1,604	76. Southern Research Institute San Antonio, Tex.	563
20. Chicago, University of Chicago, Ill.	4,838	48. Alaska, University of College, Alaska	1,556	77. Coordinating Research Council New York, N. Y.	519
21. Woods Hole Oceanographic Institute Woods Hole, Mass.	4,614	49. Purdue University Lafayette, Ind.	1,485	78. Rensselaer Polytechnic Institute Troy, N. Y.	498
22. George Washington University Washington, D. C.	4,155	50. Syracuse University Syracuse, N. Y.	1,375	79. Oklahoma State University Stillwater, Okla.	493
23. Pennsylvania State University University Park, Pa.	4,045	51. Canadian Commercial Corp. Canada	1,374	80. Rhode Island, University of Kingston, R. I.	485
24. Denver, University of Denver, Colo.	3,899	52. Colorado, University of Boulder, Colo.	1,287	81. Oklahoma, University of Norman, Okla.	468
25. Texas, University of Austin, Tex.	3,865	53. Duke University Durham, N. C.	1,225	82. Florida, University of Gainesville, Fla.	465
26. Battelle Memorial Institute Columbus, Ohio	3,692	54. Wisconsin, University of Madison, Wisc.	1,208	83. Indiana University Bloomington, Ind.	462
27. New York University New York, N. Y.	3,652	55. Wentworth Institute Boston, Mass.	1,132	84. Boston College Weston, Mass.	453
28. Ohio State University Columbus, Ohio	3,521	56. Utah, University of Salt Lake City, Utah	1,124	85. Western Reserve University Cleveland, Ohio	446
29. Harvard University Cambridge, Mass.	3,481	57. Midwest Research Institute Kansas City, Mo.	1,079	86. Flight Safety Foundation New York, N. Y.	443
30. Maryland, University of College Park, Md.	3,180	58. Pittsburgh, University of Pittsburgh, Pa.	1,077	87. Case Institute of Technology Cleveland, Ohio	440
31. Washington, University of Seattle, Wash.	3,003	59. Miami, University of Coral Gables, Fla.	1,052	88. Catholic University of America Washington, D. C.	424
32. Northwestern University		60. Northeastern University Boston, Mass.	1,045	89. Tufts University Medford, Mass.	421
				90. Georgia Institute of Technology Atlanta, Ga.	414
				91. Arizona, University of Tucson, Ariz.	398
				92. Washington University St. Louis, Mo.	372
				93. Iowa, State University of Iowa City, Iowa	369
				94. Oregon State University Corvallis, Ore.	357
				95. Notre Dame, University of Notre Dame, Ind.	339
				96. Mississippi State University State College, Miss.	336
				97. Puerto Rico, University of Rio Piedras, P. R.	334
				98. Syracuse University Research Corp. Syracuse, N. Y.	325
				99. North Carolina State College of Agriculture & Engineering Raleigh, N. C.	315
				100. De Havilland Aircraft of Canada Canada	314
				101. Hudson Institute, Inc. Harmon-on-Hudson, N. Y.	298
				102. Weizmann Institute of Science Israel	292
				103. Vanderbilt University Nashville, Tenn.	291
				104. Delaware, University of Newark, Del.	286
				105. Rutgers State University New Brunswick, N. J.	285
				106. Mellon Institute for Industrial Research Pittsburgh, Pa.	283
				107. Parsons (C. A.) Co., Ltd. England	282
				108. Utah State University Logan, Utah	275
				109. Haskins Laboratories, Inc. New York, N. Y.	269
				110. Texas, Agricultural & Mechanical College of College Station, Tex.	261
				111. Rochester, University of Rochester, N. Y.	259
				112. Carnegie Institute of Technology Pittsburgh, Pa.	259

Note: Awards to many contractors involve more than one location.
(5) indicates small business.



Martin Uses TV in Titan 2 Production

Martin Co. is using a television screen to assist workmen in Titan 2 fabrication. TV camera scans a line of dots preprinted on the missile skin which appear on the screen as a line of dark spots against a halo of light. The operator starts the drill and riveter when a dot reaches the center of the halo. Screen is currently being used on the missile's skirt assembly. Martin claims that by utilizing the television technique, the company has been able to reduce the time required for riveting a skirt assembly from 22 hr. to 5 hr., and that there has been a corresponding savings of 77% in cost. The TV hookup was designed by engineers at Martin's Baltimore facility.



Grand Commander, largest airplane in the Aero Commander line, is 6 ft. 2 in. longer than previous models, and will carry 11 persons.

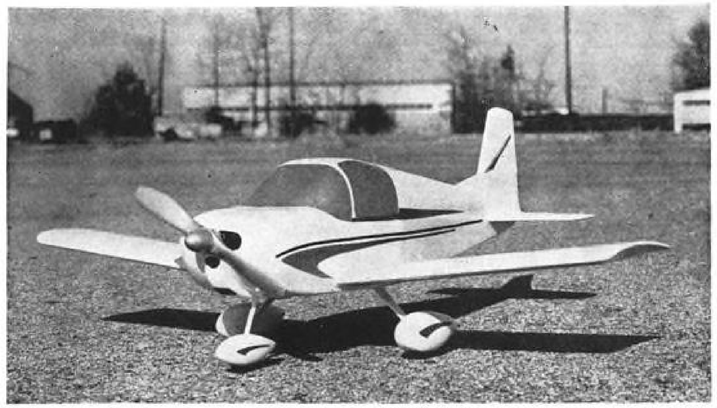
Grand Commander Features Lengthened Fuselage



Deliveries of the Grand Commander, newest and largest aircraft in the Aero Commander line, will begin in April, according to the company. New aircraft has a fuselage 6 ft. 2 in. longer than previous Commanders and will carry up to nine passengers plus a two-man crew. Crew compartment is separated from the passenger cabin. Cabin length has been increased by more than 40 in. and has more headroom than previous models. Cabin entry door is larger than earlier versions and is located forward of the wing to eliminate the necessity to stoop when entering the aircraft. Baggage compartment has been enlarged to 59 cu. ft., or almost double that on present models. Grand Commander is powered by two Lycoming IGSO-540 supercharged, fuel-injection engines. Price is under $135,000 with standard equipment. Optional equipment includes private lavatory. Flight view, left, shows Grand Commander retains standard Aero Commander configuration, but longer fuselage is obvious, below, when Grand Commander, foreground, is placed beside earlier Model 680.







BD-1 is scheduled to make its first flight in March; certification target date is at end of year.

Bede BD-1 Low Cost Lightplane Scheduled to Make Flight in March

New York—Two-place sport airplane with metal honeycomb panels in the fuselage and a glass-fiber landing gear, designed by Bede Aircraft, Inc., of Springfield, Ohio, is scheduled to make its first flight in March.

Designated the BD-1, the airplane will be priced at $2,495 with a rebuilt 65-hp. engine, minimum instruments and no radio. A de luxe version, with a higher powered engine, instruments, lights and radio, is planned at $4,200.

James R. Bede, vice president of the company, said certification target date is next fall or early winter. The project has been under development for about nine months.

Basic aircraft structure has only 375 parts, of which only 175 are different. A number of parts are interchangeable, including rudder and elevator, horizontal and vertical fins and flap and ailerons.

Wing is designed to be easily removable so that the aircraft can be towed on a trailer behind an automobile or stored in an ordinary home garage. Tubular wing spars are fitted into fuselage receptacles and held by removable pins.

Low-wing, tricycle-gear BD-1 has side-by-side seating and a stick rather than the control wheel found on most American-built light aircraft. The airplane has a wing span of 23 ft., with plain flaps extending across 70% of the span. Height is 7 ft. 6 in., and over-all length is 18 ft. 8 in.

Maximum speed, with a 90-hp. engine, is expected to be 140 mph., and the aircraft will cruise at 130 mph. at 5,000 ft. and 65% of power. Under these same conditions, the BD-1 will cruise at 126 mph. with an 85-hp. engine and at 112 mph. with a 65-hp. rebuilt Continental A65-8 engine.

Largest engine currently being contemplated for the aircraft is a 108-hp. Lycoming O-235-C1B engine.

Fuel capacity is 20 gal. With a 90-hp. engine, maximum range would be approximately 600 mi. With two persons and 40 lb. of baggage, range would be about 500 mi.

Stalling speed at gross weight of 1,156 lb. is 53 mph. Empty weight is 660 lb.

Glass-fiber spring landing gear, first tried by Bede on the XBD-2 research aircraft (AW Feb. 19, p. 67) has superior damping characteristics and is lighter than contemporary steel landing gear designs, the company says.

Bede said a market survey conducted by the company indicates that demand for an airplane of the BD-1 class would be about 1,000 per year. Tooling is being planned to enable production to reach this rate if sales should justify it.

Cost studies, however, were based on a considerably smaller number of aircraft being produced and sold each year.

First sales, according to Bede, will be from the factory, but the company intends to set up a dealer organization to handle the BD-1, the BD-3 executive aircraft, which is expected to enter the market in 1964, and other types of business aircraft which the company is planning.

BD-1 will set the bottom limit in size, Bede said, and the BD-3 will be about the upper limit in business-type aircraft. Other airplanes will fill in the gaps in the proposed line.

Company also has under development the BD-7 twin-engine, short-haul airliner (AW Oct. 29, p. 90; Dec. 24, p. 28).

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Designed to deliver positive, accurate and instant modulation with minimum bleed air loss. Instantly responsive—simple in design, extremely accurate under all service conditions.

- "Off-Shelf" qualified on current high performance aircraft
- Lightweight, compact, durable
- No moving electrical contacts
- Unaffected by vibration, shock, acceleration
- Meets latest military specifications
- Available in valve sizes of 1", 1½" and 2"

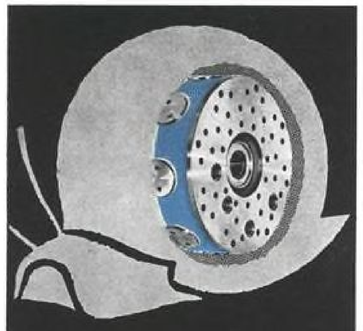
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For more information write for Bulletin No. 680.



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one revolution every 41½ days

■ Unequalled controlled speed range of the Acradrive/22 hydraulic servomotor (500 rpm to 1/60,000 rpm) is only one reason why it is being specified for big antenna and flight simulator drives.

■ Some other reasons:
Torque 3.52 in. lb./psi
Response 250 cps
Acceleration 40,000 radians per sec²

For more details, write for Publication M-2281B.

■ Cimtrol Division, The Cincinnati Milling Machine Company, Cincinnati 9, Ohio.



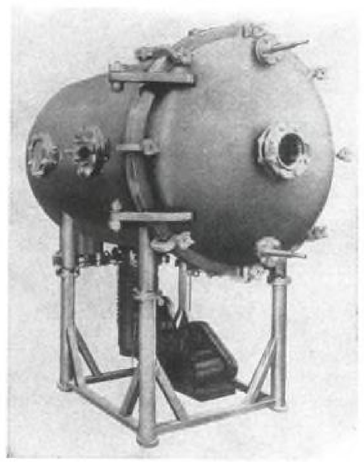
Acradrive/22 Motor
(exploded view)
Weight 156 lb.; Diameter 12½ in.

CINCINNATI

NEW AEROSPACE PRODUCTS

Space Simulation Chamber

Model SC-1 environmental space simulation chamber, measuring 4 ft. in dia. and 6 ft. long, offers free test volume 3.5 ft. by 4 ft. It is designed to simulate vacuum and cold dark space conditions at altitudes above 300 mi.

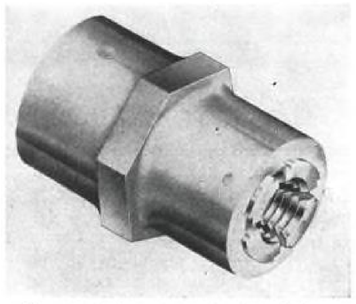


Chamber is cooled by liquid nitrogen fed through the walls and door. Inside walls and baffle surfaces have an emissivity of 0.9. High power and instrumentation feed-throughs are provided as well as a 6 in. viewing port. Four blank penetrations also are available for additional test instruments.

General Technology Corp., 3510 Torrance Blvd., Torrance, Calif.

Anti-Fragmentation Release Nut

Release nut uses a one-piece threaded collet with an integral piston which acts as a pressure seal and provides complete release with no fragmentation when electrically activated.



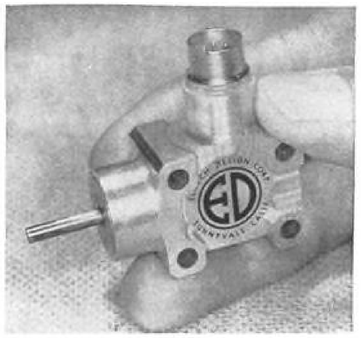
Nut is designed to develop full tension allowables of standard NAS and NS series threaded hardware. Use of standard hardware and elimination of explosive bolts makes off-the-shelf purchase feasible, according to the manufacturer.

Release can be accomplished within two to three milliseconds.

Space Ordnance Systems, 133 Penn Street, El Segundo, Calif.

Linear Actuator

Electromechanical actuator delivers a minimum of 5 lb. pulling or pushing force through a stroke of ½ in. and is designed to offer a flexible electromechanical alternative to explosive actuated devices of similar capability.



Unit, which can be immediately reset and re-actuated repeatedly, provides advantages in easy checkout, safety, reliability, installation and testing.

Actuator weighs 1¾ oz. and can be used to move or trigger mechanical couplings and detach or separate assemblies. Minimum operating temperature range is −100F to 250F.

Elmech Design Corp., 149 San Lazaro Ave., Sunnyvale 2, Calif.

Strain Gage Transducers

Series of bonded strain gage pressure transducers in ranges of 0-5 to 5,000 psi. are built to withstand rugged environments with small internal volume, minute volumetric displacement and high natural frequency for precise measurements of static and dynamic pressures in airborne applications.

Instruments use bending beam principle for high accuracy, size reduction and greater sensitivity for low range measurement. Combined non-linearity and hysteresis is less than ±0.35% of full scale for models above 50 psi. In ranges below 50 psi. combined non-linearity and hysteresis is less than ±0.5% of the full scale. Transducer housing and diaphragm are stainless steel construction.

Data Sensors, Inc., 13112 Crenshaw Blvd., Gardena, Calif.

PRODUCTION BRIEFING

Aerojet-General Corp. has awarded a $439,000 contract to E and I Co., Ft. Lauderdale, Fla., for Phase One construction work on a solid fuel rocket plant Aerojet is building south of Miami. Site is a 76,400-acre tract near Homestead AFB, Fla. Phase One work, scheduled for completion by mid-April, will include clearing sites for buildings, rough grading and filling and some road construction.

D. B. Milliken Co., Arcadia, Calif., has received a $45,000 Air Force contract for high-speed 16-mm. motion-picture cameras capable of pin-registering speeds exceeding 400 frames per sec. Cameras will be used in the Pacific Recovery Area to provide high-resolution pictures of vehicles during re-entry.

Western Electric Co. has been awarded a $19,896,130 Army contract for continued development of an advanced radar system for use in the Nike Zeus anti-missile missile system. Sharing in the award are Bell Telephone Laboratories and Sylvania Electronics.

Goodyear Aviation Products Div. has received a $2-million follow-on contract from Hercules Powder Co. for rubber liners used as insulators in Minuteman ICBM glass-fiber cases.

Douglas Aircraft Co.'s Tulsa Div. will modify 15 Thor ICBMs for future space assignments under a $3-million contract from Air Force Systems Command's Space Systems Div. Inspection and overhaul of the Thor 150,000-lb. thrust Block One engines will be done at San Bernardino Air Materiel Area prior to installation in the modified boosters.

Beech Aircraft Corp. has been awarded a $10-million follow-on contract by the Bureau of Naval Weapons for additional K2B-1 rocket-powered, Mach 2 target drones.

Lear Siegler, Inc., has received a $7.3-million contract from McDonnell Aircraft for combined attitude reference and bombing systems for the F-4C tactical fighter. Systems will be produced by Lear's Instrument Div.

Pratt & Whitney Aircraft has been awarded a $1,862,000 contract from National Aeronautics and Space Administration's Marshall Space Flight Center for development of a variable-thrust version of its 15,000-lb. RL-10 liquid hydrogen rocket engine. Engine must be capable of operating with as little as 12½% of its rated thrust.

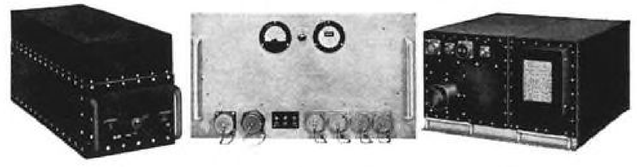
SOLID STATE POWER CONVERSION

for a broad range of power requirements

Unitron can meet exacting requirements with custom-engineered Inverters, Frequency Converters, DC/DC Converters, and Power Supplies, with the reliability of semiconductor circuitry and *no moving parts*. Units can be designed for a broad range of power requirements in airborne and ground support systems.

Unitron has compiled a valuable background of design and production experience by specializing in solid state power conversion equipment. This background provides Unitron with a unique ability to furnish custom-designed equipment with almost off-the-shelf timing and economy.

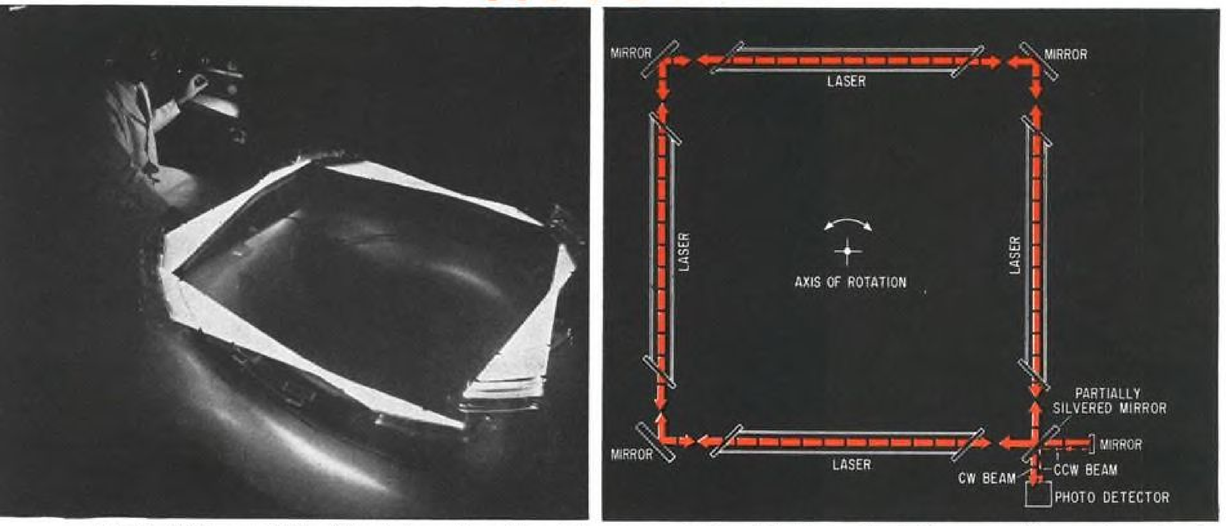
Unitron's capability is reflected by *delivered units*, such as the three examples of custom-designed Frequency Converters shown below.



3.5 KVA Freq. Converter | 1.5 KVA Freq. Converter | 8.0 KVA Freq. Converter

These 400/60 cps Converters share exceptional performance characteristics, such as better than 90% efficiency ... regulation to ±1.0% ... less than 5.0% distortion ... frequency stability from 0.001%. Their environmental and RFI characteristics are compatible with applicable military specifications.

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LASER GYRO, a radically different type of angular rotation sensor developed by Sperry Rand Corp., uses four gas lasers in ring configuration to measure angular rate from the Doppler shift it produces on contrarotating laser beams. Above left, experimental model is being rotated. Sketch at right gives schematic view of operation.

Ring Laser Device Performs Rate Gyro

By Philip J. Klass

Radically different type of angular rotation sensor which uses lasers to perform the function of a rate gyroscope has been demonstrated by Sperry Rand Corp. scientists. The "laser gyro" has no moving parts and, in theory, should be long-lived, sensitive and stable.

If the unusual device lives up to present expectations, it could mark a technological breakthrough in the art of inertial guidance for airborne, spaceborne and shipbased applications.

Sperry Rand calls the device a traveling-wave ring-laser. The company shuns the use of the word "gyro" because the device lacks the familiar spinning mass and operates on the basis of the effect discovered by the Austrian physicist Christian Doppler rather than on the laws of Sir Isaac Newton. But since the new device uses a series of lasers in a ring configuration and the word gyro is derived from the Greek "gyros," meaning a ring or circle, the term "laser gyro" appears appropriate.

While the present Sperry Rand laser gyro is bulky and unwieldy (see photo), its configuration is designed for ease of experimentation. There does not appear to be any reason why it can not be reduced to the size of a conventional gyro or perhaps even smaller, company scientists say.

Another inherent advantage of the laser gyro is that its output is available in digital form, for use by digital guidance computers. Although basically it is an angular rotating rate sensor, its output can be integrated to give angular displacement.

Present laser gyro uses four continuous-wave (CW) helium-neon gas lasers arranged to form a square ring. (See sketch.) Unlike conventional lasers, where one end of the tube is silvered and radiation is emitted only from the opposite end, energy is radiated from both ends of each of the four gas lasers in the Sperry Rand device.

At each of the four corners of the ring of lasers there is a mirror at a 45-deg. angle so that the light emitted from the end of one laser is reflected into the adjoining laser tube. In this way, the energy emitted by each laser circulates around the ring, returning to its source and continuing around the loop. But because each laser is emitting energy from both ends, there are two contrarotating beams flowing through the loop.

So long as the ring of lasers remains stationary, both contrarotating beams travel identical path lengths. But if the ring is mounted on a platform which is rotated about an axis perpendicular to the plane of the four lasers, the beam rotating in one direction will have a slightly greater distance to travel before returning to its point of origin, while the beam moving in the other direction will have slightly shorter distance to travel.

For example, if the ring laser is being rotated in a clockwise direction, the laser beam moving in this same direction requires slightly less time to complete the loop while the beam moving in the opposite direction requires slightly more time. The result is the familiar Doppler frequency shift. The frequency of the beam which must travel a slightly longer distance is reduced, while the frequency of the other beam is increased slightly. For any given laser gyro configuration, this frequency shift is proportional to the rate of its rotation.

To measure this frequency shift, access must be gained to the beams without interrupting their rotation. To accomplish this, one of the four corner mirrors can be thinly silvered, for example, so that a small amount of the energy from the clockwise and counterclockwise rotating beams passes through while the remainder is reflected and circulates.

Using an additional flat reflector, one of the two beams thus extracted is bounced off the back side of the corner mirror so that both beams are traveling the same direction and impinge upon a photo-multiplier tube. This produces a hetrodyne action in the detector, a widely used technique in laser work, to produce an audio-frequency (beat) signal which is equal to twice the Doppler shift resulting from the rotation of the ring of lasers.

The beat frequency of the signal obtained is proportional to the angular rotation rate of the ring and to the optical path length of each leg of the loop but is inversely proportional to the wavelength at which the lasers are emitting.

For the experimental Sperry Rand device, in which the optical path length of each leg is about one meter and the helium-neon lasers radiate at a wavelength of 1.153 microns, the laser gyro photo detector produces output of 250 cps. for each degree per second of angular rotation. For example, in tests at 2 deg./sec., output is 500 cps., while at 600 deg./sec., output is 150 kc.

A rotation rate of 160 deg./min. gives an output of 40 kc.

Since the output signal frequency is directly proportional to rotation rate, a digital output signal can be obtained merely by clipping the output sine waves.

Recent discovery of direct-injection gallium-arsenide laser action suggests the possibility of building a miniature laser gyro from such solid-state crystals. Because sensitivity decreases as path length is reduced, such a device would be less sensitive than the present experimental unit. But this would be partially compensated for by the shorter wavelength of emission which is around 0.71 to 0.84 microns for gallium arsenide compared with the 1.153 micron wavelength for the helium-neon lasers which Sperry Rand used.

Large optical path laser gyros could, however, be used in submarine and surface ship installations where space limitations are not critical. Another possibility is to use a spiral configuration to increase sensitivity of small size laser gyros.

Sperry Rand does not claim to have originated the basic principle upon which the laser gyro is based. In 1913, the French physicist G. Sagnac used a similar ring configuration to study the effects of rotation on the propagation of light, and in 1924, the U.S. scientists A. A. Michelson and G. H. Gale conducted similar experiments. But at that time the only light source available was the conventional non-coherent type and the two contrarotating beams were combined to produce an interference fringe pattern.

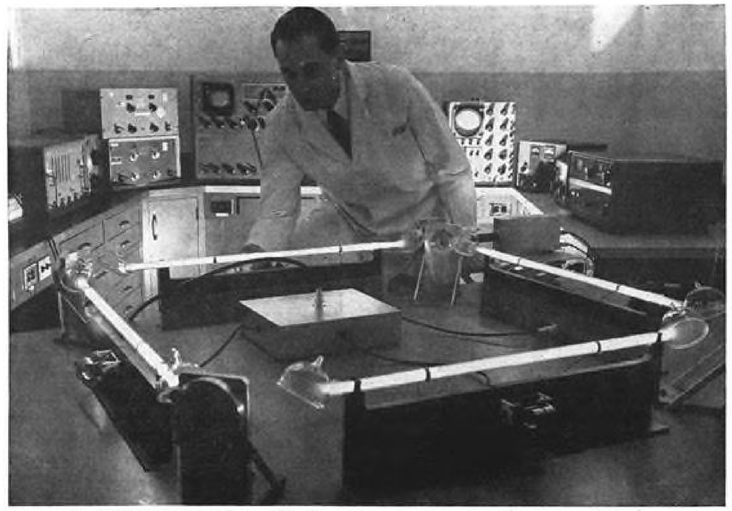
Shift in this pattern, corresponding to the Doppler shift in the Sperry Rand device, was extremely difficult to measure precisely. This required either that the ring be rotated very rapidly or the use of extremely long optical path lengths to obtain measurable fringe shift. Michelson and Gale used path lengths of as much as 2,000 ft.

Advent of the laser, with its coherent light, which permitted more accurate and convenient Doppler shift measurements, opened the way to the new type of rotation rate sensor. The possibility of using a laser to improve the sensitivity of the Michelson-Gale experiment was suggested by A. H. Rosenthal of Kollsman Instruments in the Journal of the Optical Society of America at a time when Sperry Rand was engaged in its current work. First successful operation of the new laser gyro occurred on Jan. 7.

Company scientists concede that there are problems yet to be solved before the laser gyro is feasible for operational use. These problems, now under study, include:

- **Rigidity is required** in the optical path which must be an integral number of wavelengths of the radiation emitted by the lasers.
- **Effects of laser radiation** line width, mode pulling and mode correlation on laser gyro sensitivity and operation are not fully understood.
- **Rotation direction** cannot be determined with present experimental configuration because the detector does not know which beam is which. Company is developing means to introduce an offset bias so that system will have a small Doppler shift when it is stationary, providing means for determining subsequent direction of rotation.

New laser gyro development is a part of the broad company effort in the field of optical masers. Recently, in an attempt to integrate efforts in several Sperry Rand divisions, the company formed an Infrared/Optics/Laser Group, under Robert W. Jagoe, with headquarters at Great Neck, L. I., N. Y. Included in the group are scientists at Sperry Rand Research Center, Sudbury, Mass., working in new materials and concepts, Sperry Electronic Tube Div., Great Neck, developing laser de-



FOUR HELIUM-NEON GAS LASER TUBES are arranged with 45-deg. interference-type mirrors at each corner to reflect energy into adjoining lasers. At corner near operator, thinly silvered mirror allows both beams to penetrate partially to sample their frequencies.

Infrared Imaging Techniques Studied

Los Angeles—Investigation of new techniques for producing high-quality, real-time images of infrared target radiation capable of being displayed visually so as to make possible quick data analysis will begin this month with the award of a one-year contract by Air Force's Aeronautical Systems Div. A breadboard model of an imaging system and a visual display are expected to emerge from the effort.

Air Force believes that current military infrared detection systems cannot supply this data in a simple manner, being limited by opto-mechanical scanning systems and electronically scanned infrared camera tubes. Their bandwidth, dynamic range, resolution and sensitivity all tend to be restricted.

Infrared imaging technique to be examined in the forthcoming program is expected to be able to detect a minimum dynamic range of radiant energy inputs of 1,000 to 1. Data are to be displayed with a resolution of 600 photographic lines per inch. Concepts proposed for the imaging system are not to include those used in vidicon structure imaging devices.

Whatever techniques are evolved in the investigation are intended to be adaptable as sensor and display units for surveillance and reconnaissance equipment in Air Force inventory or likely to be added in the future.

30th Inventory of Aerospace Power Issue

March 11, 1963

Never before have aerospace industry developments played such a dominant role in the shaping of world affairs. Countless millions have witnessed with excitement the manned orbital flights . . . the pioneering achievements in global communications via Telstar . . . initial exploration of the planets by satellites like Mariner II . . . progress on the revolutionary supersonic transports . . . and official acknowledgment of the Apollo lunar landing program as America's goal.

Clear understanding of these events by engineering, scientific, government and industry planners is vital to the economic welfare of our industry. As we have for the past 29 years, AVIATION WEEK & SPACE TECHNOLOGY will tackle this challenging editorial task in our March 11, 1963 INVENTORY OF AEROSPACE POWER issue.

The largest full-time editorial staff in aerospace publishing – thirty-four graduate engineers and aerospace specialists—will reveal the short and long range significance of hundreds of international technical and market developments. Included will be charts, graphs, tables and other editorial information covering all aspects of industry progress. Budgets, plans and programs on missiles, aircraft, space vehicles, support equipment, engineering, space technology and civil air transport developments will be featured.

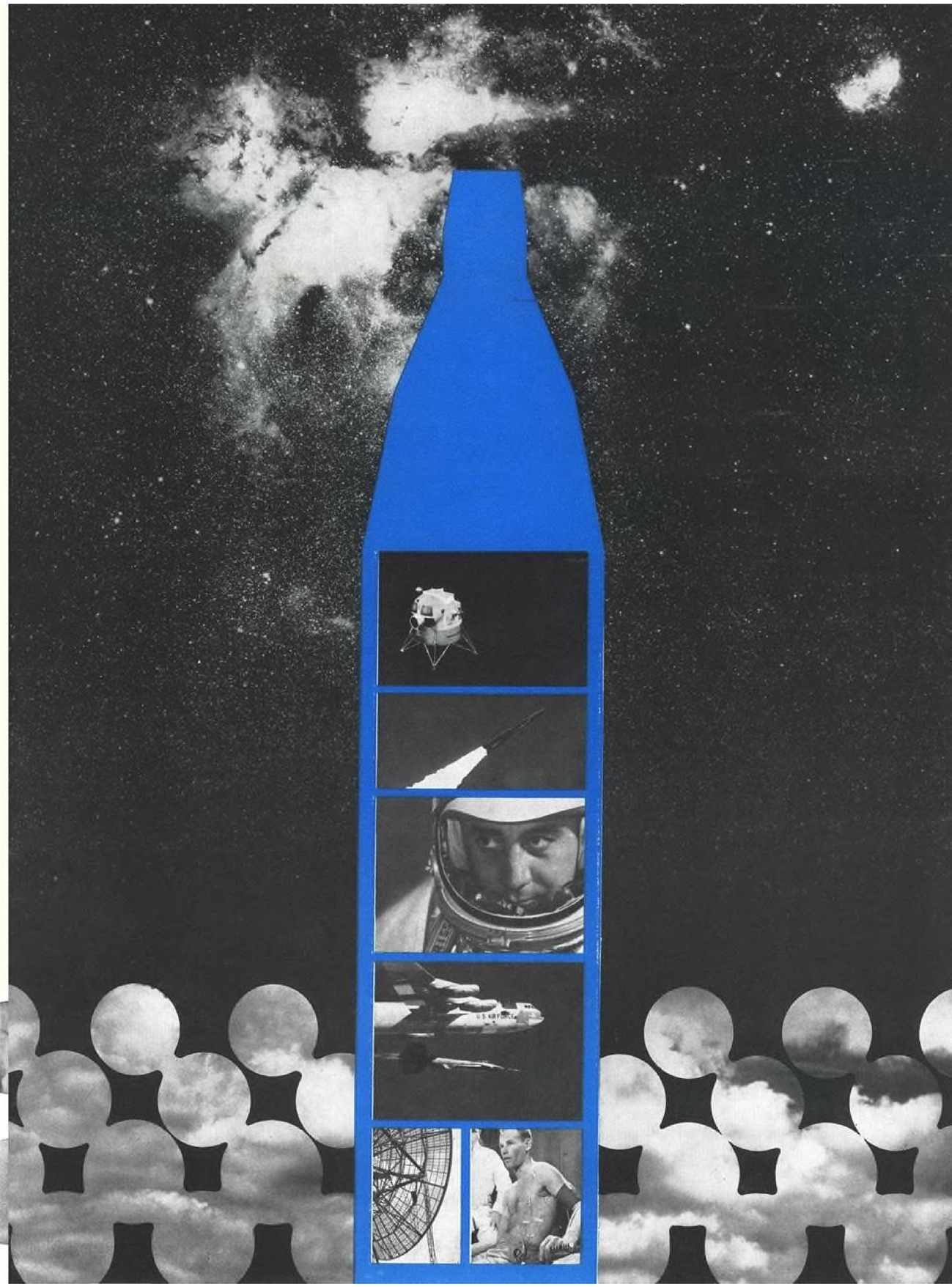
The INVENTORY OF AEROSPACE POWER issue will reach over 84,000 engineering-management subscribers—the largest audience in aerospace publishing. These men who must maintain an industry background that is technically sophisticated and up-to-date, eagerly await the annual forecasts and previews presented in the INVENTORY issue.

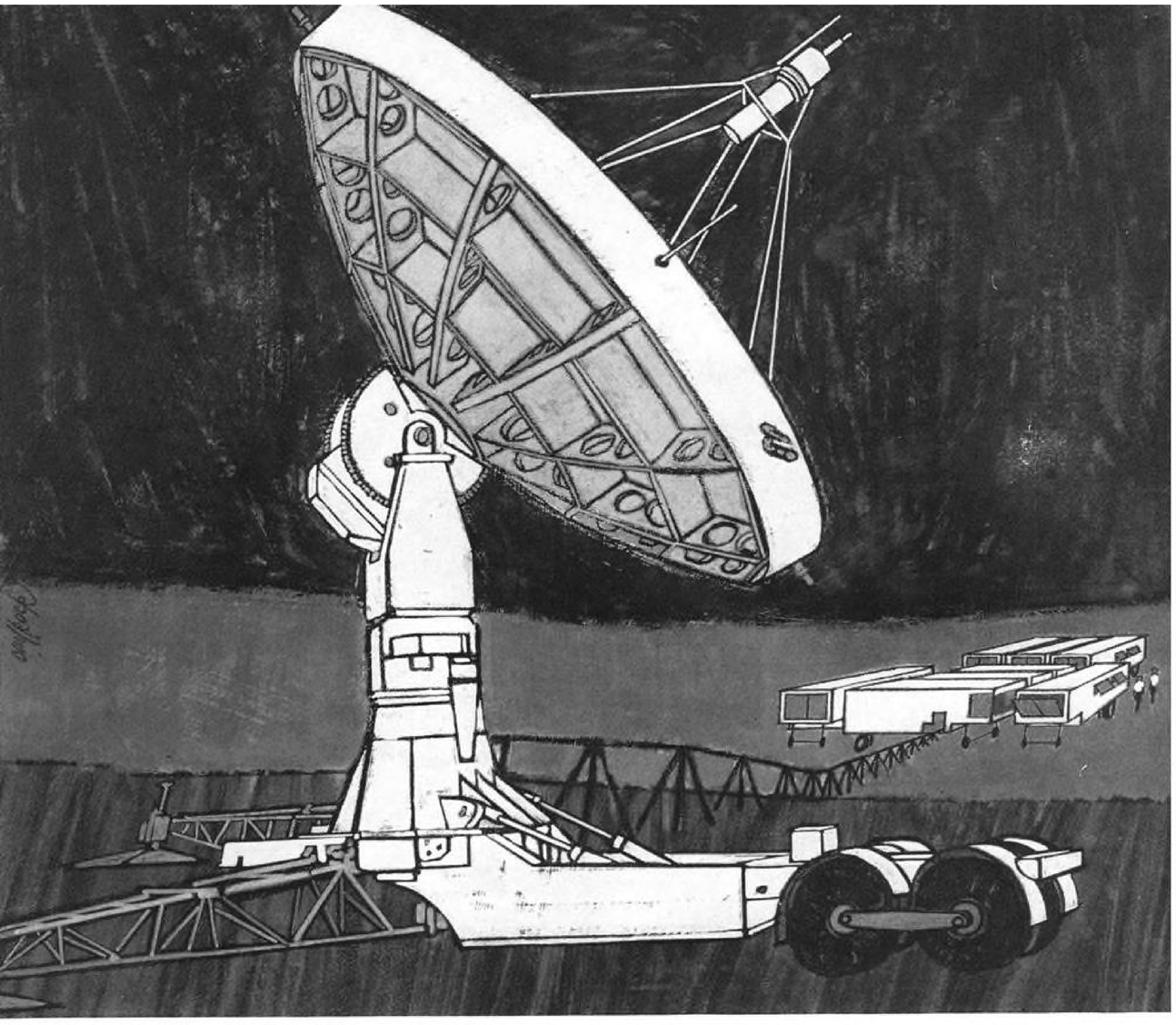
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The SYNCOM ground terminal story. It is a moving one.

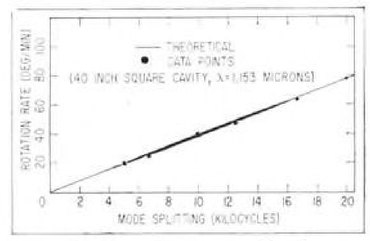
The SYNCOM experimental satellite will employ surface terminals that have no permanent locations. They can be moved as often as necessary. That's a unique feature about Project SYNCOM. It's our job to design and construct the mobile ground facilities under contract to the U.S. Army Electronic Research and Development Laboratory.

Bendix Radio's participation in Project SYNCOM—a NASA R&D program in which the U.S. Army Satellite Communications Agency has responsibility for surface terminals and communications testing—is a typical example of our capability in the fast moving communications field. Bendix Radio's experience and performance in developing equipment for fixed ground stations and shipboard terminals for the military communications satellite program helped lead to our selection by the Army to participate as a prime contractor in the NASA SYNCOM project. Project SYNCOM is to demonstrate the feasibility of communications between surface stations via a lightweight satellite in a 24-hour synchronous orbit at the 22,300 mile high altitude.

The SYNCOM ground stations in some respects represent a state-of-the-art Super High Frequency equipment development. This development also provides basic SHF building blocks for consideration in other advanced Government-sponsored programs.

Take advantage of our experience and minimize development costs in communications systems by contacting Government Sales, Bendix Radio Division, The Bendix Corporation, Baltimore 4, Maryland.

Bendix Radio Division THE Bendix CORPORATION



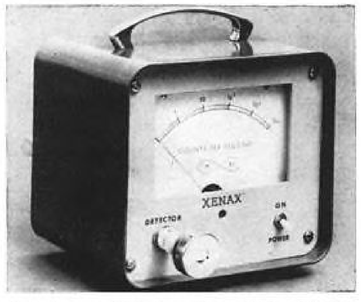
DOPPLER SHIFT frequency is directly proportional to angular rotation rate of laser gyro. Close correlation between theoretical and measured values obtained by Sperry Rand is shown above.

vices, and the Sperry Gyroscope Co., Great Neck, responsible for laser system developments.

Sperry Rand scientists who developed the laser gyro include Warren Macek, Daniel Davis, J. R. Schneider, Robert Olthuis and Dr. George White. Dr. Peter Pershan of Harvard University served as a consultant to Sperry Rand on the new development.

NEW AVIONIC PRODUCTS

• **Solid-state radiation detector,** called Xenax Ratemeter, combines functions of an alpha counter, Geiger counter, ratemeter, neutron detector and fallout



detector, weighs less than 1 lb. Device uses two silicon crystal detectors and is calibrated for up to 10,000 counts per second. Manufacturer: Atomic Laboratories, 3086 Claremont Ave., Berkeley 5, Calif.

• **Monolithic semiconductor microcircuits,** including six linear and three digital functional circuits, are now available from stock from Westinghouse Molecular Electronics Division. Linear devices include a radio-frequency amplifier, oscillator-mixer, intermediate-frequency amplifier, low-level audio amplifier, wide-band audio amplifier and video amplifier. The digital circuits include a single NAND gate, a double NAND gate and a set-reset flip-flop. Prices range from $14.20 to $19.50 in quantities of 1,000 or more. The linear microcircuits are available in flat packages while the digital microcircuits are packaged in transistor-type cans.

• **Accelerometer calibrator,** Glennite KA-2825, provides accurate measurement of very small dynamic displacements at frequencies up to 20 kc. Device uses interferometer techniques, a piezoelectric vibrator and driver, and can measure absolute displacements from 4-45 millionths of an inch. Wave form distortion is less than 2% at 20 kc. Manufacturer: Gulton Industries, Inc., 212 Durham Ave., Metuchen, N. J.

• **Solid-state d.c. power supply,** with remote sensor-regulator which maintains desired regulation regardless of resistance introduced by the load line. Regulator can be instantly changed to provide 0.05%, 0.25% or 1% regulation.



Series of three units is available to supply two amperes at 6.3, 12 or 28 v. dc., operating from 115 v., 60 cps. input power. No external heat sink or blower is required. Units have overload and short-circuit protection. Manufacturer: Victory Electronics, Inc., 145 Michael Drive, Syosset, L. I., N. Y.

• **Rectifier silicon diodes,** capable of withstanding transient reverse over-voltage as high as 1,000 v. for 25 microsecond interval, are available in three types 1N3938, 39, 40, with peak reverse voltage ratings of 200, 400 and 600 v. The diodes are mounted in pigtail cases measuring 0.57 in. long and rated at 2 amps. Manufacturer: General Instrument Corp., Rectifier Division, 65 Gouverneur St., Newark, N. J.

• **Digital phase shifter,** operating in ultra-high-frequency band, provides real time delays in 16 equal steps between zero and one UHF period for use in electrically steered antenna arrays. Phase shifter, including couplers and diode switches, is printed on single sheet of dielectric filled strip transmission line and measures 8 in. in dia. It exhibits phase error of less than four degrees with over-all insertion loss of less than 2 db. Manufacturer: Hylectronics Corp., 185 Cambridge St., Burlington, Mass.



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Series 6107

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Haydon Switch Incorporated 6100 Series miniature hermetically sealed switches sound a warning horn in the pilot's compartment:

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2. If the flaps are not in the proper position for landing;
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RCA Makes New Type Of Small Microcircuit

Technique for producing large numbers of metal-oxide field-effect transistors in microcircuit arrays, with up to 850 devices on an area the size of a dime, has been announced by RCA Laboratories. The development is result of research sponsored by USAF Cambridge Research Laboratories.

Company says the new type microcircuits show promise of being less costly, more reliable and more radiation resistant than more conventional types. Preliminary tests indicate that the metal-oxide transistors are 10 times less sensitive to radiation than conventional transistors, RCA Laboratories says. The new devices have a switching speed of 10-20 nanoseconds and will operate over a temperature range of −80C to 190C.

The RCA field-effect transistor is one of several approaches under investigation in the field of metal-oxide transistors. Its characteristics in some ways resemble those of a pentode vacuum tube. Input impedance is extremely high compared with a conventional transistor. Units fabricated to date have had a typical input impedance of a billion megohms and seven picofarads, a transconductance of 2,800 microhms, a cut-off bias of eight volts and a rise time of about 14 nanoseconds, RCA reported.

To fabricate a microcircuit array of the new devices, RCA first produces conducting paths on a crystal of high-resistivity silicon, leaving gaps which will become active elements. Next, the silicon in the gap is oxidized and a metal electrode is deposited on top of this oxide insulator to form a "gate." When a suitable voltage is impressed on the gate electrode, the gap becomes conducting and the circuit is completed between the two adjoining conductors, one referred to as the "source," the other as the "drain."

The drain current that flows is proportional to the drain voltage in much the same way as current flow in a triode varies with plate voltage, or screen-grid voltage in a pentode, until saturation occurs.

The level at which current saturation occurs depends upon the applied gate voltage, roughly equivalent to the grid voltage of a vacuum tube.

Company officials say it should be possible to fabricate a digital computer entirely from the new field-effect metal-oxide microcircuits without using other components.

Company plans to put the new microcircuits into production at its Semiconductor and Materials Div., Somerville, N. J.

System engineering for airborne weapon systems

FIRE CONTROL SYSTEM FUNCTIONAL DESIGN

Responsibilities: The determination of detailed functional design requirements for complex Airborne Weapon Control Systems; system design per customer requirements; theoretical analysis of system performance and liaison assistance to engineering departments to develop equipment to fulfill system requirements.

Experience in one or more of these areas: **1.** System engineering involving missile or fire control systems. **2.** Field engineering on airborne systems. **3.** Test evaluation. **4.** Pulse doppler and other radar systems. **5.** Digital computer —airborne system. **6.** Inertial and microwave components. **7.** Circuit design, electrical power, armament control and IR subsystems, navigation and target tracking systems. **8.** Aircraft display and controls, human factors and electronic packaging.

Education: B.S. in E.E., M.E. or Physics. Applicants should be articulate in writing and communication as related to their responsibilities. U. S. citizenship required.

MISSILE SYSTEM FUNCTIONAL DESIGN

Responsibilities: Determine functional design requirements for advanced air-launched missiles; the design of such systems to meet customer requirements and theoretical analysis of system performance; coordinate and assist engineering departments in the development of equipment to fulfill the system requirements.

Experience: Two years minimum in one or more of the following fields: **1.** System engineering on missile or fire control systems. **2.** Field engineering on airborne fire control systems or missile systems. **3.** Test and evaluation of comparable systems. **4.** Radar systems (pulse doppler). **5.** Target tracking systems. **6.** Autopilot and control systems. **7.** Microwave systems. **8.** Digital computers. **9.** Navigation systems. **10.** Inertial components. **11.** Electrical power and armament control subsystems. **12.** Circuit design and electronic packaging.

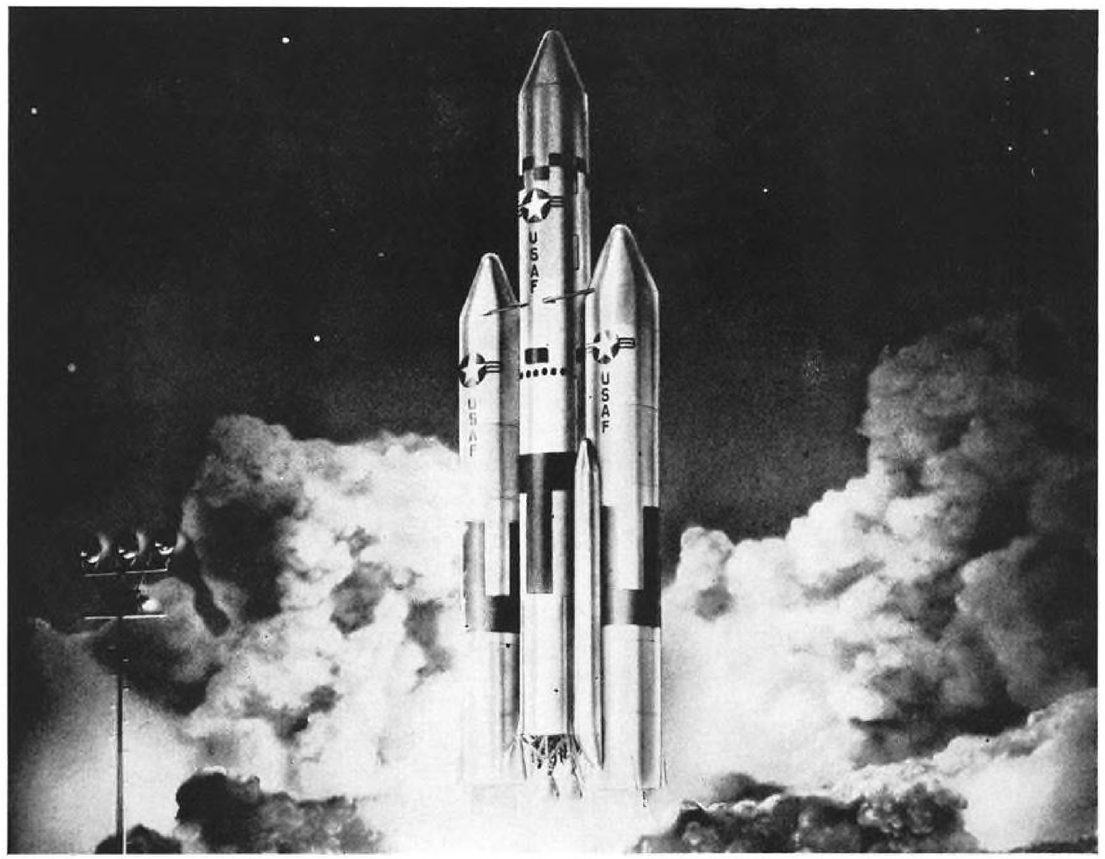
Education: B.S. in E.E., M.E. or Physics. Articulate in communications. U.S. citizenship required.

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(Formerly United Technology Corporation)

FILTER CENTER

► **Avionics Companies Prepare for VAX Competition**—Avionics companies are preparing for a Navy competition for studies of the avionics package for the Navy's VAX close-support aircraft. Companies expected to submit bids for the studies—proposals for which are expected to be requested soon—include Autonetics, Minneapolis-Honeywell, Sperry Rand, Westinghouse, General Precision, and a team of Litton Industries and Texas Instruments. The avionics package probably will include an inertial system, sensors, a central computer and communications gear.

► **NASA Reports Radiation Resistant Solar Cell Test Results**—Early results of tests of N on P solar cells commercially offered by a number of companies, including Western Electric, Heliotek, Hoffman, Radio Corp. of America, Texas Instruments and International Rectifier, were reported recently at NASA's Goddard Space Flight Center. Samples were exposed to radiation at energies of 1 million electron volts in tests performed for NASA by Naval Research Laboratories. Results clearly indicated radiation resistance superiority of N on P over P on N cells and degradation on performance of N on P cells was uniform from manufacturer to manufacturer. This suggests that the industry has mastered fabrication techniques for this type of cell. Experimental versions of the drift field, N on P solar cell made by Electro-Optical Systems showed less degradation than conventional N on P cells, but initial efficiency was less.

► **USAF Comsat Stresses Simplicity**—Air Force's 369 Medium Altitude Communications Satellite Program for which industry is now readying proposals probably will consist of extremely simple unstabilized satellites which will broadcast signals omnidirectionally. The emphasis on this simple approach is reported to reflect a desire to avoid technical pitfalls that have stymied other, more sophisticated Air Force space projects.

► **Radioisotope Generator for Imp**—Radioisotope generator using plutonium 238 as a fuel and capable of supplying 40 or 50 watts of power over a several year period is being considered by NASA for its Interplanetary Monitoring Probe (Imp) scheduled for launch next year. Imp is intended to determine the nature and magnitude of the radioactive hazard to Apollo, measure interplanetary particle fluxes from a few electron volts to several mev as well as magnetic field strength, and continuously monitor particle population and magnetic fields in cislunar space. Should the radioisotope generator be adopted for Imp, it probably will be the first NASA vehicle to employ such a device as an electrical power source. (The curium 242 thermoelectric generator that Martin Co. is developing for the Surveyor (AW Oct. 8, p. 76) probably will not be flown before 1965.)

► **Solar Cell Future in Space**—Solar cells will remain with the nation's space program as long as there are space missions, despite the degrading effects of high energy radiation on their lifetimes revealed after the high-altitude nuclear blasts last summer, according to Walter C. Scott, who heads NASA's space power technology program. The power output for a reasonably shielded N on P solar cell system aboard an earth satellite orbiting at a 5,000 naut. mi. altitude would not degrade more than 30% over a three-year period, he reported at the National Winter Convention on Military Electronics. Power systems can be designed for long life by derating components. As a rule of thumb, a 10% increase in solar cell area will double the useful lifetime of the system.

► **Signed on the Dotted Line**—Major contract awards recently announced by avionics manufacturers include the following:

• **Electronic Specialty Co.,** Los Angeles, will build a Transit satellite injection station at Rosemont, Minn., under $1.1-million contract from Navy Bureau of Yards and Docks.

• **CBS Laboratories,** Stamford, Conn., will develop an airborne reconnaissance film processor-scanner which takes exposed film from an aerial camera, automatically develops it and electronically scans the image for radio transmission to the ground, under contract from Naval Air Development Center. Equipment is to be able to process and scan a 4½ x 4½ in. frame in 10 sec. with resolution of 20 optical line-pairs per millimeter.

• **International Electric Corp.** will develop a comprehensive plan for meeting national missile and space vehicle test requirements in the 1965-70 period under $500,000 USAF contract. Program is known as RIPS (Range Instrumentation Planning Study). Major subcontractors to IEC are Cubic Corp., Northrop Space Laboratories and Raytheon Corp.

• **Electro-Mechanical Research, Inc.,** Sarasota, Fla., $7.4-million award from National Aeronautics and Space Administration, to manufacture and install PCM telemetry stations for NASA's global tracking range.

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HONEYWELL ENGINEERS ARE DOING THINGS IN FLORIDA

WHO'S WHERE

(*Continued from page 23*)

Honors and Elections

T. H. Davis, president of Piedmont Airlines, elected chairman of the Assn. of Local Transport Airlines, Washington, D. C., and **Keith Kahle,** president of Central Airlines, elected vice chairman.

Alfred M. Bertolet, president of Reading Air Service, elected president of National Aviation Trades Assn., Washington, D. C.

Dr. Robert C. Langford, director of General Precision's Aerospace Research Center, has been appointed to the National Aeronautics and Space Administration's Research Advisory Committee on Communications, Instrumentation and Data Processing, and also appointed chairman of the American Institute of Aeronautics and Astronautics' Technical Committee for Guidance and Control.

A. W. Bayer, vice president of Hughes Tool Co.'s Aircraft Div., elected chairman of the Aerospace Industries Assn.'s Vertical Lift Aircraft Council for 1963, and **Charles H. Kaman,** president of Kaman Aircraft Corp., elected vice chairman.

Walter W. Braznell, assistant vice president-flying of American Airlines, has been elected chairman of the Operations Committee of the Air Transport Assn. of America, succeeding **Capt. S. H. Miller,** chief pilot, Overseas Div., Pan American World Airways.

Changes

John E. Crosthwait, manager-Army aircraft programs, Advanced Systems and Research Dept., Douglas Aircraft Div., Long Beach, Calif.

Fred K. Guest, assistant director, Systems Integration and Evaluation, Mobile Midrange Ballistic Missile Program, Aerospace Corp.'s Technical Div., San Bernardino (Calif.) Operations, and **Robert E. Trudel,** associate group director.

Calvin A. Gongwer, senior scientist and scientific adviser to the vice president, Azusa (Calif.) plant of Aerojet-General Corp.

David B. Newman, manager-advanced programs, LFE Electronics, a division of Laboratory for Electronics, Inc., Boston, Mass., and **George V. Woodrow, Jr.,** director-research and engineering.

Dr. Car Hammer, director-scientific computer government marketing, Univac Div., Sperry Rand Corp., Washington, D. C.

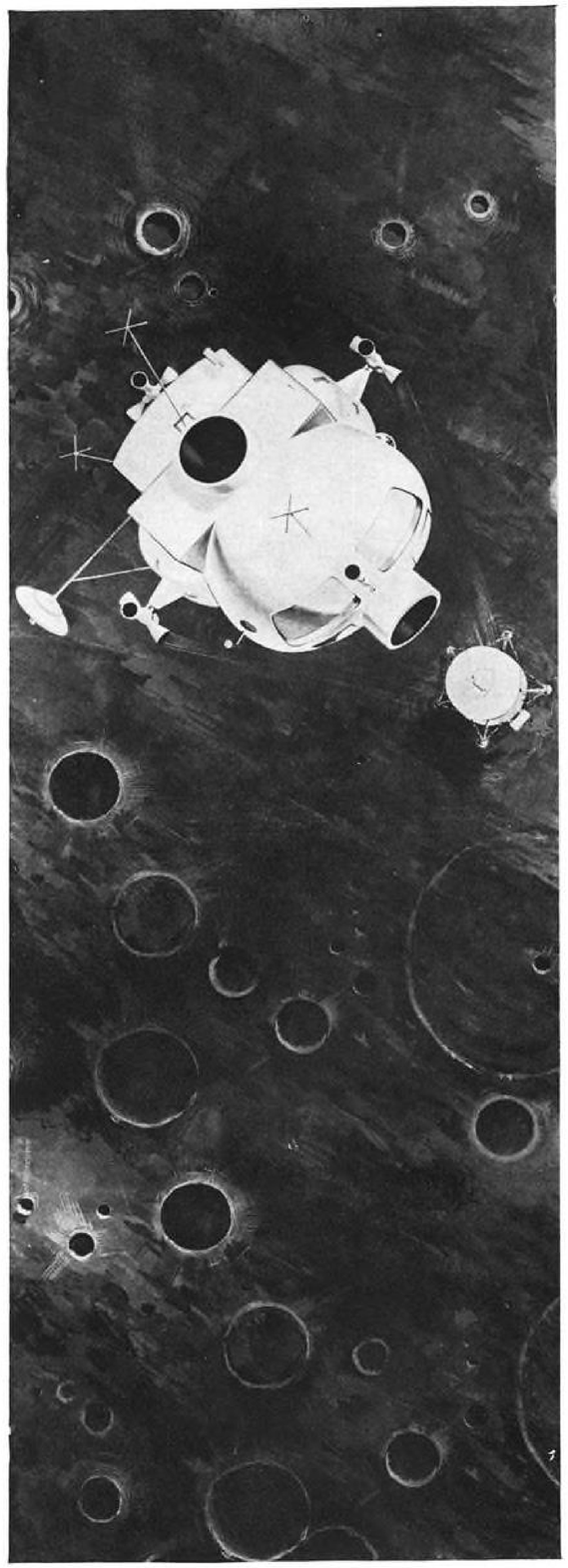
Dr. Harold Asher, Deputy Assistant Secretary of Defense (Programing), Office of the Assistant Secretary of Defense (Comptroller).

William E. Palmquist, manager, Aero/Space Engineering, C. T. Schjeldahl Co., Northfield, Minn.

Emmett H. Bradley has been assigned management responsibility for Atlantic Research Corp.'s missile systems operations, with offices in Arcadia, Calif.

Robert C. Booth, general sales manager, and **Roy Brown,** director of passenger service, Braniff International Airways.

Lt. Col. Robert Chesney (USAF, ret.), government marketing services representative, Radome Department, Corning Glass Works, Corning, N. Y.



LUNAR LANDING AND RENDEZVOUS PROGRAM OFFERS ENGINEERS & SCIENTISTS THE GREATEST TECHNICAL CHALLENGE OF OUR TIMES

The selection of Grumman to design, develop and fabricate the NASA Lunar Excursion Module (LEM) which will be used to achieve the Apollo program's goal of landing astronauts on the moon, opens a new chapter in the conquest of space. Boosted by a three-stage Saturn C-5 vehicle, the Apollo spacecraft will enter lunar orbit and LEM will separate from the spacecraft to begin its epoch-making descent to the lunar surface.

Later, it will launch itself back into orbit and rendezvous with the Apollo Command and Service Modules permitting the lunar astronauts to return to earth, while the LEM is jettisoned into lunar orbit.

The Lunar Excursion Module and other space programs at Grumman are creating unprecedented professional opportunities at the company. Make 1963 a year of personal achievement in an endeavor that ranks among the greatest of all times. Current requirements are detailed on the next page. We invite your inquiry on the attached inquiry form or by personal resume to Mr. W. Brown, Manager Engineering Employment, Dept. GR25.

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Environmental Control Engineers – BS in Engineering with experience designing systems involving oxygen supply cryogenics, cabin pressure control, atmosphere conditioning including humidity, CO_2 and contaminant control, temperature control of space suits, cabin atmospheres and electronic equipment. Duties will involve all aspects of the development of Environmental Control and Life Support systems mentioned above including establishment of system requirements and configuration, preparation of specifications for vendor supplied items, testing, liaison with customer and vendors.

Rocket Propulsion Systems Design Engineer – BS in Engineering with experience in design of liquid rocket motor and associated systems. Aircraft fuel system experience sufficient. Duties include conception, analysis, and design of storable and cryogenic bi-propellant rocket systems, gas pressurization systems, and cryogenically-fueled power supply systems for space application. Duties also involve design of rocket motor installations and supervision of manufacturers of motors and other components.

Rocket Propulsion System Testing Engineers – BS in Engineering with experience in testing liquid rocket propulsion systems and familiarity with techniques, instrumentation, and test procedures desired. Cyrogenic experience also desired. Duties will involve all aspects of testing storable liquid bi-propellant rocket systems including gas pressurization. Applicant may prepare test procedures, procure and set up hardware, conduct tests, collect and reduce data, or prepare test reports. Scope involves laboratory testing of components, subsystems, and complete systems; culminating ultimately in hot firing of motors and systems. Testing cyrogenic systems also required.

Structural Designers – BS in CE, ME or AE with experience in light weight space vehicle design. Familiarity with materials in space environment and pressure vessel design essential.

Structures Engineers – Experienced in aircraft or space vehicle structural analysis in one or more of the following areas: Stress analysis; aero-dynamic or dynamic loads; heat transfer and thermal stresses; shock, vibration, and thermal studies; research in structural methods and development; static, dynamic, and environmental testing; materials investigations involving metallurgy, plastics, finishes, lubricants, sealants, welding and heat treating processes. B.S. or M.S. degree or equivalent experience and education is desirable.

Junior Engineering Planners – BA or BS with 2 to 4 years experience in engineering man-power control and forecasting, vendor engineering, cost evaluation, new program estimating and engineering work statement preparation. Should also be familiar with scheduling techniques.

Specification Writers – Minimum of 3 years college engineering and 2-5 years experience with Government contract requirements for the preparation of contractor, spacecraft and electronic equipment specifications.

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Analytical Engineering – Acoustics and Environmental Vibration • Gas Dynamics • Vibration Testing • Space Dynamics • Guidance Dynamics • Heat Transfer & Thermodynamics • Stress, Structural Methods, Test, Materials • Control Dynamics • Programming • Rocket Propulsion Systems.

Systems Technology – Systems Synthesis • Systems Analysis • Data Processing Systems • Systems Integration • Sensor Systems • Control Systems • Systems Simulation • Programming Analysis • Reliability Analysis • Human Factors • Component Parts Analysis • Engineering Statistics • Weight Control • Reliability Test Engineering • Part Task Trainers.

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Background and experience (Brief resume of experience, recent history of employment)

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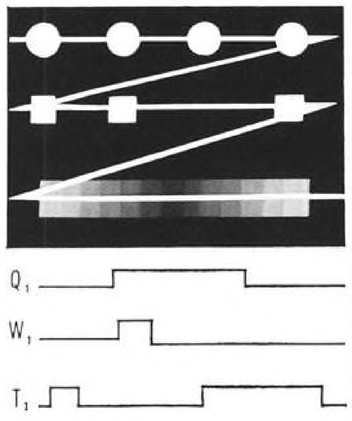
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PROJECT ENGINEER

MSEE or BSEE with minimum 5 years experience large electronic or electro-mechanical systems with some analog or digital computer background. Will assume administrative and technical control of new and advanced simulation systems contracts.

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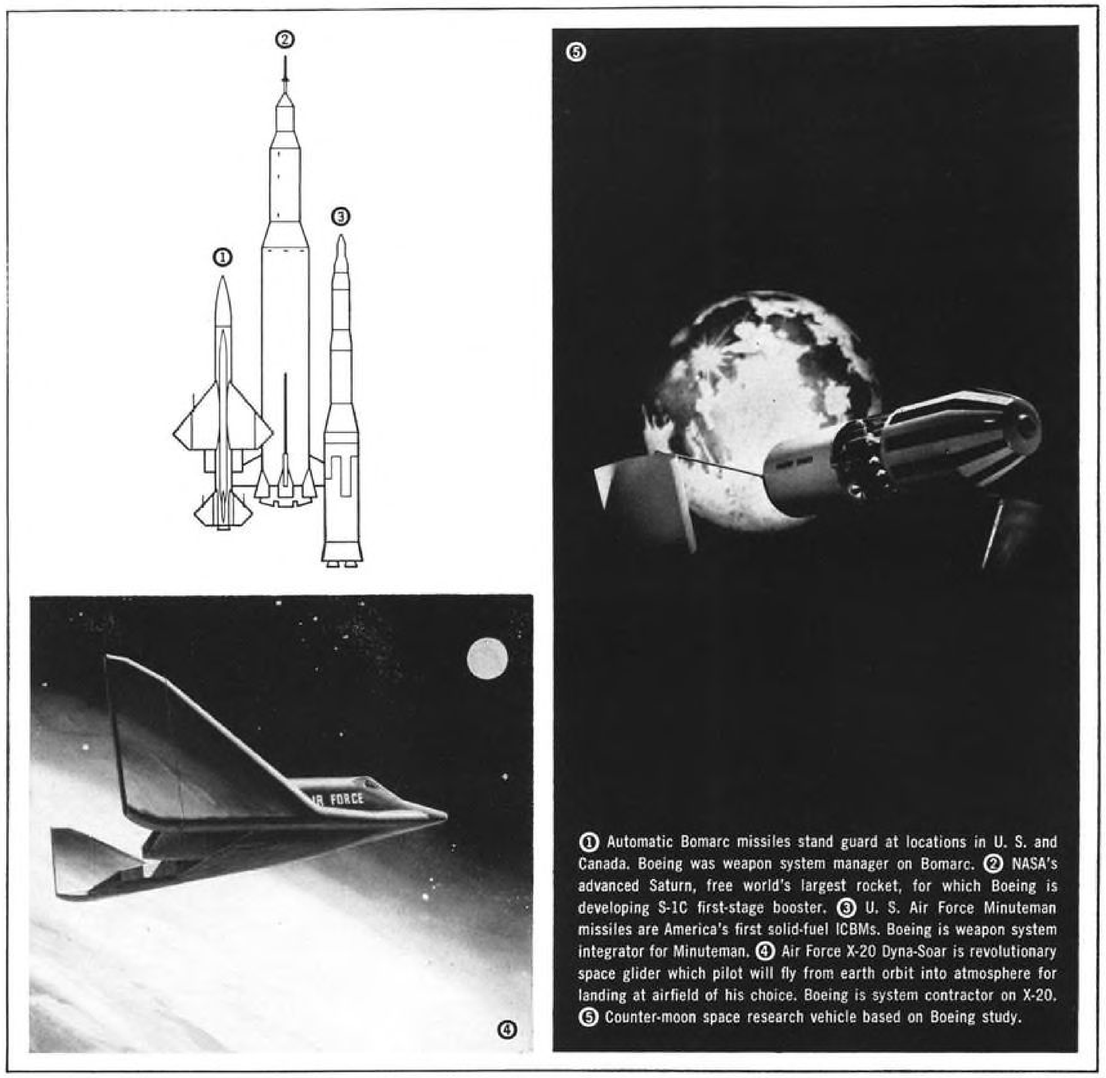
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Continued on page 116



① Automatic Bomarc missiles stand guard at locations in U. S. and Canada. Boeing was weapon system manager on Bomarc. ② NASA's advanced Saturn, free world's largest rocket, for which Boeing is developing S-1C first-stage booster. ③ U. S. Air Force Minuteman missiles are America's first solid-fuel ICBMs. Boeing is weapon system integrator for Minuteman. ④ Air Force X-20 Dyna-Soar is revolutionary space glider which pilot will fly from earth orbit into atmosphere for landing at airfield of his choice. Boeing is system contractor on X-20. ⑤ Counter-moon space research vehicle based on Boeing study.

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ELECTRO-MECHANICAL TECHNOLOGY . . . failure analysis, electrical interference, spectroscopy, preliminary configuration design.

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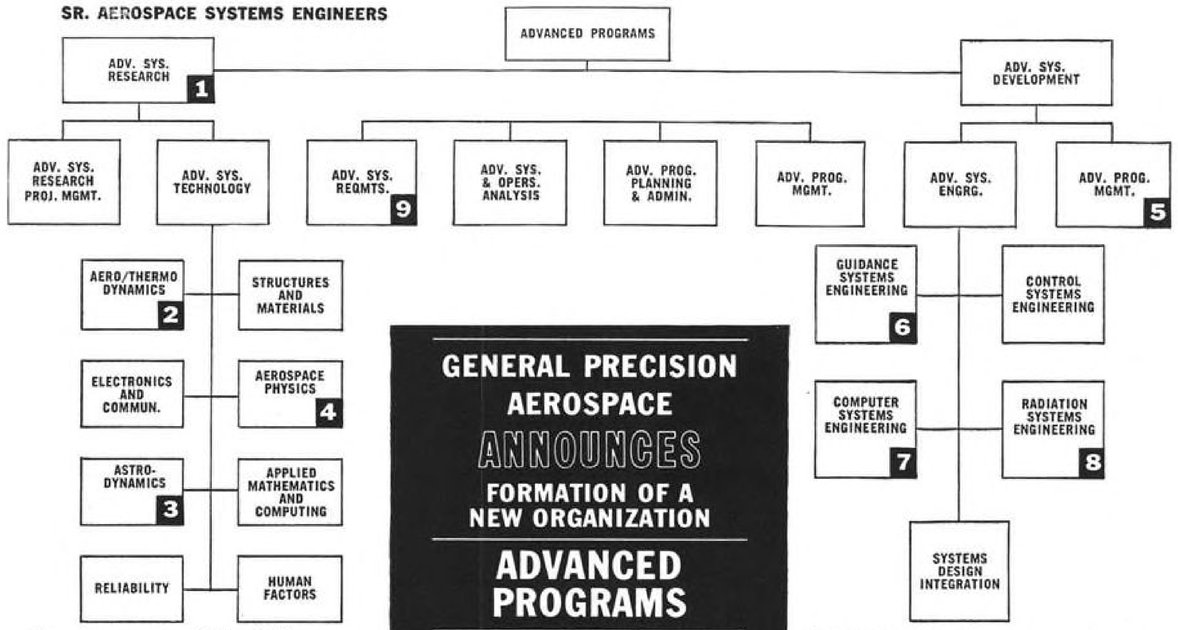
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ANNOUNCES

FORMATION OF A NEW ORGANIZATION

ADVANCED PROGRAMS

And the Creation of Many Key Positions

The primary responsibility of this new organization is to provide the advanced systems capabilities required for major new systems business. Broad diversification as well as growth is sought in the area where General Precision Aerospace already has established an outstanding competence: **guidance and control systems for aircraft, missile and space vehicles.** For example, in Advanced Programs, we are actively pursuing the development of systems whose **mission,** rather than function, is guidance and control. We are also developing a **total** capability for management and technical direction of **complete** missile and space vehicle system programs.

This effort is being based upon a comprehensive program of advanced systems research and advanced systems and technology development. The Table of Organization above indicates the scope of endeavor at Advanced Programs.

A PROGRESSIVE PATH TO ADVANCEMENT IS OFFERED THE DISCIPLINE-ORIENTED MAN

An engineer or scientist in Advanced Programs will spend as much time as required on the development of his technology as well as on its application. He will not be restricted to one program, in the manner of vertical organizations, but will contribute to many.

Insight into the diversity here may be gained from this partial list of major areas in which we are currently working: Advanced Aircraft Navigation & Guidance / Advanced Strategic Missile Guidance & Control / Maneuvering Re-Entry Vehicle Guidance & Control / Advanced Tactical Missile Systems / Advanced Space Vehicle Guidance & Control / Advanced Space Vehicle Systems.

Rendering technical services on systems projects as varied as these offers the staff member unique opportunities not only to keep pace with progress in his discipline but to contribute to advancement in the state-of-the-art.

PROGRAMMED STAFF EXPANSION

A personnel complement of over 100 engineers and scientists is contemplated for Advanced Programs in 1963

Strongly supported by the parent company, General Precision Aerospace, this new activity is part of a major program initiated in 1962 to meet the electronic systems needs of the next decade. Included in this program are new facilities: a Systems Engineering Building, for which ground was broken last fall; an excellently equipped Aerospace Research Center, which has just recently been completed.

ENGINEERS & SCIENTISTS ARE INVITED TO DISCUSS OPENINGS IN ANY OF THE FUNCTIONAL GROUPS ON THE ORGANIZATION CHART

1. PROGRAM MANAGERS — Advanced Systems Research
Manage team efforts related to systems research programs dealing with advanced concepts and future systems requirements, mission effectivity, and investigation of sub-system design criteria. Comprehensive experience required with major aerospace subsystems and demonstrated supervisory skills in managing major systems research programs.

2. SECTION HEAD & SENIOR STAFF ENGINEER — Aerothermodynamics
Conduct theoretical studies and research in aerodynamics and thermodynamics concerned with high Mach number vehicles, spacecraft, and re-entry bodies. Specific experience required in dynamics, thermodynamics, and aero-elastic problems associated with space vehicles and re-entry bodies.

3. SECTION HEAD & SENIOR STAFF ENGINEERS — Astrodynamics
Theoretical and experimental research and studies of space flight profiles and problems to determine design requirements, influence systems configurations and to identify future research efforts. Emphasis on guidance and control, navigation, attitude stabilization and related technologies.

4. SECTION HEAD & SENIOR STAFF ENGINEERS — Aerospace Physics
Research and study of the effects of space regimes and planetary environments on space vehicles and subsystems. Analysis of guidance trajectories. Experience required in nuclear physics, astronomy, or dynamics of planetary motion.

5. PROGRAM MANAGERS — Advanced Systems Development
Supervise and direct major proposal and development program efforts, utilizing modern management methods. Comprehensive systems engineering background required in complex electronic systems, guidance and control and communication sub-systems and the application of radar, stellar trackers, and digital computers in aerospace systems. Conduct preliminary design analysis and synthesis of future systems.

6. SENIOR SYSTEMS ENGINEERS — Guidance Systems
Engineering design and systems configuration of advanced aerospace guidance systems to meet future requirements. Experience in sophisticated systems analysis, hardware design and systems configurations required.

7. SENIOR SYSTEMS ENGINEERS — Computer Systems
Generate computer specifications and preliminary designs to meet computational and data processing requirements of future aerospace systems. Sophisticated and broad knowledge is required of logical organization and associated electronics.

8. SECTION HEADS & SENIOR SYSTEMS ENGINEERS — Radiating Systems
Preliminary design engineering and systems configuration of radiating subsystems to contend with hostile environments such as cosmic and nuclear radiation, temperature and pressure extremes, solar flares, and meteorites.

9. SENIOR STAFF ENGINEERS — Advanced Systems Requirements
Systems engineering analysis of new concepts and novel designs of aerospace systems to identify technology and design engineering requirements. Translate customer requirements into systems design criteria. Thorough knowledge of weapons systems design, trade-offs, and optimization techniques required with emphasis on guidance and control and related technical areas.

Additional engineering openings elsewhere in Aerospace Group.

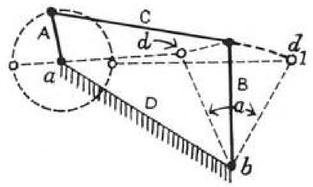
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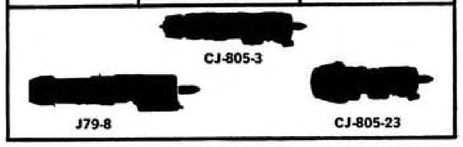
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LM-1500	13,000 hp turboshaft engine designed for speeds up to 60 knots	First hydrofoil built in U.S.



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LETTERS

IFR Structure

I can't understand the wails and moaning of the "Ex-non-professional pilot" (AW Dec. 24, p. 94) from San Diego who wrote that the poor general aviation pilot can't cope with modern "jet age" IFR operations unless he flies at least 25 hr. a month.

I operate a Piper Comanche on instruments, and pretty much 100% on IFR flight plan regardless of the weather. I average 10 to 15 hr. a month—not 25—but don't consider myself a misfit in the IFR structure, nor have I been told I was a menace. In fact, I have nothing but praise for the polite and courteous manner of Center controllers and am constantly amazed at their uniform patience.

I have never had a controller growl at me—nor an airline pilot. If anything, I'm guilty of this—having chewed out a United DC-7 one time on Newark Approach Control frequency for overtaking and passing me much too close.

The IFR system, for all its short comings, is still one of the greatest advances we've seen in modern aviation. With it you can usually get where you want to be when you want to be there.

I just don't understand why your "ex non-pro" from San Diego has thrown in the sponge. Maybe I just don't understand the situation or am not used to congested traffic—except that we base in the New York area (White Plains) and 75% of our IFR business is with the New York Center.

William D. Strohmeier
Executive Vice President
Davis, Parsons & Strohmeier, Inc.
New York, N. Y.

This refers to the letter in the Letters column in Aviation Week of Dec. 24 (p. 94); J. N. Shaw, who signs himself as an ex-non-professional pilot, says "Certainly the air traffic system scares the non-professional pilot . . ."

I am a non-professional pilot with 1,100 hr., all of them accumulated in the last five or six years. The air traffic system doesn't scare me. In fact, all of the new aids to navigation make me feel much more confident flying into large airports, such as Idlewild, La Guardia, Miami and O'Hare, than I was before all this new equipment was placed into use.

Why should a non-pro pilot misunderstand an instruction? Didn't non-pro Shaw ever learn the words "say again?"

In all of my flying into major airports I have never experienced any delay in being caught by airliners on "IFR milling about in clear weather." Usually a general aviation aircraft operated with reasonable proficiency can get into a major airport ahead of a large airliner.

Non-pro Shaw says, "If you can't fly more than 25 hr. a month you just can't keep up with 'progress'." My flying averages about 17 hr. a month and I seem to have no trouble getting in or out of airports. In fact, I thoroughly enjoy flying into a large metropolitan airport because the controllers appreciate the efficiency of a pilot of a general aviation aircraft.

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.

More than once I have had a "Thank you, sir" for keeping the controllers fully informed and accurately following their instructions.

It would appear to me that if non-pro Shaw represents other non-pro pilots, he and this group have given up any desire to increase their efficiency and really just wish for the "good old days."

W. C. Weeks
Non-professional Pilot
Reading, Pa.

Solar Cell Sales

For several years, with the heavy application of electronic components into space programs, we have often found Aviation Week & Space Technology leading the way in timely and accurate technical business information.

To our chagrin, however, the Dec. 17 issue contained a significant error of omission on the subject entitled, "Radiation Resistant Solar Cell Situation" (pp. 71, 75). The implications left with the reader are that radiation resistant cells are not yet available in quantity and that only four companies are developing these cells.

The RCA Electron Tube Div. announced commercially available N-on-P silicon solar cells almost a year ago, in February, 1962. Production facilities at Mountaintop, Pa., have been expanded continuously to keep ahead of major NASA procurements.

Because of RCA's early investigations of radiation resistant solar cells (1955 U. S. Army Signal Corps contract) and a product development program starting in 1960, we are able to offer N-on-P silicon solar cells with competitive pricing and conversion efficiencies to the non-radiation-resistant type. We have no P-on-N cell inventory to liquidate and are not involved in product line conversion problems. As a result, we're able, willing and ready.

We would appreciate a brief notation of the above situation in Aviation Week & Space Technology to dispel any fears that industry has not kept pace with the technical requirements of government space programs.

H. F. Kazanowski
Advance Market Planning
Radio Corp. of America
Electron Tube Div.
Lancaster, Pa.

(Aviation Week & Space Technology *regrets the omission, particularly since in an earlier story on radiation resistant solar cells (AW Sept. 17, p. 32), RCA's pioneering work on N-on-P silicon cells as well as on the even more resistant gallium arsenide cells was reported.*—Ed.)

COIN Rivalry

The very fine article by Larry Booda titled "Urgent COIN Aircraft Program Planned" in your Dec. 6 issue (p. 26) is most interesting and informative. I have written some articles on this subject and feel that the program is the victim of interservice rivalries and misunderstandings. The facts in the article indicate little understanding about procurement costs because the COIN airplane cannot be mass produced for as little as $100,000 apiece. If the figure of 1,150 hp. for each of the two turboprop engines is correct, it will be difficult to procure such engines for less than $30,000. Two such engines will use up $60,000 per airplane leaving a meager $40,000 for the airframe, instruments and electronics.

As a matter of comparison, the Grumman Mohawk airplane uses two turboprop engines of similar horsepower. Since it is also a STOL airplane, the Mohawk and the COIN airplane are bound to be very similar in size, weight, performance and cost. The Mohawk sells for something over $500,000, so it would seem impossible for the COIN airplane to be much less. I do not wish to sell Mohawks, but I do wish to save money for the U. S. taxpayer (me, in particular) so if we must have such a COIN airplane, let us buy modified Mohawks for the job. However, anyone who knows much about close air support (and I do) will not buy the Mohawk for close air support for many obvious reasons.

The article should wake up a lot of people to call for an investigation to expose this COIN-close air support mess dominated by too many self interests.

J. H. Reinburg
Colonel, U. S. Marine
Aviation Reserve
Mt. View, Calif.

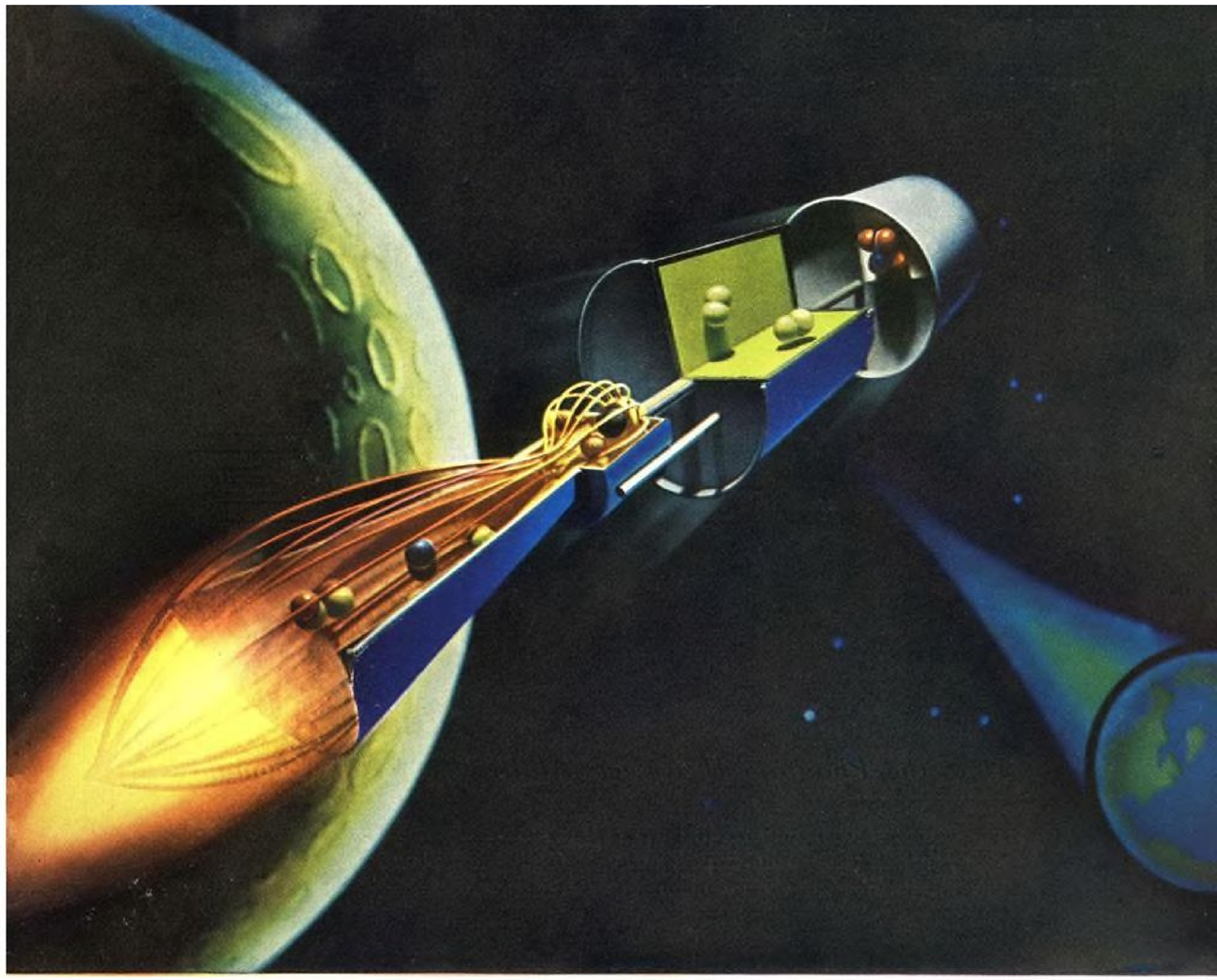
Transistor Problem

Re: "Transistors Face New Radiation Hazard" (AW Jan. 21, p. 85), there is a major misimpression which could be of vital significance to us and which we would like to set straight. The impression is generated that all diffused silicon transistors are subject to the degradation described through ionization of air or gas within the transistor package as it passes through the radiation field. We have contacted Dr. G. L. Miller of the Brookhaven National Laboratory, cited in the article as co-discoverer of the phenomenon, and have his report as follows, "This is simply not true of planar transistors."

We would like to point out that the major illustration at the head of the article shows a mesa transistor and emphasize Dr. Miller's quotation that the phenomenon is not true of planar transistors.

Since planar devices are our invention and our principal product, we would greatly appreciate clarification of this point. Thank you for your cooperation.

Robert N. Noyce
General Manager
Fairchild Semiconductor Div.
Mt. View, Calif.



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But — until recently — the techniques in handling liquid fluorine hadn't been refined. Fluorine's vast energy was locked in theory (as far as rocket engines go) until Bell engineers devised ways to store it and pump it through a rocket engine's innards at high pressure without having it leak out or react with the plumbing itself.

Now fluorine can be used safely and readily with common materials like nickel, aluminum, stainless steel, brass. Now it's ready for space.

The taming of the fluorine shrew is one important contribution of Bell Aerosystems Company in the field of High Energy Propulsion. Perhaps we could do a job for you.

Bell Aerosystems scientific and engineering personnel are engaged in many other challenging projects — highly-reliable inertial guidance systems, rocket engines and reaction controls for space, ground effect machines, jet VTOL aircraft, automatic all-weather landing systems, small rocket lift devices. If you are qualified, we invite your inquiry.

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FEB. 12 1963



How the Phantom II Affects Multiple-Mission Economy

The combat value of an aircraft carrier is directly related to the strike capability of its aircraft. Navy planners, seeking to increase the combat potential of aircraft carriers, are vitally aware of the economic advantages of aircraft capable of more than one mission. The Navy's new multiple-mission fighter, the Phantom II, has demonstrated effective delivery of huge loads of conventional or nuclear ground strike weapons while retaining full capability for instant conversion to an air-to-air fleet defense mission.

Sparrow III missiles for anti-air warfare are semi-submerged in the fuselage and are carried on all missions. The Phantom II literally flies its own protective cover on surface attack missions because it retains full capability for all-weather air defense at any time.

Great numbers of conventional bombs, rockets, guided missiles, napalm tanks or nuclear weapons can be slung beneath the wings and the fuselage for delivery against ground targets. Simply varying the armament load of the Phantom II fits the carrier force to shifting combat situations regardless of weather, day or night.

The multiple-mission Phantom II is now being delivered to the United States Navy, Marines and Air Force.



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