Aviation Week and Space Technology

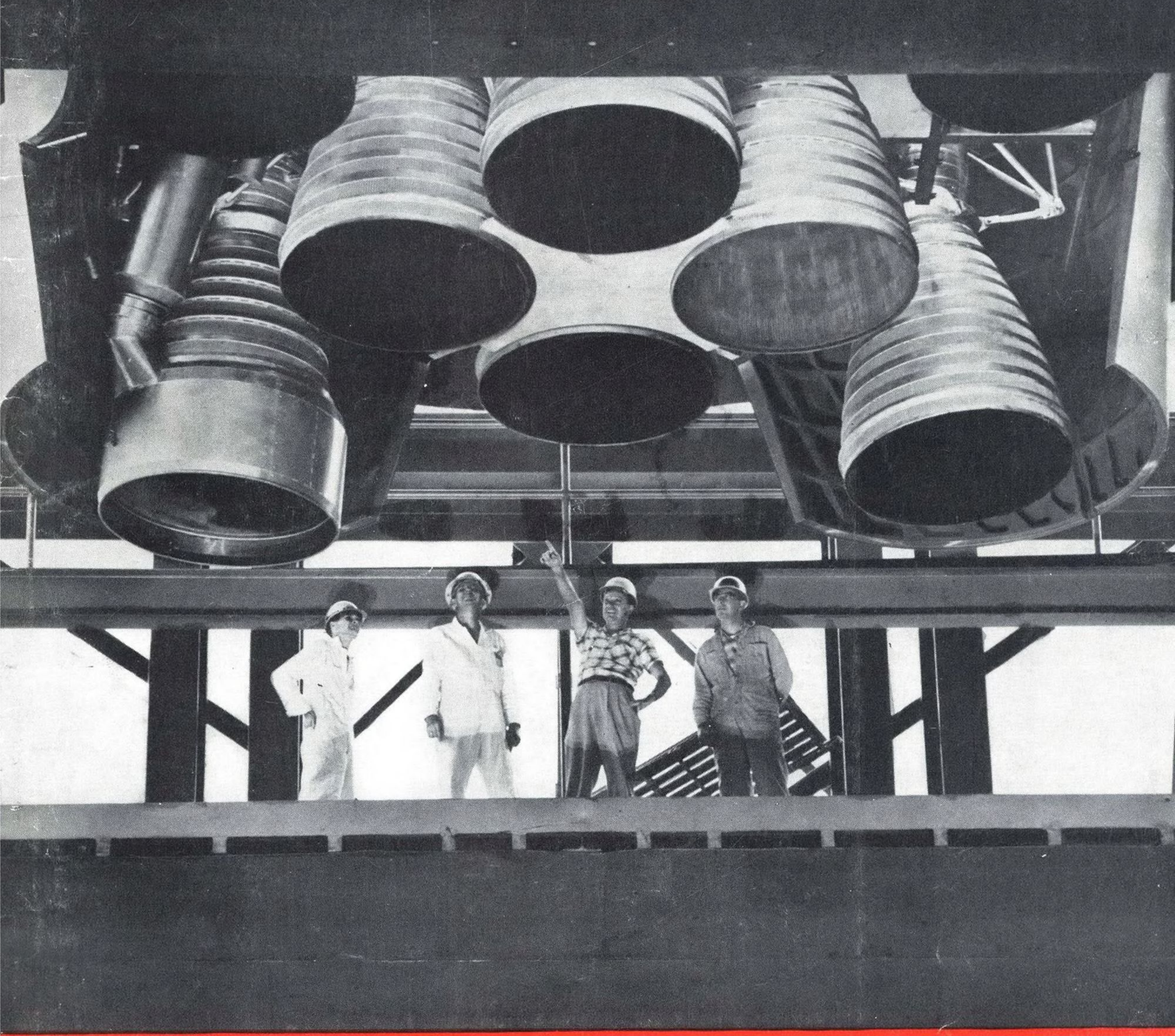
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A McGraw-Hill Publication

May 9, 1960

All-Glass Fiber Rotor Blades Undergo Testing

Saturn Eight-Engine Rocket Cluster



Safety, Reliability, Dictate Saturn Design

AIRBORNE RADAR DESIGNERS:

VOI-SHAN SCR-MAGNETIC PULSER FOR MAGNETRONS...

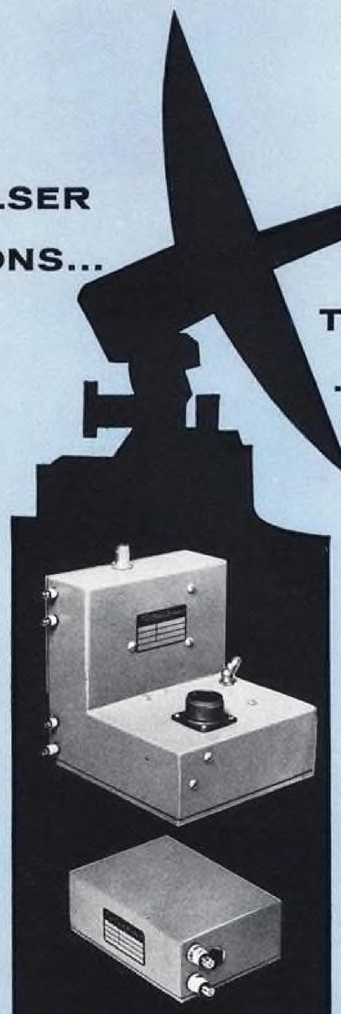
TRIMS PULSE JITTER TO LESS THAN .010 MICROSECOND DURATION – *NOW AVAILABLE*

Voi-Shan Electronics' new SCR-Magnetic Magnetron Modulators replace and out-date thyratrons with simplified solid-state circuitry utilizing silicon-controlled rectifiers and saturable cores. The result is unsurpassed life and reliability, assured by the use of refined potting techniques.

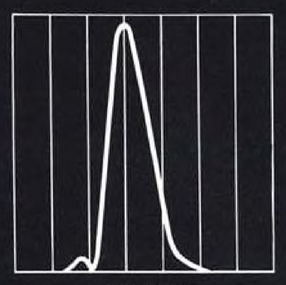
Voi-Shan modulators now in production have been use-proven at altitudes up to 100,000 feet—are smaller, lighter, and lower in cost than any previously available, and produce a finer spectrum. They operate off any available AC or DC prime power source—eliminating a separate high-voltage power supply.

The configuration and specifications shown here can be readily modified to meet your own particular design requirements. For a prompt quote, contact Don M. Worden at the address below.

Voi-Shan Electronics' activities include the design and manufacture of transistorized time delay relays, intervalometers, sequential programmers, voltage sensors, frequency sensors, magnetic amplifiers and regulators, as well as programs encompassing travelling wave tubes and electro-mechanical counters. A request on company letterhead brings your free copy of our new electronics catalog.



MODEL M10-1009



Frequency

SPECTRUM PLOT

SPECIFICATIONS, MODEL M10-1009:

INPUT:	115 Volts, 400 cps
OUTPUT:	Magnetron Pulse Peak Voltage: 8.0 K V Peak Current: 7.5 amps Pulse Width: .5 microseconds (measured across 1000 ohm load at 50% amplitude) Rise Time: .05 to .15 microseconds (measured at 10% to 90% amplitude) Pulse Repetition: Frequency: 800 cps System Trigger Peak Voltage: −60 volts Load: 93 ohms Pulse Characteristics: Same as magnetron pulse
KEEP ALIVE VOLTAGE:	Open Circuit Voltage: −900 VDC Closed Circuit Voltage: −750 volts
ENVIRONMENT:	Temperature: −55°C to +125°C Altitude: 100,000 feet Shock & Vibration: In accordance with MIL-T-5422D
MECHANICAL:	Weight: 7.5 lbs. Size: 110 cubic inches

VOI-SHAN ELECTRONICS
13259 Sherman Way • North Hollywood, Calif.

VSI

VOI-SHAN MANUFACTURING COMPANY
A Division of Voi-Shan Industries, Inc.



Here's a brand of inflation that's easy to take—Goodyear's inflatable structures that can take to the air in folded form, blossom out on-site into tough, lightweight shelters, radomes, fuel farms.

Shown above are a few recent developments in rubberized fabrics by Goodyear:

(A) **Fuel Farm** of PILLOW Tanks – these huge containers can be set up, filled and pumping in minutes. Drained, they roll up like rugs for compact storage and transport. Capacities to 50,000 gallons or more.

(B) **"Soft-Top" Radomes** by Goodyear provide all-weather protection that shrugs off snow, ice, 150-mph gales. In sizes to 100 feet in diameter, Goodyear radomes offer highest transparency to radar waves. Even radar antenna is inflatable in new design above.

(C) **Personnel Shelters** of Air Mat fold into light packs, inflate in minutes. Provide comfort and protection in worst weather. Ability to hold air eliminates air-locks and need for constantly running compressor.

(D) **Mobile Command Post** features Goodyear's 9-inch Air Mat fabric—with highest strength/weight ratio known. Stored in truck side, structure unfolds and inflates to room 25-feet-square in 15 minutes.

Portable—lightweight—super-tough—flexible—these are the *product* qualities you can count on in Goodyear inflatables. But the real secret is Goodyear's design-engineering ability to fashion rubberized fabric into shapes and constructions you'd never think possible. And the odds are that our staff can fabricate the answer to *your* problem. Find out by writing on company letterhead to The Goodyear Tire & Rubber Company, Aviation Products Division, Dept. Q-1715, Akron 16, Ohio, or Los Angeles 54, California.

Lots of good things come from

Pillow—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

GOODYEAR

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a message to men who are not alone in their thinking . . . Leonardo da Vinci, engineer, scientist, theorist, was the victim of an age when three centuries had to pass before many of his concepts could be regenerated by other men of vision. ☐ Today's quick minds are the fortunate product of an era when methods, materials and machines can be mated to their needs—an age when a spark of inventiveness ignites a fury of progress. ☐ If such a chain reaction of creativity is characteristic of your group, we invite you to discover how Ex-Cell-O can fuse into your operation a reliable source for precision products amply backstopped by research, development and manufacturing facilities, plus the experience required to help you meet the challenge of your own thoughts. ☐ Contact the Ex-Cell-O Representative in your area, or if you wish, call or write direct to our Aircraft Division's central offices, Detroit.

Artist's conception of Leonardo da Vinci's 15th Century spring-driven aerial screw, predecessor of today's helicopter.

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AVIATION CALENDAR

May 16-20—Aviation Fire Safety Seminar, National Fire Protection Assn., Queen Elizabeth Hotel, Montreal, Canada.

May 18-20—National Meeting, Society for Experimental Stress Analysis, Hotel Severin, Indianapolis, Ind. Theme: Stress Analysis of Propulsion Systems.

May 22-29—Fourth Annual Reserve Navigation Competition, Ellington AFB., Tex.

May 23-25—12th Annual Meeting, German Society for Rocket Engineering and Space Flight Research, Heidelberg, Germany.

May 23-25—1960 National Telemetering Conference, Miramar Hotel, Santa Monica, Calif. Sponsors: Instrument Society of America; American Rocket Society; American Institute of Electrical Engineers; Institute of the Aeronautical Sciences; Institute of Radio Engineers.

May 23-25—14th Annual Armed Forces Communication and Electronics Association Convention, Sheraton Park Hotel, Washington, D. C.

May 24-26—1960 Convention, American Society for Quality Control, San Francisco, Calif.

May 25-27—National Specialists Meeting on Guidance of Aerospace Vehicles, Institute of the Aeronautical Sciences, Hotel Somerset, Boston, Mass.

May 26-27—"Psychophysiological Aspects of Space Flight," symposium, Hilton Hotel, San Antonio, Tex. Sponsored by the School of Aviation Medicine, USAF Aerospace Medical Center (ATC), and arranged by Southwest Research Institute. Unclassified, but by invitation.

May 27-30—12th Annual Wright Memorial Glider Meet. For information: Soaring Society of Dayton, Inc., Far Hills Branch, P. O. Box 581, Dayton 19, Ohio.

June 3-4—11th National Maintenance & Operations Meeting, Reading Aviation Service, Reading, Pa.

June 5-9—Semi-Annual Meeting and Avia-

(Continued on page 6)

AVIATION WEEK and Space Technology
May 9, 1960
Vol. 72, No. 19

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False Vampire (Lavia Frons)

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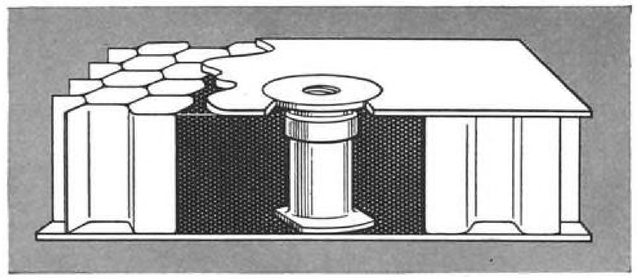
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2,880,830

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AVIATION CALENDAR

(*Continued from page 5*)

tion Conference, American Society of Mechanical Engineers, Statler Hilton Hotel, Dallas, Tex.

June 14-16—35th Meeting, Aviation Distributors and Manufacturers Assn., Queen Elizabeth Hotel, Montreal, Canada.

June 15-17—1960 Heat Transfer and Fluid Mechanics Institute, Stanford University, Stanford, Calif.

June 22-24—1960 Conference on Standards and Electronic Measurements, NBS Boulder Laboratories, Boulder, Colo. Cosponsors: Institute of Radio Engineers' Professional Group on Instrumentation; Radio Standards Laboratory, National Bureau of Standards; American Institute of Electrical Engineers' Instrumentation Division.

June 23-25—16th Annual Meeting, Institute of Navigation, U. S. Air Force Academy, Colorado Springs, Colo.

June 26-July 1—63rd Annual Meeting and Apparatus Exhibit, American Society for Testing Materials, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 27-29—Fourth National Convention on Military Electronics, Institute of Radio Engineers, Sheraton-Park Hotel, Washington, D. C.

June 28-July 1—National Summer Meeting, Institute of the Aeronautical Sciences, Ambassador Hotel, Los Angeles, Calif.

July 3-4—Fourth Annual Fort Wayne National Championships (civilian, closed-course airplane races), Fort Wayne, Ind.

July 18-19—Liquid Rockets and Propellants Conference, American Rocket Society, Ohio Union Building, Ohio State University, Columbus, Ohio.

July 28-29—Seventh Annual Symposium on Computers and Data Processing, Denver Research Institute, University of Denver, Stanley Hotel, Estes Park, Colo.

Aug. 1-3—Fourth Global Communications Symposium, Statler Hilton Hotel, Washington, D. C. Sponsors: Institute of Radio Engineers; U. S. Army Signal Corps.

Aug. 8-11—Western National Meeting, American Astronautical Society, Olympic Hotel, Seattle, Wash.

Aug. 8-12—1960 Pacific General Meeting, American Institute of Electrical Engineers, El Cortez Hotel, San Diego, Calif.

Aug. 15-20—11th Annual Congress, International Astronautical Federation, Royal Institute of Technology, Stockholm.

Aug. 23-26—Western Electronic Show & Convention, Institute of Radio Engineers, Ambassador Hotel, Los Angeles, Calif.

Sept. 5-11—1960 Farnborough Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, Eng.

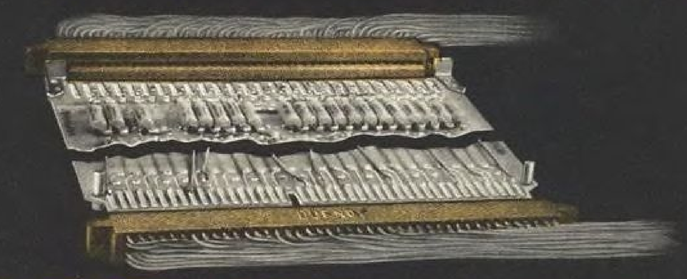
Sept. 12-16—16th Annual General Meeting, IATA, Copenhagen, Denmark.

Sept. 12-16—Second International Congress, International Council of the Aeronautical Sciences, Zurich, Switzerland.

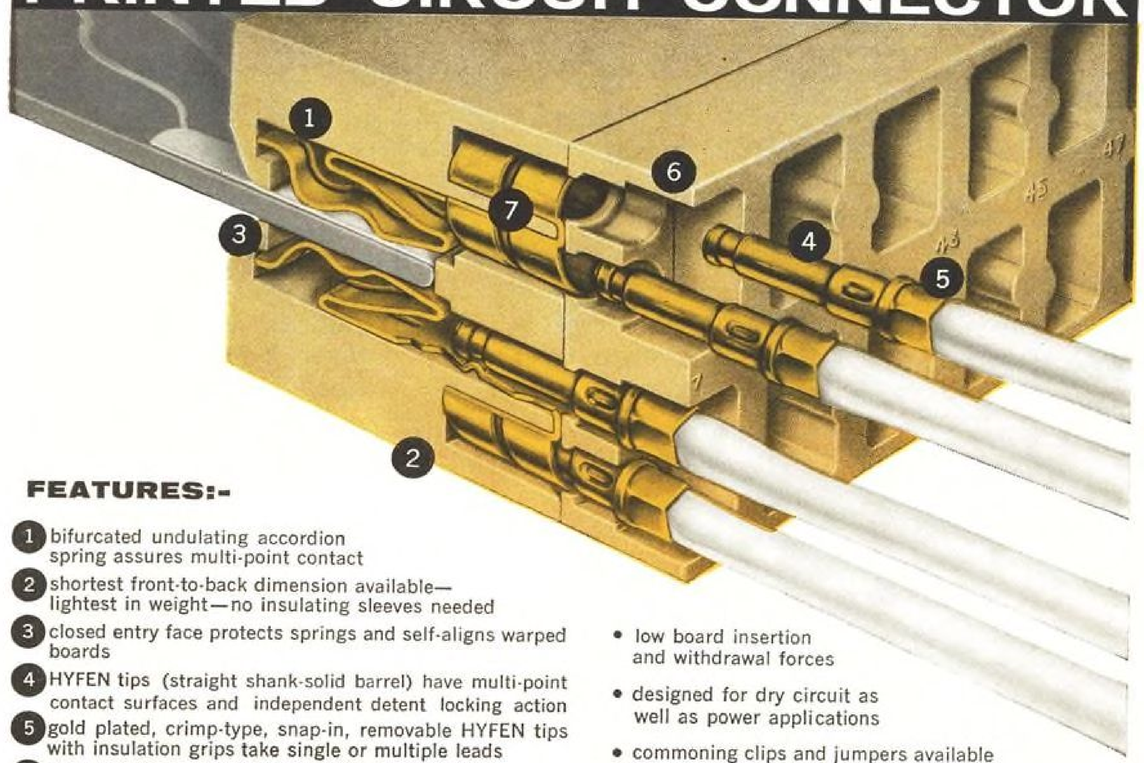
Sept. 21-25—National Convention and Aerospace Panorama, Air Force Assn., Civic Auditorium and Brooks Hall, San Francisco, Calif.

Sept. 27-30—Power Systems Conference, American Rocket Society, Miramar Hotel, Santa Monica, Calif. Cosponsors: USAF; U.S. Army; U.S. Navy; National Aeronautics and Space Administration; Atomic Energy Commission.

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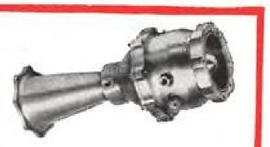
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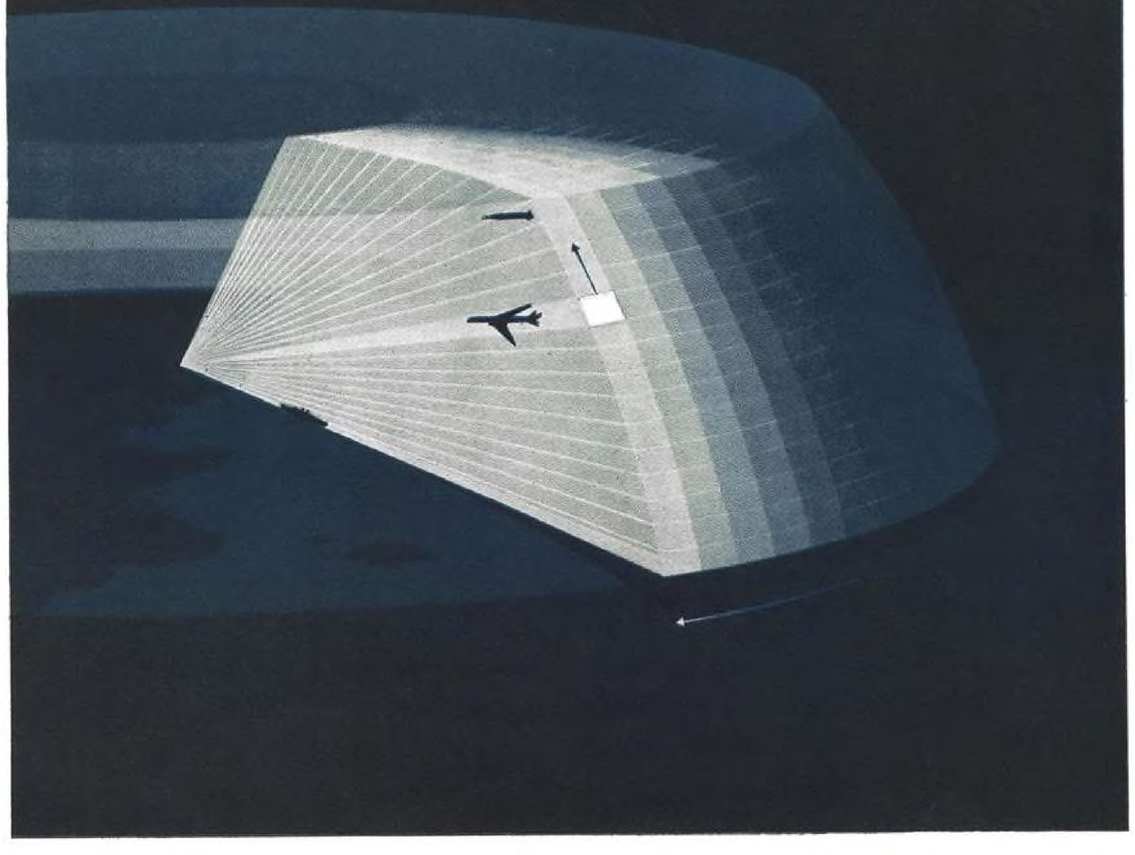
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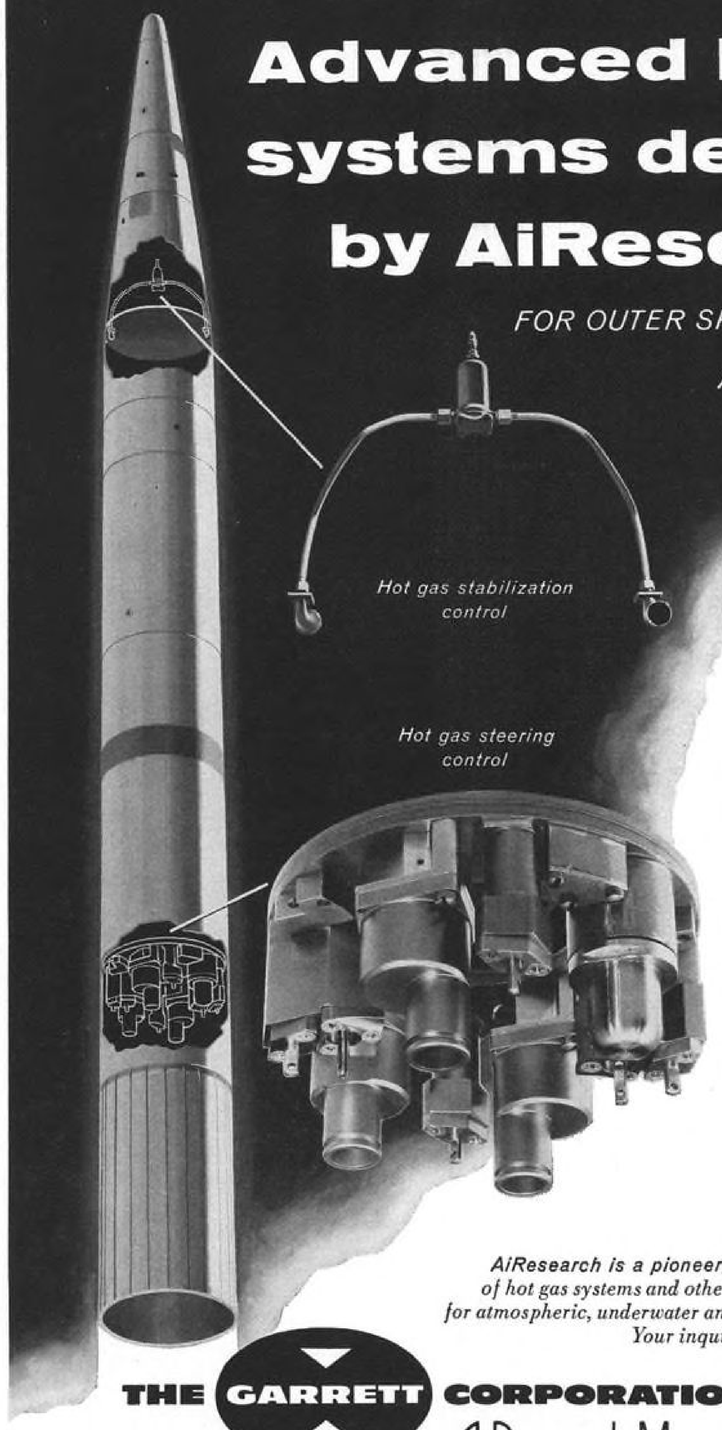
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FOR OUTER SPACE, ATMOSPHERIC AND UNDERWATER STEERING



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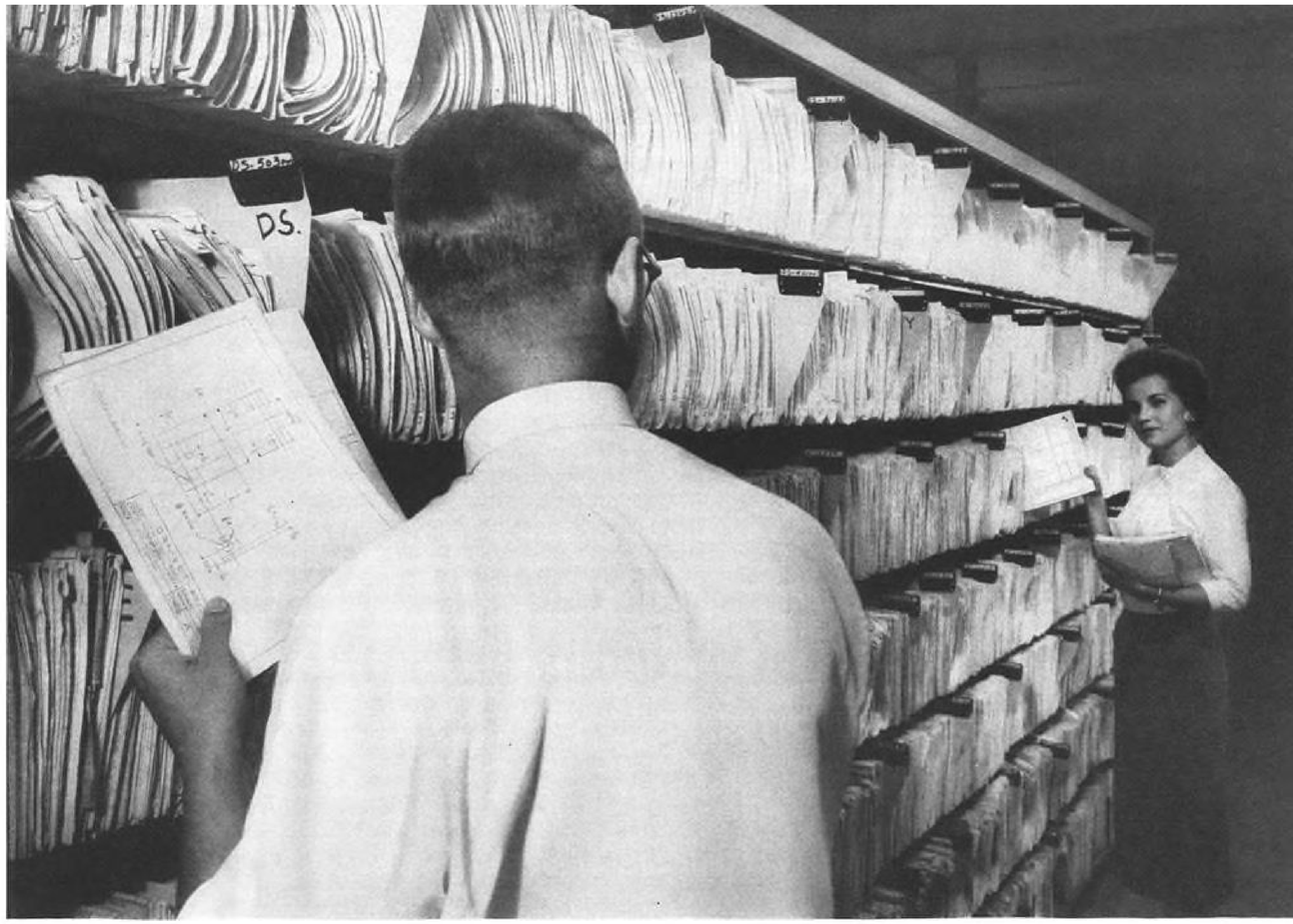
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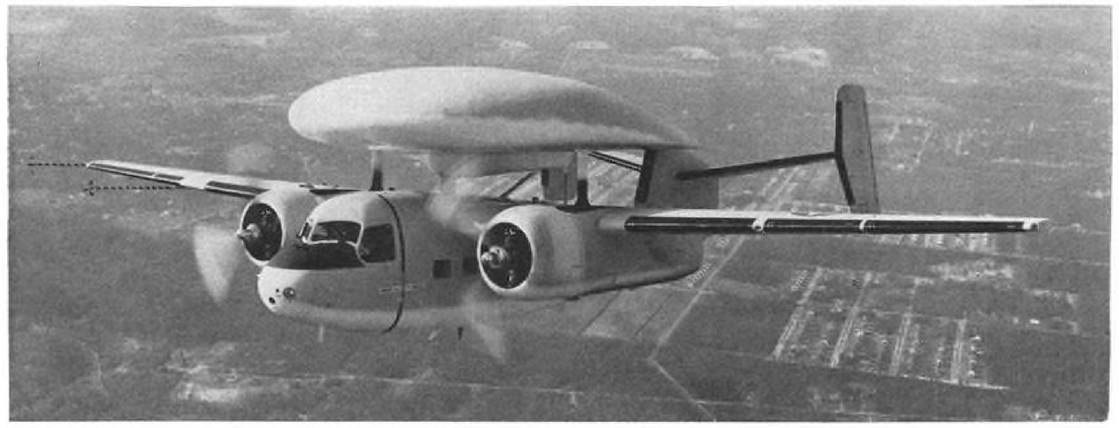
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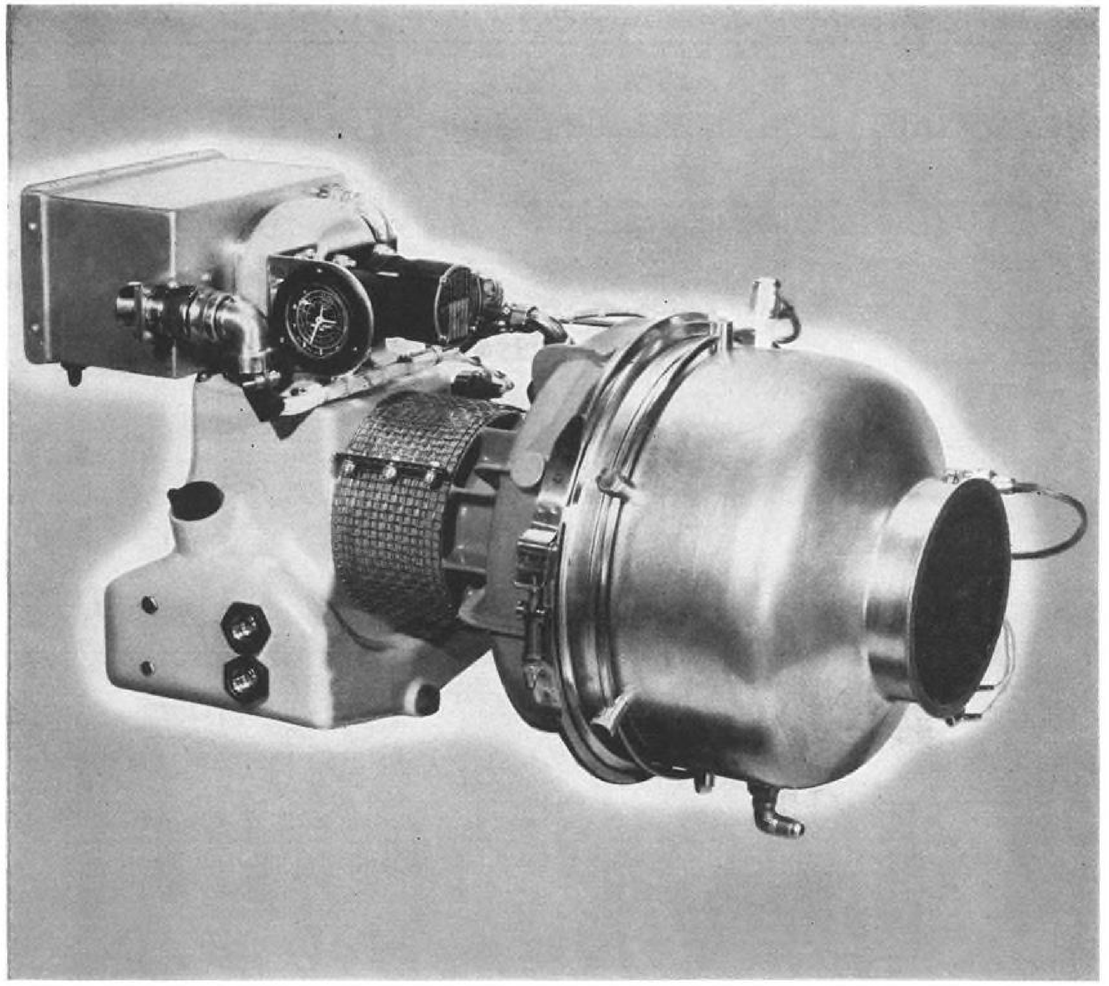
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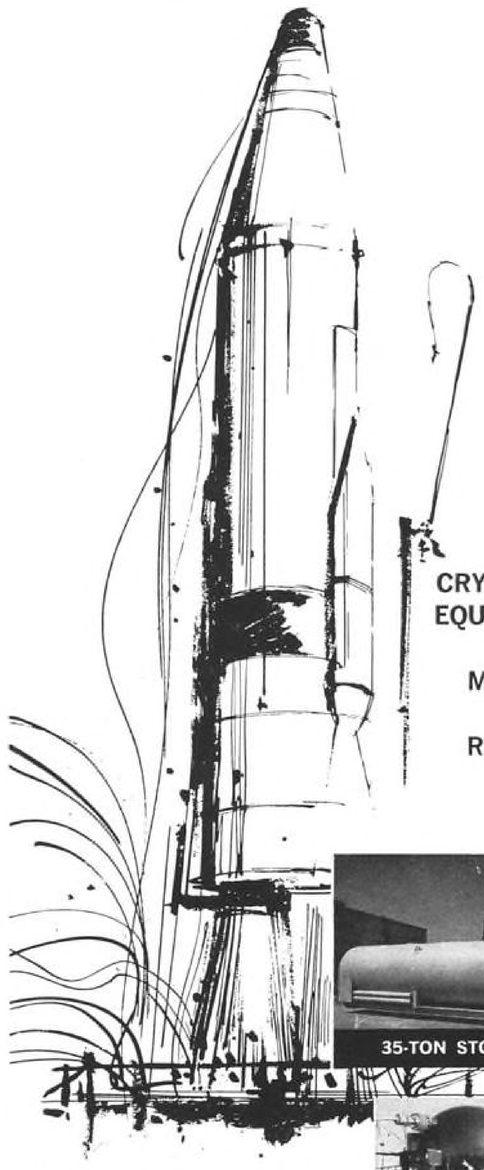
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Announcement



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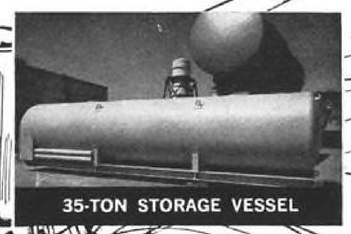
NRC-2 weighs 71.5% less by volume than perlite. Payloads are thus easily increased and important economies in overall dimensions can be effected because of the reduced annular insulation space required.

Through its high efficiency, NRC-2 cryogenic insulation can eliminate the need for a costly protective jacket of nitrogen. This factor alone could reflect considerable savings on operation and maintenance of storage equipment.

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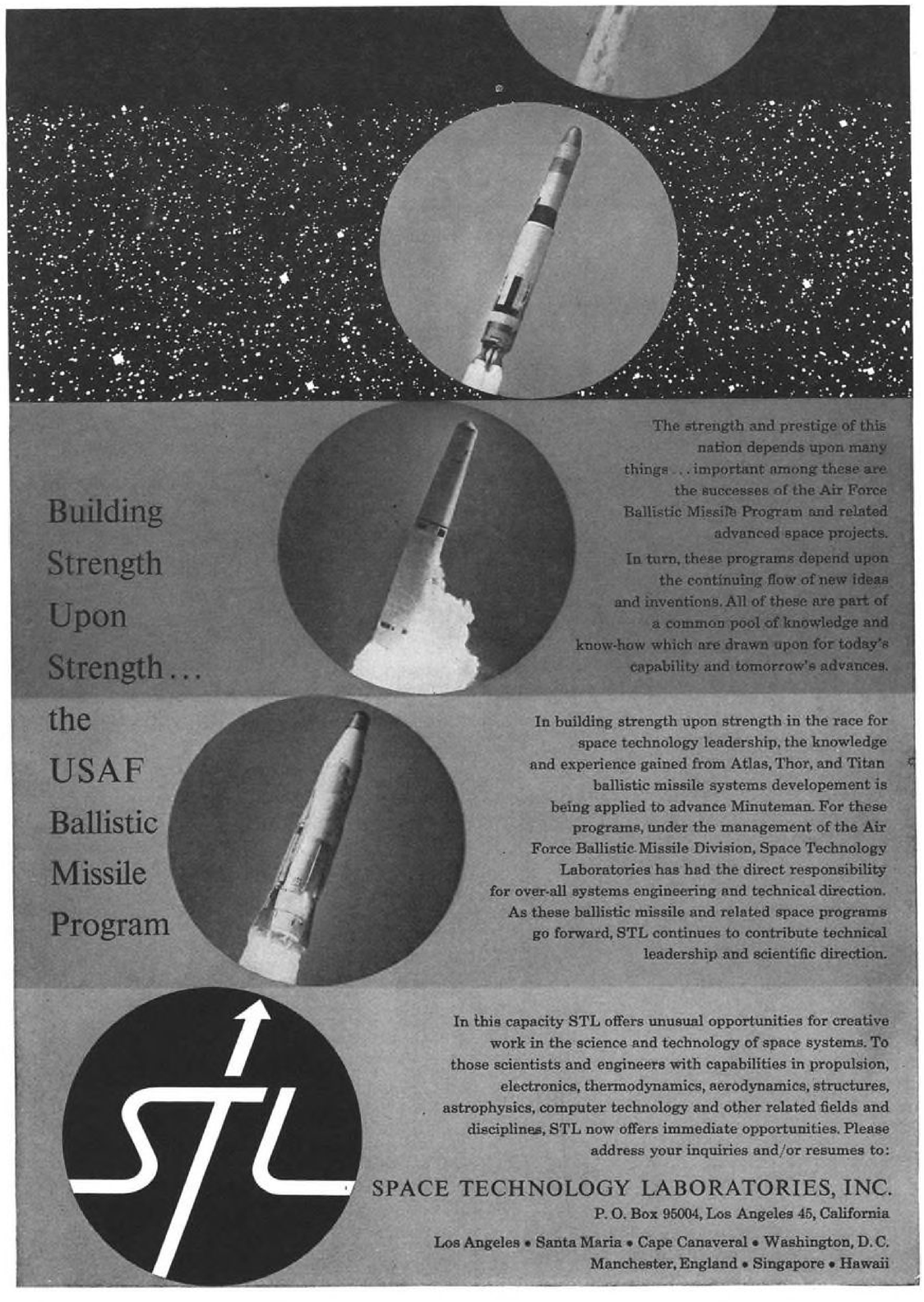
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COVER: Saturn S-1 booster mockup is shown mounted on the large Army Ballistic Missile Agency static test tower at Huntsville, Ala. Mockup was used during the extensive tower modifications required to fire eight engines simultaneously, record vehicle performance data on more than 800 instrumentation channels and withstand a thrust load of more than 1.5 million lb. All eight engines were fired for first time on Apr. 29 in an eight second static test. For Saturn design details, see p. 52.

PICTURE CREDITS

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EDITORIAL

An Excellent Report

The House Defense Appropriations Subcommittee has done an excellent job in acting on the problems posed by the Fiscal 1961 Defense Department budget. Rep. George Mahon (D.-Tex.), chairman of this subcommittee and a veteran of many years of distinguished congressional service on defense policy, and his committee members from both sides of the aisle deserve a heartfelt vote of thanks from the American people for the conscientious and courageous job they have done in this extremely critical year. The Fiscal 1961 defense budget is critical, not because there is an immediate defense crisis facing the nation today. It is critical because the Fiscal 1961 budget will determine our defense posture in the admittedly critical years of 1961-64.

The Appropriations Committee, in reporting out the bill as amended by Mr. Mahon's group, has made only a slight change in the total defense budget—adding $121.9 million in a total budget of $39.3 billion (see page 30). This action supports the contention of many critics of the Administration's defense program that major increases in defense appropriations are not the real answer to the defense problems facing the nation in the critical years ahead.

The Real Need

What is really required is a more selective concentration of the money available on the most modern and militarily significant weapon systems and a far better management of the military establishment tailored to clear-cut requirements of national strategy in a world of rapid technological change. In assaying this problem, Mr. Mahon's House group has done a particularly fine job. We predict their analysis of the defense problems facing us now and their recommended reallocation of funds toward the most significant weapon systems of the future will endure the crossfire of public debate and the acid test of history far better than the original budget submitted by the President last January. This committee, in a commendably bi-partisan spirit, has done a far better job than the original Administration budget planners in allocating the defense dollar where it will do the most good.

Few Americans, after studying the testimony of Gen. Thomas S. Power, head of Strategic Air Command, before Congress in recent months will quarrel with the Mahon subcommittee's conclusion that funds must be increased to provide for the long leadtime procurement of spares necessary to develop an airborne alert capability for a significant portion of SAC's B-52 bomber fleet and its supporting jet tanker environment. The committee's recommended increase of $115 million for this purpose, combined with the original Fiscal 1961 budget request of $85 million and $175 million obtained from reprograming earlier budgets and dipping into the war reserve mobilization fund, will provide logistic support for a SAC airborne alert capability of a size below the 25% force level recommended by Gen. Power. These funds do not provide for acquisition or training of any additional air or ground crews required for the accelerated operations of the airborne alert. It must be obvious to the committee that a mechanical capability unsupported by sufficient trained flight and maintenance crews offers little increase in real combat capability. It is puzzling as to why they stopped short of the full solution after such a promising start. One answer may lie in their renewal of the President's authority to incur a deficiency in Defense Department funds any time he deems it necessary to mobilize an airborne alert for SAC. However, with the 10-12 month leadtime required for training bomber and tanker crews and key electronic and engine maintenance personnel, this authority may count for little if a crisis comes upon us swiftly.

The committee's action in providing funds to accelerate development of the key military Midas and Samos reconnaissance satellite systems appears imminently sound. It is difficult to understand the technical footdragging at the top levels of the Pentagon that have combined with constant reorganizations to artificially retard these vital programs. These reconnaissance systems offer great promise to decrease our vulnerability to an enemy surprise attack with ballistic missiles. The technical state of the art in this area is far more advanced now than was the ICBM technology when national top priority was accorded to push the Atlas and Titan programs. If our avowed national policy to use space for peaceful purposes has any validity, these programs should be pushed as hard as possible. For, although they will be military-operated systems, they offer a major advance in our ability to prevent any aggressor from waging successful war.

Procurement Process

The Mahon subcommittee report also has some interesting, and we think valid, comments on the military procurement process and the system of budget ceiling control that has come to be the primary control method in operating the Defense Department fiscal machinery. There is little doubt but that this budget ceiling approach to formulating the defense budget offers little hope for providing truly effective defense budgets adequate to cope with the pace of modern technology.

A detailed study of the Mahon subcommittee observations and analysis of these points as contained in its report to the House will be rewarding to American citizens who have been puzzling over the many apparent inconsistencies arising from the fact that we are spending about $40 billion annually on national defense and are still not meeting the technical challenge of the future or that of our most vigorous competitors.

In fact, every serious student of the defense problem and every American who is interested in the future survival of his country and its political philosophy should read and study this report carefully. It is a major contribution to the national debate on the adequacy of our planning for defense in the critical period looming on the immediate horizon.

—Robert Hotz

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WHO'S WHERE

In the Front Office

Dr. Charles L. Critchfield, vice president-research, Telecomputing Corp., Los Angeles, Calif. Dr. Critchfield, formerly director of scientific research for the Convair Division of General Dynamics Corp., will continue as a member of Convair's board of scientific consultants.

The following executives of International Harvester Co. have been elected directors of Solar Aircraft Co., San Diego, Calif., a Harvester subsidiary: **Harry O. Bercher, William R. Odell, Harold B. Myers, David G. Moyer.**

James W. Clyne, manager of sales and service of Sikorsky Aircraft Division of United Aircraft Corp., a new position. Mr. Clyne, associated with Douglas Aircraft Co. since 1935, had served as director of the firm's international commercial sales since 1952, as president of Douglas Aircraft Co. (Japan), Ltd., since its establishment last year.

Webster H. Wilson, president, Hazeltine Corp., Little Neck, N. Y., succeeding **William A. MacDonald,** who continues as board chairman.

Douglas V. Dorman, corporate vice president of industrial relations, The Martin Co., Baltimore, Md.

Chandler C. Ross, manager of Aerojet-General Nucleonics, San Ramon, Calif., a subsidiary of Aerojet-General Corp. Mr. Ross is vice president-engineering of Aerojet-General.

Iden F. Richardson, a vice president, Hughes Aircraft Co., Culver City, Calif. Mr. Richardson continues as manager of the company's commercial products activities.

Jack Kuhner, vice president-general manager, Military Products Division, Hoffman Electronics Corp., Los Angeles, Calif.

Don R. Wilson, vice president-flight, Continental Airlines, Inc.

T. F. Huntington, a vice president, Trans World Airlines, Inc. Mr. Huntington continues as executive assistant to the president.

Raytheon Co., Waltham, Mass., has elected the following as vice presidents: **Stuart D. Cowan,** commercial marketing and international services; **John E. Gagnon,** industrial relations; **Robert L. McCormack,** general manager, Industrial Components Division; **Dr. Martin Schilling,** government programs and planning.

Honors and Elections

Melvin N. Gough, director of National Aeronautics and Space Administration operations at the Atlantic Missile Range, has received the Laura Taber Barbour Air Safety Award of the Flight Safety Foundation for his activities as chief test pilot and chief of the Flight Research Division at Langley Research Center from 1942 to 1958.

Warren D. Novak of GPL Division, General Precision, Inc., has been named national chairman of the Institute of Radio Engineers' Professional Group on Production Techniques.

(Continued on page 125)

INDUSTRY OBSERVER

► Chance Vought and Grumman are reportedly the two finalists in Navy's competition for an aircraft for use as a launching platform for its Eagle long-range air-to-air missile system. Final decision is expected within the next few weeks. Grumman is believed to have proposed a slightly modified version of its new Mach 0.9 A2F (see p. 94) and has quoted on a fixed-price basis.

► **Douglas Aircraft Co. has an Air Force study contract for VEWS (Very Early Warning System) involving space vehicle, tropospheric scatter links, tracking stations and a ground network.**

► Initial launch of a Project Courier delayed relay communications satellite (AW Apr. 27, 1959, p. 28), under development by Army for the Advanced Research Projects Agency is now scheduled for July.

► **Air Force is considering a 600-ft. rotating, directional antenna for possible use in an advanced, very-high-power microwave system. Almost circular antenna would stand on a pedestal some 300 ft. high. Its rotational machinery would control the antenna's position to within 0.02 in.**

► Air Force plans to use a fleet of 18 Douglas C-133B turboprop transports for airlift of Atlas and Titan ICBMs from factory to operational and test sites. C-133B, of which two already have been delivered, incorporates enlarged cargo doors that will accommodate either of the later model Atlas missiles minus vernier engines, or both stages of the two-stage Titan in a single load.

► **New competition for the GJQ-9 ground checkout system for Douglas' GAM-87A Skybolt air-launched ballistic missile and the North American Hound Dog penetration missile system has been narrowed to three contenders by Wright Air Development Division—Packard Bell, Bendix and International Telephone and Telegraph Corp. Former competition held by Douglas for a system for the Skybolt alone has been abandoned.**

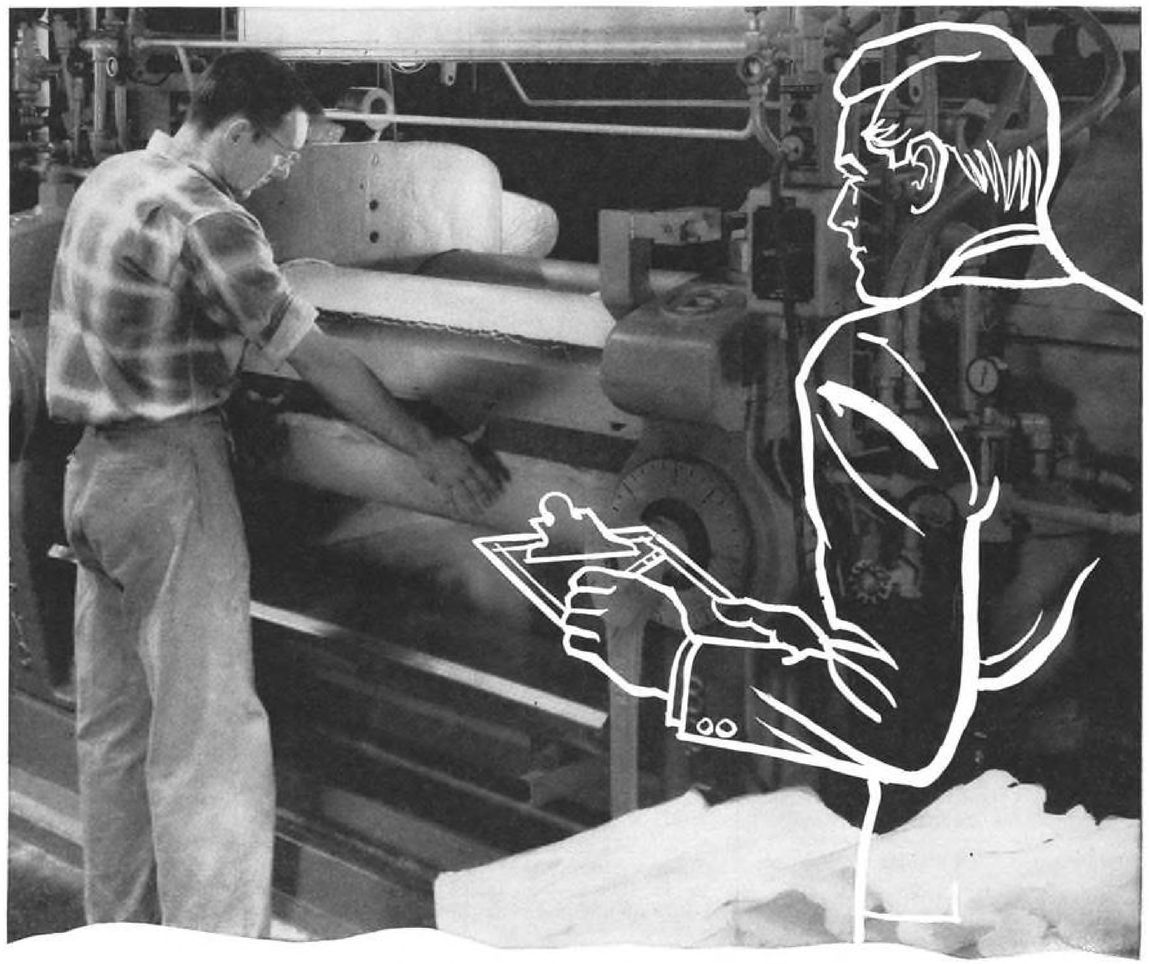
► Navy is increasing the combat radius of later-model Douglas A4D attack planes by substituting the 8,500-lb.-thrust Pratt & Whitney J52 turbojet for the Curtiss-Wright J65. New engine also permits additional attack capability from five externally-mounted combat stores.

► **Launch Pad 13 at Cape Canaveral, Fla., damaged in March by an explosion, is now being modified to handle the operational E-series of the USAF-Convair Atlas ICBM and is expected to be ready for service next month. Pad 11, damaged a month later by another Atlas explosion, also is scheduled to be ready in June. Pad 12, used for Atlas and Atlas-Agena launches, and Pad 14, reserved for Atlas and Project Mercury launchings, are both in operation.**

► Convair Atlas-D, scheduled to boost Mercury space pilots into orbit, now has a record of 21 successful firings out of 26 attempts since the trouble encountered early last year was overcome. An additional Atlas-D exploded on the launching pad at Vandenberg AFB, Calif., during a training exercise in which no launch was planned due to personnel error. Atlas has had only five failures in the last 28 launching attempts.

► **Air Force interest in ordering North American's A3J-1 Mach 2 attack bomber (AW Nov. 2, p. 23) is largely predicated on the feasibility of obtaining an aircraft capable of carrying larger loads than Navy's carrier-based version without seriously compromising high-speed-mission profiles. Two possible versions are now under study. Navy's A3J-1 is scheduled to begin initial carrier evaluation trials within the next two weeks and may become operational within the next year.**

► McDonnell F4H-1 Mach 2.4 fighter is expected to become operational with the Navy sometime this fall. Aircraft recently successfully completed its carrier trials except for what is described as a "minor and easily solved" arresting hook problem.



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Washington Roundup

Single Management For Rover

Watch for Harold B. Finger to be named manager of a joint NASA-AEC office to run Project Rover. Single management approach will replace the current system of coordinating separate NASA and AEC efforts in the nuclear rocket development program. Finger currently is NASA's nuclear propulsion chief.

NASA held a bidders' conference last week on a study contract to define the Rover flight test program. Study will evaluate the vehicles, support equipment and techniques involved. Conference was attended by 30 companies.

Air Force is seeking congressional support for a plan to pay Thompson Ramo Wooldridge $25-million compensation for facilities taken from Space Technology Laboratories as a nucleus for the proposed new USAF nonprofit organization. Rep. Carl Vinson reports that USAF Secretary Dudley Sharp told him the Air Force has the authority to make such a deal. Sharp estimated it would cost $40 million a year to operate the nonprofit corporation, a new group which is to take over the STL technical management function in missile and space programs.

General Accounting Office is investigating this proposal. Evaluation of the plan is expected to be included in the GAO report on USAF ballistic missile program management, which is to go to Congress shortly.

Tighter Procurement Policy

Congress is pressing the Pentagon to tighten procurement policies in the wake of a stream of General Accounting Office reports citing excessive military contract costs.

House cut $400 million from Fiscal 1961 military procurement budget last week to force the issue. Appropriations Committee cited "admitted waste," proposed the cut to compel "prompt remedial action." The group also said military contracting officers will be called to explain their actions in administering "certain suspect contracts."

House Armed Services Committee has launched an attack on incentive contracts used by Air Force and Navy in aircraft and missile procurement. House group, led by Rep. Carl Vinson, maintains this type of contract permits contractor windfalls. Key witness supporting committee position at hearings last week was Renegotiation Board Chairman Thomas Coggeshall.

Senate Small Business Committee spotlighted a GAO claim that Convair spent too much for B-58 air-conditioning carts. GAO says Convair-Ft. Worth spent $2.6 million unnecessarily by having special equipment designed and developed at Convair's San Diego plant instead of adapting existing equipment.

Borrowing 'Fees'

Sen. Harry F. Byrd, Finance Committee chairman, attacked the Defense Department last week for allowing "fees" to cover contractor borrowing costs. Fees are a loophole to get around the fact that interest on loans isn't an allowable contract cost. Practice was begun after Defense resorted to partial financing of contracts in late 1957 to defer cash outlays. Contractors had to borrow to finance their military work.

Look for a strong effort in the Senate to restore the B-70 to a full weapon system development program. House Appropriations Committee approved the Administration approach to building two prototype aircraft. Considerable support for an expanded program is expected from members of the Senate Armed Services and Appropriations Committees as well as from other individual senators.

Chief Air Marshal K. A. Vershinin, commander-in-chief of the Soviet air force, and nine of his top aides have accepted invitations to visit the U. S. this week, returning the 1956 visit to Russia by Gen. Nathan F. Twining, then USAF chief of staff, four years later.

Invitation was extended only two months ago when, according to a Defense Department spokesman, "it was deemed appropriate in view of the increasing exchange of visits by Russian and American officials." Vershinin group will witness Armed Forces Day air show at Andrews AFB near Washington on May 14 and 15.

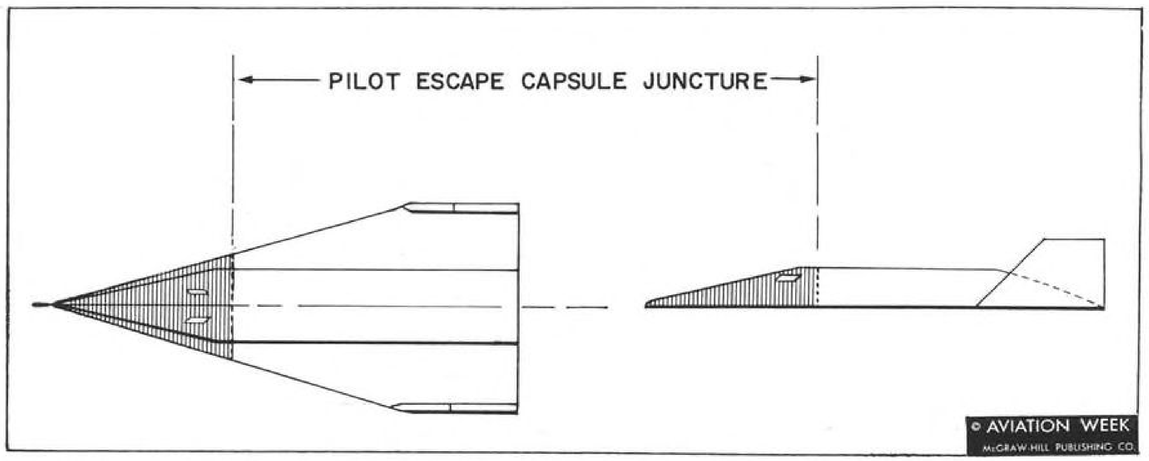
Soviet Missile Accuracy

Adm. Harry D. Felt, U. S. commander in the Pacific area, rates Soviet ballistic missiles as accurate as similar U. S. weapons. He told the House Military Appropriations Subcommittee that reports indicate the Russians met their goals in their recent Pacific tests and their accuracy "was as good as we get." Adm. Felt noted the Soviet missile is bigger than U. S. models and "their guidance system is probably simpler and very, very good."

Senate and House space committees are watching activities of NASA's new Office of Life Sciences closely. They want to make sure NASA keeps its promise not to duplicate existing military aerospace medical facilities.

House Committee on Science and Astronautics will hold hearings next week on supersonic transport development problems and status of related research. Committee will hear witnesses from NASA, FAA, CAB, Air Force, airlines and aircraft industry.

—Washington Staff



MANNED BOOST GLIDE configuration chosen for Dyna-Soar is similar to the winged, flat-bottomed shape shown above.

Dyna-Soar Flight Test Schedule Detailed

First air drop from B-52 planned for fall of 1963; initial manned glider launch slated for early 1965.

Washington — Development of the Dyna-Soar manned boost glider, the subject of Air Force and industry studies since 1954, is finally under way on a timetable that calls for:

- **First air drop of a Boeing** glider from beneath a Boeing B-52 near Edwards AFB, Calif., in the fall of 1963. Drop tests will include manned gliding flights.
- **First launching of an unmanned** glider by means of a modified Martin Titan-J missile booster from Pad 19 or Pad 20 at Cape Canaveral, Fla., in early 1964.
- **First launching of a manned** glider by missile in early 1965.

Next step in the Dyna-Soar program is to define precisely the subsystems of the glider and booster, prepare detailed design and performance specifications and hold competitions for subsystem contractors.

For the glider, this will be done by Boeing with the Dyna-Soar Weapon System Project Office supervising. Contracts are expected to be awarded in the early fall, but it has not yet been decided whether subsystem manufacturers will be associate contractors working directly under Air Force supervision or subcontractors to Boeing.

The subcontractor arrangement, favored by Boeing, now seems more likely, but USAF's strong determination to retain the systems manager role (AW Nov. 16, p. 26) may mean that the associate structure will be chosen.

Although competitions will be the rule in selection of subsystems makers, Air Force says that a sole source will be accepted if the glider contractor can justify this procedure. Justification will be very difficult, however, and a sole source will be the exception.

Present schedule calls for completion of a glider mockup by early 1961 and release of 90% of the drawings by the spring of 1962. The first unmanned air drop follows by some 18 months.

Decision to go ahead with Phase I of the program, which will carry development through the non-orbital flights, came after a special technical review under Phase Alpha (AW Mar. 28, p. 31). Phase Alpha was interjected into the program ahead of actual development for two main reasons:

- **To get from proponents** of a number of different ideas on re-entry their views as to the best way to handle this problem. In addition to the idea of a low-lift, capsule-type re-entry body, which was strongly supported by a number of companies, re-entry suggestions included folding wings, inflatable structures and use of a modified North American X-15 instead of an all-new vehicle. This review—to ensure that the best approach was being used—was ordered by the then Assistant Secretary for Research and Development Joseph V. Charyk.
- **To develop a fairly definite** plan for solving each of the expected problems—structural, materials, heating, etc.

Project Alpha produced a stack of reports 13 ft. high and concluded that the re-entry shape should be essentially the same glider configuration that was selected last fall.

The glider will weigh about 10,000 lb., have a wing loading of less than 30 psf., and a lift to drag ratio of between 1.5 and 2.5, depending on velocity. In general appearance it will resemble the glider proposed by Boeing's one-time competitor for Dyna-Soar, the Bell Aircraft Corp.

While there is no military requirement for a Dyna-Soar vehicle at the moment, USAF feels that this glider will meet the general military needs for a hypersonic vehicle as they are now conceived. Dyna-Soar is expected to either verify current thinking or point the way to more realistic definition of requirements for such a vehicle.

Structure probably will consist of an erosion shield on the outer surface; a layer of insulation, probably foam ceramic; coolant passages, and beneath that a truss structure resembling that used in old fabric-covered aircraft to bear the principal loads. Coolants probably will be circulated by a pump system, but a wick system that would allow water or some other coolant to boil off is still a possibility.

USAF believes that hypervelocity vehicles can be categorized as:

- **Ballistic shapes** with a lift-drag ratio of zero, including missile nose cones and NASA Mercury manned capsules.
- **Modified Mercury follow-on** capsules and nose cones with any type of asymmetrical geometry that will provide some lift.
- **Vehicles with a lift-drag ratio** of from 1.25 to 3.0. Both the Dyna-Soar glider and the Eggers high-lift, high-drag re-entry "boat" can fall in this category.

USAF believes that existing research vehicles are exploring the first two lift-drag regimes adequately and that Dyna-Soar will take care of the third. This lift-drag ratio also will give USAF the maneuverability it feels it must have in an orbital weapon system.

Under a letter of agreement signed last Nov. 15 by USAF Chief of Staff Gen. Thomas D. White and NASA Deputy Administrator Hugh L. Dryden, NASA is serving as technical adviser to Air Force, and the program is being run as a research aircraft project. It differs from programs such as the X-1, X-2 and X-15 in that a weapon system will evolve directly, instead of as a separate development drawing upon the X-aircraft technology, if the program is successful. Except for load capacity, the research vehicle will have needed operational performance characteristics.

USAF believes that use of the unmanned gliders will allow it to study a wide Mach number range on each flight, and to cover the entire flight spectrum in a few flights. This will avoid the more costly test program of progressing in slow velocity increments, an approach still favored by a number of NASA technical people. USAF thinks that the unmanned approach, with attempts to take large steps on each glider flight, is the only one it can afford. It has stressed to contractors that the number of test flights must be held to a minimum—11 or 12.

The Alpha review convinced USAF that it has the best approach to the glider's design within today's capabilities. Even if the new materials, etc., that are desirable were available today, it still might be done the way it is presently planned. Possibilities of the materials, structural approaches, etc., were projected, allowing for growth, but the studies increased confidence in the feasibility of the program.

Flight Tests

Flight tests will be supervised by a committee composed of Air Force Flight Test Center personnel with NASA Flight Research Center personnel and chaired by a USAF colonel. Data acquisition, reduction and dissemination will be supervised by a similar committee, chaired by an NASA man.

Gliders launched from the Air Force Missile Test Center's Cape Canaveral site will land on island stations along the Atlantic Missile Range. Facilities such as skid strips, runway barriers, landing control stations and aeromedical laboratories are expected to be installed at Grand Bahama Island, some 150 naut. mi. from the Cape; at Mayaguana Island, 544 naut. mi. downrange; at Mayaguez, Puerto Rico, 944 naut. mi. downrange; at St. Lucia, 1,400 naut. mi. downrange, and at Ascension Island, which is 4,400 naut. mi. from the Cape.

When and if Dyna-Soar proceeds to Phase II, which will call for orbital flights, they would be boosted from Cape Canaveral by an improved Titan or possibly an improved Atlas, and would land at Edwards AFB, Calif. If a weapon system follows, it will be boosted by the Saturn vehicle.

Major Reorganization Designed To Broaden WADD Capabilities

By Philip J. Klass

Dayton—Drastic reorganization of Wright Air Development Division designed to increase its capability for performing systems engineering and integration of complex weapon systems is now under way here.

Major feature of the reorganization is the division of the laboratories into two separate groups, one to conduct advanced state-of-the-art development, the other to provide system engineering support for Weapon System Project Offices (WSPO).

The reorganization is the most far-reaching in the history of the Air Force facility here. During the next several weeks, an estimated 3,700 persons, nearly half of the total complement at WADD, will be shifted to new buildings and offices.

New Plan

Under the new plan, WADD now consists of three major directorates plus four supporting groups:

- **Systems Management,** under Brig. Gen. Joseph R. Holzapple, will incorporate Weapon System Project Offices for aeronautical systems which formerly were part of the Air Research and Development Command headquarters' Systems Management Directorate (earlier known as Detachment 1).
- **Systems Engineering,** headed by Col. F. J. Ascani, is the new organization formed to provide technical support for the Systems Management Directorate.

New WADD Philosophy

Dayton—Wright Air Development Division plans to perform more of the systems engineering and integration functions which it previously delegated to industry under the original weapon system prime contractor concept, according ot Brig. Gen. Joseph R. Holzapple, WADD director of systems management. Gen. Holzapple told the recent National Aeronautical Electronics Conference:

"Our plan is to increase the active participation of the WSPO in the integration of the various system elements through an associate contract structure. The single prime contractor, such as we used in the B-58 program, F-108 program and some others, is probably going to be modified somewhat in the future, particularly now that reduced numbers of systems allow us to do more work inside the Air Force."

Personnel for this new directorate will come largely from engineers and scientists who formerly were members of one of the 12 laboratories which constituted the old directorate of laboratories of the Wright Air Development Center.

- **Advanced Systems Technology,** headed by Col. A. L. Wallace, will consist of four divisions, each containing four laboratories, which will devote their efforts to applied research and state-of-the-art development. Function is to advance technology for weapon systems limited to feasibility models.

The Directorate of Advanced Systems Technology is expected to be the largest of the three, with approximately 2,100 personnel, followed by the Directorate of Systems Engineering with about 1,800. Directorate of Systems Management is expected to employ about 700.

The Directorates of Systems Management and Systems Engineering have been established with parallel structures, reflecting the fact that the two will be complementary organizations. In most cases, it is expected that personnel from the two directorates working on the same project will share the same or adjacent offices. The Systems Management Directorate will have "Super-WSPOs" for the North American Mach 3 B-70 bomber, Dyna-Soar boost glide vehicle and the Skybolt GAM-87A air-launched ballistic missile projects. The balance of the project management groups for existing weapon systems will be placed in three major divisions: Offensive Systems, Defensive and Experimental Systems and Airborne Support Systems. The latter will include trainer aircraft, transports and helicopters.

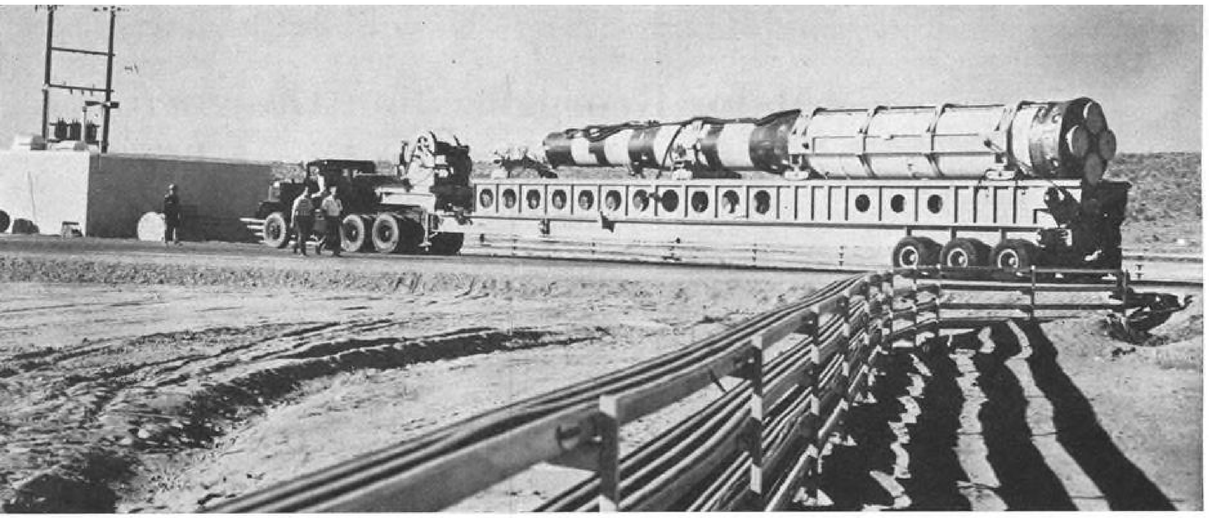
The Systems Engineering Directorate will have a similar organization, with project engineering offices for the B-70, Dyna-Soar and Skybolt, and engineering division offices for offensive systems, defensive and experimental systems and airborne support systems.

In addition, there will be five other divisions included in the Systems Engineering Directorate:

- **Ground Support Equipment.**
- **Operational Support Division.**
- **Systems Dynamic Analysis Division.**
- **Engineering Standards Division.**
- **Missile & Electronic Engineering** Support Division.

The Directorate of Advanced Systems Technology will consist of:

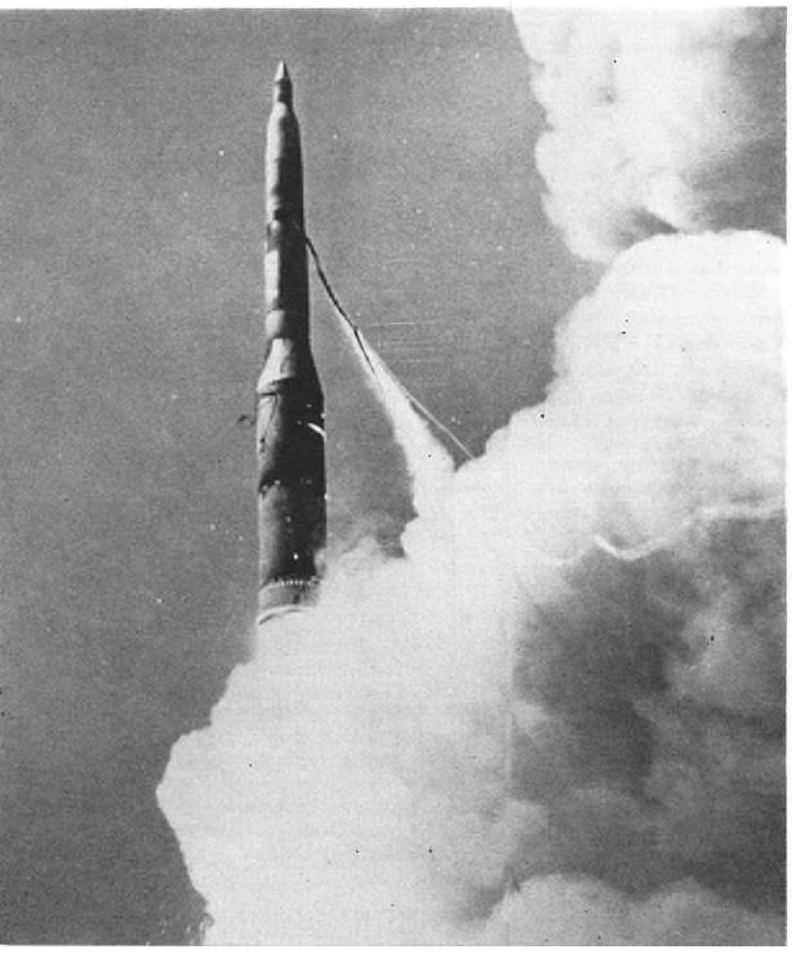
- **Avionics Division.**
- **Aeromechanics Division.**
- **Materials Central.**



MINUTEMAN TEST VEHICLE loaded on its transporter vehicle is on the way to Edwards AFB, Calif. for one of its seven successful silo test firings. Because of development program progress, in which basic configuration of the missile has been determined, launch of the eighth vehicle this month will conclude the test series, which originally called for 18 firings. Initial operation capability is scheduled for 1962. Contractors include Boeing Airplane Co. for assembly and test, Autonetics Division of North American Aviation for guidance, Thiokol Chemical Corp. first stage propulsion and Aerojet-General second and third stage propulsion.

Minuteman Ready for Rail Mobility Tests

NYLON TETHER restricts flight of full-scale Minuteman silo test vehicle.



Los Angeles, Calif.—Mobile Minuteman intercontinental ballistic missile concept will begin to undergo tests this month using existing railroad rolling stock owned by the Department of Defense and maintained by the Army's Transportation Corps.

Six different deployments of the test train, comprising approximately 14 cars including locomotive and caboose, are planned for this summer and fall, each deployment differing in the control procedures and tactics to be tested. Data will be collected concerning the effects of varied geographical conditions, such as desert area operation, in the mountains and through heavily congested railroad areas in all types of weather, day and night.

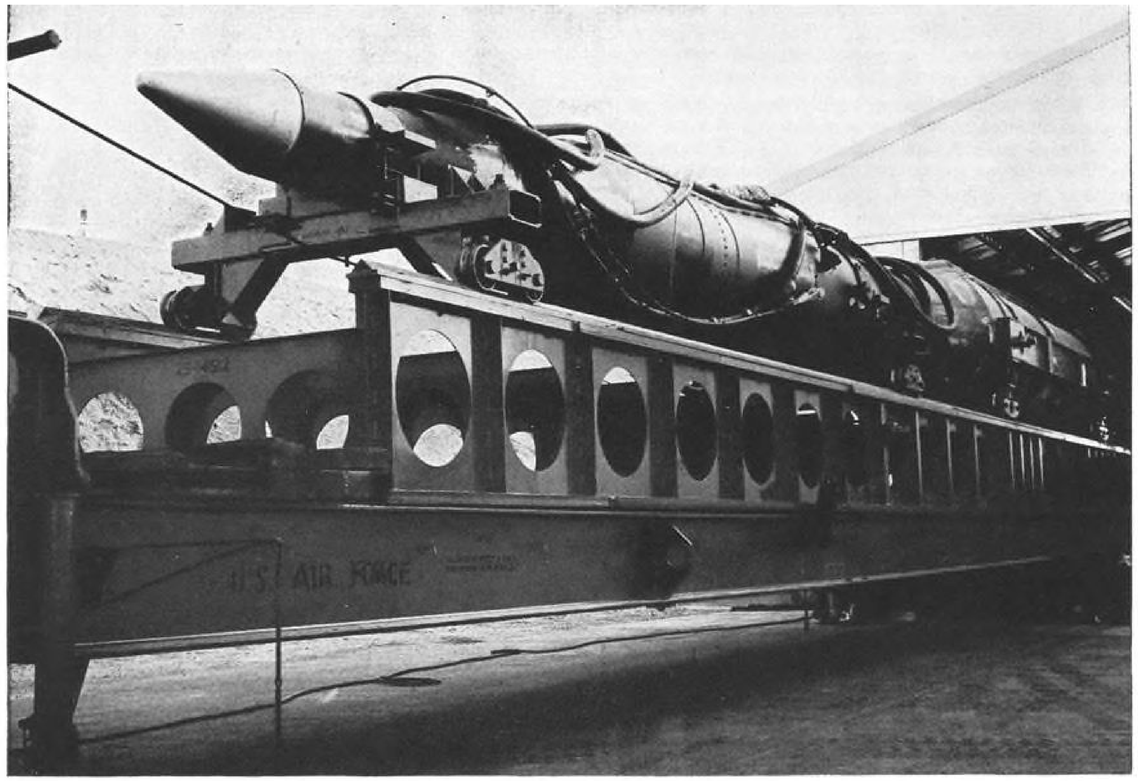
Initial three deployments will be operated in the West and Northwest sections of the country and the final three deployments in the Midwest area around Des Moines, Iowa. Each trip will last seven to 14 days, with several days interval between trips to permit analysis of the different tactics under study.

Tactics to be tried include random movement between sidings scheduled in advance of the trip and also timing movement of the train to specific sidings over the best available trackage under time limitations.

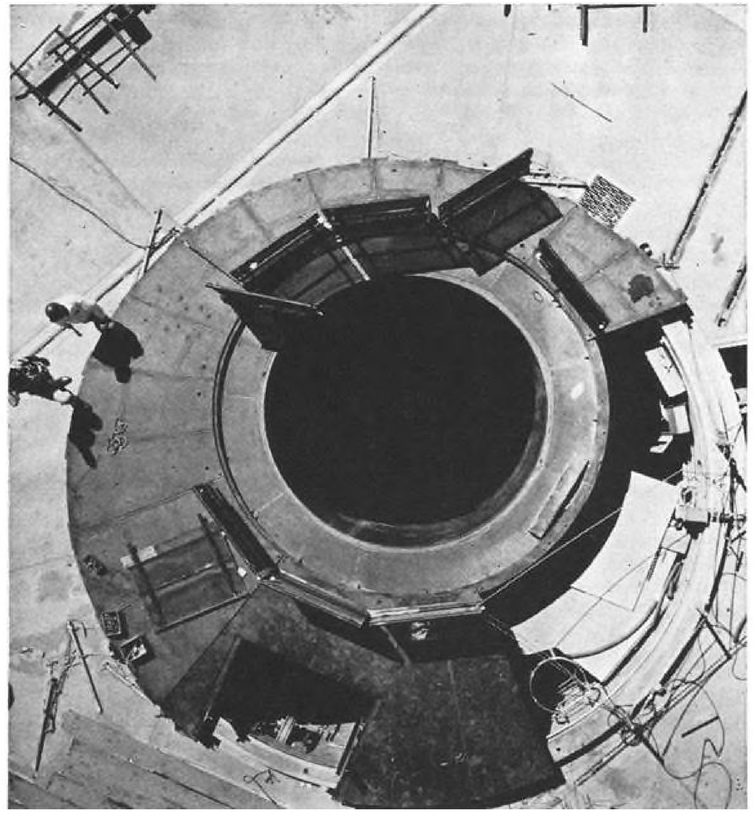
Strategic Air Command will function as test operator of the train, which is primarily to be an evaluation of command control and communications, not missiles. A SAC task force and control center was activated last week at Hill AFB, Ogden, Utah, to monitor the command's portions of the program and continuous control over the train during its travels. Task force is commanded by Col. Virgil M. Cloyd, Jr., who has been director of operations for SAC's First Missile Division, Vandenberg AFB, Calif.

Other agencies concerned with the Minuteman mobility study:

- **USAF Ballistic Missile Division** will serve as test director and will be responsible for technical and scientific activities connected with the program.
- **Air Materiel Command,** through the Ogden Air Materiel Area, will furnish logistical support for the train and its military crew and for additional personnel assigned to Ogden for the duration of the tests.
- **Boeing Airplane Co.,** associate contractor on the Minuteman, has responsibility for installing instrumentation and USAF-owned single-sideband and UHF radios in the command and control car. This radio gear, plus the communications systems of each of the participating railroads, will permit the train control center at Hill AFB and SAC headquarters, Omaha, Neb., to maintain continuous contact.
- **Assn. of American Railroads** and participating members will furnish locomotives, cabooses and railroad crews. Association representatives and individual railroad supervisors will be aboard for liasion. The association also will provide a dispatching supervisor on



IMPROVISED NOSE CONE (above) is used for ballast in silo tests. First missiles launched in this series had dummy upper stages approximating size and weight of Minuteman. Later vehicles carried flight weight upper stages with inert propellants. Avco Corp. is contractor for the re-entry vehicle. Minuteman test silo for firings at Edwards is shown below. Burning time of the solid propellant first stage is limited to a few seconds in these firings.



duty at the train control center to coordinate train movement requests and orders with the individual railroads.

Most of the cars on the test train will be used for sleeping and feeding the 21-man SAC train crew and military and civilian observers, with other cars handling control and communications functions, storing food supplies, drinking water, diesel fuel and providing minimum recreational facilities for off-duty personnel.

Test will assist in developing SAC capability to move over existing U.S. rail networks on a random basis, complicating the enemy's targeting problems. Train movement pattern will be completely unpredictable. It may move only a short distance and then spend a relatively long time parked on an existing siding or move long distances and spend short times at the sidings.

USAF is programing a number of Minuteman missile-carrying trains to operate in widely separated portions of the country. The amount of trackage used of the more than 100,000 mi. available in this country will depend upon the number of trains operated and the area of operation of each train. The number of missiles on each train, when the system becomes operational, will vary from one to several.

Sabotage potential in such an operation has undergone a complete study and SAC feels that this is a minimum problem, although security measures will be applied during the test as well as actual operation.

House Group Revises Defense Budget

By Ford Eastman

Washington—House Defense Appropriations Subcommittee has boosted the Administration's amended Fiscal 1961 defense budget by $121.9 million and made sharp revisions in defense programs in an effort to update needs and meet the challenge of modern military strategy.

The bill calls for a total of $39.337 billion for defense and boosts Administration requests in the fields of research and development, aircraft, missiles, military satellite programs and ships and submarines. It also increases funds to provide a greater airborne alert capability for the Strategic Air Command.

The Administration originally submitted a defense budget of $39.335 billion. It was subsequently reduced to $39.215 billion as a result of revisions suggested by the Air Force and Secretary of Defense during the hearings (AW Apr. 4, p. 29).

Proposed Increases

The Air Force proposed increases for space projects, missile warning systems and ballistic missiles that would be more than offset by a decrease in air defense spending. The Defense Secretary recommended a cut in the Navy's attack submarine program and increase in the Polaris fleet ballistic missile submarine program. The subcommittee approved the Air Force revisions but rejected the cutback in attack submarines.

Total additions made to the Defense budget by the subcommittee amounted to $1,529.7 million while reductions in other programs totaled $1,407.8 million.

Increased funds, in addition to those proposed by the Air Force and already accepted, include:

• **Airborne alert**—to provide for a greater capability for the Strategic Air Command to institute an airborne alert "if and when necessary," an increase of $115 million.

• **Air defense**—to provide the Air Force with 50 more Convair F-106 interceptor aircraft as replacements for Boeing Bomarc B interceptor missiles, which would be cut back under the Air Force proposal, $215 million increase.

• **Minuteman solid propellant ICBM**—to speed development of a mobile capability for the Air Force Minuteman missile, $20.7 million.

• **Military space projects**—to speed work on the "urgently needed" Midas ballistic missile early warning satellite, the Samos reconnaissance satellite and the Discoverer, $54 million.

• **Airlift modernization**—to provide for the procurement of "urgently needed" modern aircraft to increase the airlift capability of the Military Air Transport Service. $250 million increase split between the Lockheed C-130B and Boeing C-135 (see p. 37).

• **Polaris submarine system**—to provide for expediting the Navy's Polaris program by fully funding five submarines, with supporting missiles and equipment, and partially funding seven more rather than fully financing three and partially financing nine as proposed by the Defense Department, $241 million. This will complete funding for 14 submarines and partially fund seven more for a total of 21.

• **Anti-submarine warfare**—to provide for a "more aggressive" ASW program by financing three nuclear attack submarines for the Navy at a cost of $171 million, one more than the original budget request, and retaining the two proposed for elimination by Defense Department adjustments to the budget, and to provide for two destroyer escort vessels and financing further high-priority research efforts, $321 million.

• **Army modernization**—to provide additional high priority equipment for Army modernization, $207.6 million.

Reductions recommended by the Defense subcommittee are as follows:

• **USAF Bomarc interceptor missile**—to eliminate financing for the Bomarc B missile except for $50 million to continue development testing if found necessary. Involved is a reduction of $40.4 million in funds requested for Fiscal 1961 and $253.6 million in Fiscal 1960 and prior year funds for a total of $294 million.

• **Navy aircraft carrier request**—to eliminate financing for an additional conventionally-powered aircraft carrier, $293 million.

• **Travel**—a 10% reduction supported by a limitation to curtail "abuses" in travel by all the services, $73.1 million.

• **Communications**—to compel consolidation and better management of communications facilities within the Defense Department, $84.3 million.

• **Departmental administration** — to bring under control the headquarters military and civilian "bureaucracy" in the Defense Department, $33.6 million.

• **Operation and maintenance**—for various service-wide economy adjustments in addition to travel and departmental administration, $85.8 million.

• **Army procurement**—funds not needed because of slippage in jeep vehicle deliveries and anticipated recoupments from off-shelf sales, $128 million.

• **Procurement generally**—to reflect a reduction and force more economical procurement practices in the Defense Department, $400.5 million.

• **Transfers of surplus stock** fund cash, $15.5 million.

In reporting out changes in the Defense budget, Rep. George H. Mahon (D.-Tex.), subcommittee chairman, said:

"It is firmly believed that the overall effect of these actions will substantially strengthen our defense posture over the next few years as they become fully effective.

"The additions made will unquestionably add greatly to our defense. The reductions were made to effect economies wherever possible. In considering these reductions, a majority of the committee felt that they would have no endangering effect on our over-all defense capability."

The capability to maintain an airborne alert within the Strategic Air Command will be a "very important element" of the retaliatory force, the committee said. The additional $115 million, together with the $85 million recommended in the President's budget, will make $200 million available in Fiscal 1961 "for application toward attaining a capability of initiating and sustaining an airborne alert, if and when necessary, at very near the proportion of our strategic bomber forces considered most reasonable by the Department of the Air Force."

In addition to these funds, $100 million has been made available through reprograming actions in Fiscal 1960 to begin preparations for an airborne alert. An additional diversion of about $75 million of war reserve mobilization material also was proposed for the air alert program. The additional funds are recommended exclusively for the procurement, storage and distribution of extra engines, spare-part stocks and supplies necessary to sustain the accelerated rate of aircraft operation if it should become necessary, the committee said.

In an earlier re-evaluation of the air defense problem, the committee said the Air Force proposed to reduce previously planned requirements for the Bomarc B in Fiscal 1961 from $421.5 million to $40.4 million, a cut of $381.1 million. After due consideration, the report said, a majority of the committee decided it was advisable to reduce the Bomarc program even further by eliminating all funds not firmly committed for the Bomarc B missile and leaving only sufficient funds to continue a limited development program. As a result, the committee cut another $294 million, including previously appropriated funds, making a total reduction from the original 1961 budget requests and prior years of $675.1 million.

Although the committee recommended that the $75 million requested for continued development of a nuclear powered aircraft, it urged the Joint Committee on Atomic Energy to reexamine the program fully.

Since the U.S. has been a leader in the development and use of nuclear propulsion for ships, the report said it would be "most unfortunate" if another nation gained supremacy in nuclear propulsion for aircraft, particularly "in view of our efforts to date."

The report also said that many of the problems in defense program management, which have taken on major significance in the past year or two, stem from the policy of controlling military programs by a fixed expenditure ceiling applied inflexibly, regardless of other considerations.

Polaris Communications

Underwater communications to enable Polaris submarines and other submersibles to contact aircraft and one another while they are submerged are being explored with Navy backing at Crosley Division of Avco, General Electric, International Telephone and Telegraph Corp. Laboratories, Raytheon and Sylvania.

Work on one method, Secure Submarine Communications (SESCO), developed by the Naval Electronics Laboratory is well along at the Naval Research Laboratory and Navy Underwater Sound Laboratory. SESCO is a method of voice modulating sonar for communications and reportedly is an outgrowth of Navy's older Gertrude system, whereby submarines in close proximity were able to maintain telephone contact.

Raytheon is manufacturing one SESCO system for the Bureau of Ships under a $1,692,000 contract. Crosley and General Electric are probing newer, long-range submarine communications.

U-2 Missing; Soviets Say U. S. Plane Down

Washington—Soviet Union shot down a U. S. aircraft over Russian territory on May 1, Premier Nikita Khrushchev told a stormy Supreme Soviet session last week. The plane apparently was an unarmed National Aeronautics and Space Administration Lockheed U-2 weather research plane whose civilian pilot had experienced trouble with his oxygen equipment at 55,000 ft. in a flight near the eastern border of Turkey.

The U-2 was one of four operated from Incirlik Air Base at Adana, Turkey, by Lockheed under contract to NASA. It took off at 8 a.m. Adana time May 1. Flight plan called for the first check point to be at 37 deg. 25 min. North, 41 deg. 23 min. East, and for a left turn to be made to the Lake Van beacon; thence to the Trabazon beacon, thence to Antalya and return to Adana. Scheduled time was 3 hr. 45 min. and total distance was 1,400 naut. mi.

The pilot called on emergency radio frequency at about 9 a.m. Adana time saying he had oxygen trouble and would head for the Lake Van beacon to get his bearings and return to Adana. He was then between 50,000 and 55,000 ft. altitude.

His last report indicated he was attempting to receive the Lake Van beacon. He presumably was on a northeasterly course at the time. If the pilot had lost consciousness and the plane was on automatic pilot, it might have continued on a northeasterly course, NASA said.

Air search began soon after the last message was received and continued through last Thursday over the rugged mountains of eastern Turkey.

Khrushchev, in a belligerent, emotional speech, said his government had ordered its military men to shoot down a U. S. aircraft on May 1 because "the aggressor knows what he is doing when he invades somebody else's territory, and, if he remains unpunished, he will launch new provocations." He said he would ask the United Nations' Security Council to consider the matter.

A U. S. plane escaped after invading Soviet territory on Apr. 9, Khrushchev said, and "American military men evidently like the impunity they enjoyed . . . and decided to repeat their aggressive act." State Department said it had "absolutely no knowledge" on the alleged Apr. 9 flight. President Eisenhower ordered an inquiry and public report into the Soviet claim and the missing U-2.

Khrushchev said the aircraft that was shot down did not carry "the usual markings" and said "it appeared that the plane was American, although the identification marks were painted out."

The NASA U-2 painted with a dark blue anti-corrosion paint, carried a 20-in. circular NASA symbol on the tail and a horizontal yellow tail stripe 12 in. high, with the letters "NASA" across the stripe. It carried no wing or fuselage markings. NASA said there apparently was no attempt to lure the U-2 across the Soviet border by radio signals and no scramble of Soviet fighters was detected.

The aircraft's mission was a clear air turbulence study, NASA said. It carried an angular velocity recorder, modified VGH recorder to measure head-on gust components; continuous recorder for airspeed, pressure altitude and normal acceleration; airspeed and altitude transducer to measure pressure altitude and indicated airspeed; AN/AMQ-7 temperature and humidity measuring set; vortex thermometer and USAF Air Weather Service cloud cover cameras. NASA said these cameras were not for reconnaissance and the plane was not carrying radiological detection gear.

U-2 was designed in 1954 with a sailplane-type wing and specially designed Pratt & Whitney J57 engine for sustained high altitude flight. It has a ceiling over 60,000 ft. Lockheed began operating 10 U-2s for NASA under contract in 1956. One exploded over Germany that year and another crashed in the U.S. in 1958. NASA now has one at Edwards AFB, Calif., three at Atsugi, Japan, and three left at Adana. At other times, they have operated from Alaska, New York, England, Germany, Pakistan, Okinawa and the Philippines.

Lockheed also has operated some in its research work and USAF's Strategic Air Command and Air Research and Development Command have used them in the U.S. ARDC has used one in Hawaii in the Discoverer satellite program. USAF trains its U-2 pilots in Texas. NASA late last week had not stopped its U-2 flights.

Pioneer V Provides New Scientific Data

By Craig Lewis

Washington—Pioneer V is continuing to telemeter data from space as early studies of its broadcasts provide new scientific insight into the magnetic and radiation patterns between the earth and Venus orbits.

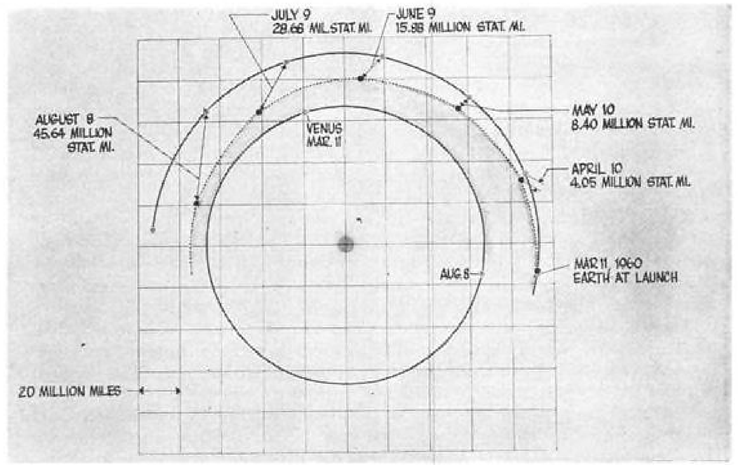
Coupled with data from Explorer satellites and measurements made on earth and from balloons, Pioneer V data is providing comparisons of radiation effects near the earth and in space during quiet days and during periods of intense solar activity. Magnetometer data shows evidence of a steady magnetic field in space and a large, annular ring current flowing westward around the earth at a distance of about 10 earth radii.

Acoustic impact detector carried by Pioneer V to measure collisions with micrometeorites has shown wide variations in impact patterns. Discussing early results, from Pioneer V, Maurice Dubin, head of the Aeronomy Section in the National Aeronautics and Space Administration's Office of Space Flight Programs, said that the validity of the data from this experiment is in serious question because of the probability that the equipment has not worked properly.

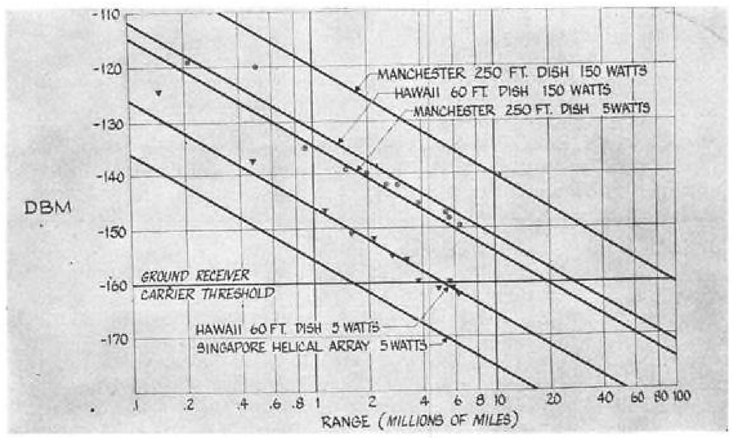
Pioneer V will pass the 9-million-mi. mark late this week as it moves away from earth along an orbital path that lies between the earth and Venus orbits. Adolph K. Thiel, Space Technology Laboratories' director of experimental space projects, reports that telemetered data on payload performance indicates temperatures and other conditions are within acceptable limits.

Ground stations have taped more than 100 hr. of information from the probe. As it has moved away from earth, signals from its five watt transmitter have become weaker. Although the receiving station at Hawaii will have command capability on the five watt unit out to 20-25 million mi., signals received in response already are too weak to be usable.

The 250 ft. Jodrell Bank radiotelescope at Manchester, England, is still able to receive data, but it will have to command a conversion to the 150 watt transmitter within a week or so when the probe is approximately 10 million mi. from earth. This also will bring the Hawaiian station back into the receiving schedule. This transmitter is expected to be still transmitting usable data over a 46 million mi. distance when the probe passes close to the Venus orbit on Aug. 10.



PIONEER V is following a trajectory that will carry it close to Venus' orbit in August.



SIGNAL STRENGTH is indicated as a function of distance from Pioneer V transmitters.

Hydromagnetic Ring Current

Data from the search coil magnetometer in Pioneer V provides the first observation of the hydromagnetic ring current long described in theory by geophysicists. It confirms deductions made from Explorer VI data. This ring current is centered at about 10 earth radii and covers the area from about 7 to 13 earth radii—outside the two Van Allen radiation belts. Total current flowing westward in this annular ring is estimated at 5 million amperes.

Magnetometer data also indicates that, at least at times, the earth's magnetic field extends out as far as 14 earth radii. This is considerably farther than the six-eight earth radii generally assumed for the field.

In interplanetary space, Pioneer V has produced evidence of a steady field that makes a large angle with the plane of the earth's orbit. Disturbances in this quiet-day pattern are being correlated with cosmic ray experiments, particularly those conducted during solar storms, to determine their relationship.

Dr. Charles P. Sonett, director of the Space Physics Section in STL's Research and Development Division, said the evidence "is strong enough to question whether magnetic storms on the earth, the classical type of magnetic storm, occurs in exactly the manner that theory has indicated for years."

Solar Flare Study

Series of solar flares that began late in March has permitted comparison of effects in space with those near the earth. According to Dr. John A. Simpson of the University of Chicago, a large flare apparently launched a burst of plasma toward the earth on Mar. 30 which reached Pioneer V and the earth early the following day. This produced a typical magnetic storm. The University of Chicago instrument package in the probe, which measures protons with energies higher than 75 mev and electrons with energies higher than 13 mev, recorded a sharp decrease in galactic cosmic ray intensity, known as the Forbush decrease.

DATE	DISTANCE FROM EARTH (MILLION MILES)	DISTANCE FROM SUN (MILLION MILES)	DISTANCE IN ORBIT (MILLION MILES)	COMMUNICATION TRANSIT TIME
APR. 6	3.5	91.0	44	37.6 SEC.
APR. 28	6.5	88.5	81	1 MIN. 10.0 SEC.
MAY 2	7.1	88.0	88	1 MIN. 16.4 SEC.
MAY 16	9.4	85.8	117	1 MIN. 41.0 SEC.
JUNE 25	21.8	79.1	179	3 MIN. 54.2 SEC.
JULY 25	37.7	75.2	239	6 MIN. 47.0 SEC.
AUG. 10	46.0	74.9	258	8 MIN. 15.0 SEC.
SEP. 13	65.8	79.0	316	11 MIN. 48.0 SEC.
OCT. 23	81.2	85.7	383	14 MIN. 34.0 SEC.
DEC. 2	86.5	87.7	451	15 MIN. 30.0 SEC.

TRANSIT time of broadcasts from Pioneer V increases as the probe moves away from earth.

Comparisons Cited

Comparison of Explorer VI and Pioneer V results with measurements taken on earth proved that this decrease does not depend upon the existence of the earth's electromagnetic system, according to Dr. Simpson. He said this data ". . . tells us directly that we are here dealing with a plasma ejection from the sun. It provides us with some of the strongest experimental evidence we have to date for the existence of this type of mechanism."

Another large solar flare occurred on Apr. 1, and solar protons arrived in the vicinity of Pioneer V and the earth about 20 min. later. At the same time, there was evidence that electrons also arrived, providing the first evidence that electrons from the sun travel to earth fairly quickly. Simpson said this electron emission indicates that the sun accelerates electrons "because we see the direct effect of the accelerated electrons."

Radiation Measured

Ionization chamber and Geiger-Muller tube designed for Pioneer V by the University of Minnesota School of Physics, like the Chicago experiment, was similar to equipment carried in Explorer VI. Minnesota experiment is sensitive to lower energies than the Chicago equipment. Early in the flight, the Minnesota instruments measured radiation in the Van Allen belts, then intensity dropped off substantially to the level of galactic cosmic radiation in space. This level continued fairly steady until the period of solar activity.

Solar-produced particles were recorded in a pattern which correlated with solar cosmic ray measurements made at the same time from balloons. A fourth type of radiation was detected which was identified as X-rays produced by electrons bombarding the payload.

Dr. John Winckler of the University of Minnesota pointed out that radiation present in space during periods of high solar activity might produce a biological hazard. He said the intensity inferred is in the range of five to 50 roentgens per hour, an estimate based on an intense solar event studied last July.

Radiation Count

Comparing Pioneer V experience with data from Explorer VII, Dr. Brian O'Brien of the State University of Iowa, said a fairly lightly-shielded Geiger counter in the satellite was counting at the rate of about 200 counts per second in the outer Van Allen belt during the two weeks preceding Mar. 31. During the magnetic storm that day, the counting rate dropped to 10 per sec. and stayed low for several hours. Then, the rate built up to 10,000 per sec. over the following week before it began to decay.

A similar counter with a slightly lower energy sensitivity in Pioneer V recorded some small fluctuations of similar electrons in space, and Dr. O'Brien conjectured that Pioneer V detected the incoming plasma cloud, but with very low efficiency. He suggested that, when part of this plasma entered the earth's magnetic field, the field was disrupted and dumped trapped radiation, lowering the counting rate. Then, it is assumed that the sharp increase in the counting rate was produced by some process of acceleration of the trapped particles from the plasma within the Van Allen belt which increased their energy enough to make them detectable.

Outer Radiation Belt

This conjecture leads to the conclusion that the earth's outer radiation belt is not produced by injection of particles from the sun itself, but by some local process of acceleration after the material is trapped in the magnetic field.

Explorer VII measured solar proton counting rates as much as 30 times the normal cosmic ray rate in the highest lattitudes covered by the satellite on Apr. 1 when these protons were being measured by Pioneer V. Explorer VII also detected the Forbush decrease in galactic cosmic rays recorded by Pioneer on Mar. 31. These cosmic rays can be measured only when the trapped radiation is at a very low level, as it was at that time.

Fairchild-Umbaugh U-18 Nears Flight

New York—First of five prototype U-18 autogyros Fairchild Engine & Airplane Corp. is manufacturing for Umbaugh Aircraft Corp. may make its first flight this week.

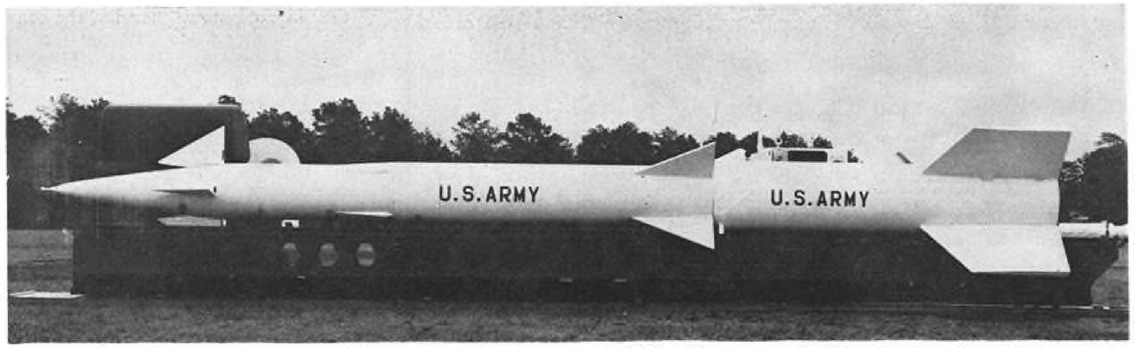
The remaining four prototypes are expected to be completed 1-1½ months thereafter, assuming no major changes are incorporated in them. The five prototypes will be used for certification and testing.

Production tooling will be about 80% complete when the first prototype is rolled out. Fairchild has received about $300,000 from Umbaugh for work performed to date on the prototype autogyros and production tooling, according to Willard L. Landers, Fairchild vice president-operations. The prototypes and production tooling were subcontracted to Fairchild by Umbaugh under an agreement signed in December. A contract was signed in August (AW Aug. 24, p. 133) by both Umbaugh and Fairchild for production of 10,000 U-18s.

Initiation of production depends on how the certification program turns out, Landers said.

Umbaugh is responsible for financing the U-18, and for the design, performance, engineering and sales of the autogyro, which Umbaugh says it will sell for $9,995. Fairchild is responsible solely for manufacturing. Umbaugh provides propellers, rotor blades, the 185-hp. Lycoming powerplant, battery, wheels, tires, brakes and some instruments.

Umbaugh has an earlier prototype which has not been certificated. This prototype takes off in about 75 ft., Landers said, but specifications for the U-18s Fairchild has subcontracted to build call for practically no takeoff roll.



NIKE ZEUS mockup shows two sets of small fins which replace former near full length, upper staging fins. Configuration is believed to be the final one for the Army anti-missile missile. Zeus may be operational in two years, rather than six years as estimated earlier.

Army Changes Nike Zeus Configuration

By Michael Yaffee

Ft. Benning, Ga.—Army's Nike Zeus anti-missile missile has shed the exaggerated forward fins that gave it an arrowhead shape and replaced them with two sets of smaller fins, one a canard set, the other at the back of the sustainer motor.

This new configuration is believed to be the final one for the Zeus. Defense Department still has not given the go-ahead on production of the missile, which recently completed successful propulsion and airframe tests at White Sands, N. M., missile range.

At the same time, Army and industry are conducting preproduction planning programs on the Zeus so that production of tactical systems can begin as soon as authorized. High-ranking Pentagon officers and aviation industry officials (other than Zeus contractors), AVIATION WEEK has learned, now believe the Nike Zeus could be operational in two years, not five to six years as estimated earlier.

Wooden mockup of the Zeus in its new configuration was publicly displayed here along with other new Army weapons—some still in the development stage—during Army's three day Project MAN (Modern Army Needs) conference which was attended by more than 600 top industry and military leaders, congressmen and representatives of the press. President Eisenhower, Secretary of Defense Thomas Gates, Jr., and Secretary of the Army Wilber Brucker were present.



DAVY CROCKETT close-range nuclear weapon can be jeep-mounted or man-carried.

Project MAN, in static displays and live firings and assaults, demonstrated Army's latest capabilities in firepower, mobility and communication. The "needs," shown more by implication than by exposition, are for greater capabilities in these three areas than Army now has.

Two needs about which Army talked little or not at all during the conference were nuclear protection and target acquisition. Both these areas are critical, a high Army officer told AVIATION WEEK, particularly the ability to keep the lethal neutrons from a nuclear warhead from penetrating weapons such as tanks and personnel carriers.

Economy Stressed

Another important need—that for economy in weapon system development and procurement—was stressed by Brucker. He called upon industry to display greater initiative in drawing upon its own resources for the development of new ideas in weaponry and equipment. The Army does not have the money to procure everything that might be "nice to have," he said. Industry must not allow the desire for profits to assume greater influence in its plans and activities than the desire to serve the nation faithfully and well, the secretary added.

On the other side of the ledger, one Pentagon officer pointed out, the United States may be overplaying its work on the development of counter-countermeasures for nuclear-tipped ballistic missiles—that is, on the development of arming, safing and fuzing mechanisms that cannot be prematurely tripped by the enemy. This is a problem the enemy should be most worried about.

High points of the displays here, besides the Zeus, were the Pershing missile and the Davy Crockett weapon system. For the first time, the Army put its new Pershing transporter-erector-launcher, manufactured by Thompson Ramo Wooldridge Corp., on public display. Still new enough to be manned by contractor personnel (most of the weapons were handled by soldiers), the Pershing transporter is a small tracked vehicle.

For erection of the Pershing, a small circular base plate is first placed on the ground. Three stabilizing jacks on the small missile launching stand are lowered and set into the plate, and the missile is raised to 5 deg. of the vertical. At this point, a small motor takes over and elevates the missile to the vertical slowly to prevent oscillations. The three jacks automatically level the small launcher base for the Pershing.

An electric interlock system prevents the missile from being erected until the base is perfectly level. The entire operation is less complex than that for the Army's new Sergeant missile and there was some speculation here that the Pershing will eventually replace the Sergeant, which now has the advantage of being ready for use while the Pershing is still in development.

While the Army is pleased with the Pershing, Lt. Gen. Arthur Trudeau, chief of Army Research and Development, pointed out that Army has no weapon to cover ranges beyond that of the Pershing (estimated range is 20 to 450 mi.). The Russians, he said, have an entire family of weapons. The Army would prefer the same thing, and toward this end, it is pushing its A, B and C weapon concept for a family of missiles which will have complementary ranges.

Davy Crockett low yield nuclear weapon system for use at close range was shown without its warhead, in a light, man-portable and heavy jeep-mounted version. Developed by Army Ordnance Corps, the Davy Crockett can fire conventional as well as nuclear warheads. It now is under test at Aberdeen Proving Ground. The shoulder-fired Redeye anti-aircraft missile was also displayed. Manufactured by Convair Division of General Dynamics the missile is about 4 ft. long, approximately 3 in. in diameter and weighs about 20 lb. Launcher tube for the Redeye also serves as its shipping container.

Two other missiles, the wire-controlled Nord SS-10 and SS-11 anti-tank missiles were shown in live firings. The SS-10 is a two-stage solid propellant missile with a range of 480 to 1,700 yd. It carries a 105 mm. warhead and is fired in a cluster of three from the back of a one-quarter-ton truck (a modified jeep). It has been accepted by U.S. Army.

The somewhat larger SS-11 is still under test. It has an effective range of from 530 to 3,700 yd. In the demonstration here it was fired from a Bell HU-1A helicopter on the ground, hovering and in flight. Both the SS-10 and SS-11 (in all three firings) scored direct hits.

In other demonstrations, the Army fired Little John and Honest John rockets, flew some of its reconnaissance drones, and showed off its various helicopters in a wide variety of applications.

One of the more interesting uses of the helicopters was made by an Army experimental unit, the aerial reconnaissance and security company. Initial mission of this group is to obtain information on enemy locations. A two-helicopter scout team using Bell H-13 helicopters, flying low and following the terrain for maximum protection, moved in to draw enemy fire. Once they drew fire, the scouts dropped low behind a protective hill and then rose alternately, like two jack-in-the-boxes, to suppress enemy fire with two 38-cal. machine guns mounted on the H-13 and to make observations.

They then withdrew to a covered position and reported to the platoon leader. Later, six scout H-13 helicopters were used to cover the landing, operation and withdrawal of a rifle squad carrying out ground reconnaissance.

The rifle squad was brought in and taken out by a Sikorsky H-34 transport helicopter which was also armed and was used as an additional source of covering firing for the rifle squad.



PERSHING transporter-erector-launcher is built by Thompson Ramo Wooldridge. Entire launching operation is less complex than for Sergeant missile.

Soviet Missile Show

Moscow—Soviet armed forces showed little new last week in the missile section of a May Day parade that concentrated heavily on peace and economic growth.

Missiles in the parade included a short-range artillery rocket with a bulbous nose mounted on an amphibious tracked chassis which was seen in a November, 1957, parade and another mobile artillery rocket which apparently is a new, improved version of the one seen previously (AW Nov. 18, 1957, p. 26). A relatively short-range rocket mounted on a tank chassis also had been seen in 1957.

Surface-to-air missile was shown which has been designated Guideline by North Atlantic Treaty Organization. This anti-aircraft missile had been shown earlier, as had a medium range ballistic missile, probably similar to the Army-Chrysler Redstone.

Radio Moscow reported that each of the ballistic missiles in the parade requires at least two railway flatcars for rail transportation and that they are "capable of pinpointing targets with pinpoint precision under any weather conditions."

UAC Shifts Space

United Aircraft Corp. has abolished its two-year-old Missile and Space Division and distributed its personnel and functions among other operating divisions of the corporation.

Bulk of the former Missile and Space Division personnel and its two study contracts will be shifted to the Hamilton Standard Division headed by Charles M. Kearns, Jr., who also was elected to a corporate vice president.

Wright Parkins, former general manager of the Missiles and Space Division, relinquishes that assignment and will continue as UAC vice president for engineering. Two other division contracts for Talos missile fins have been transferred to the Sikorsky Aircraft Division. Total of 190 Missile and Space Division employes will be reassigned to other UAC divisions.

Manned Aircraft Need to Continue Into 1970s for Army and Navy

Los Angeles—U. S. Army and Navy envisage requirements for large numbers of manned aircraft through the 1970s because both services feel that possibility of all-out nuclear warfare is highly unlikely.

High-ranking Army and Navy officials told Aviation Writers Assn. members assembled here for their annual convention that:

• **U. S. Army** has programed a fleet of over 8,000 new aircraft of seven different types by 1970, compared with current inventory of some 5,500 aircraft of 15 different models.

• **U. S. Navy** desires to maintain a level of approximately 7,200 aircraft, although in recent years budget limitations have permitted buying only approximately half of the 1,200 new aircraft it feels it needs to maintain this inventory.

Army is instituting strict controls on future procurement to reduce the number of types, while at the same time increasing its inventory to reduce logistics problems of air mobility, which also embraces ensuring that all new aircraft are designed for very low maintenance requirements, according to Lt. Gen. John C. Oakes, deputy chief of staff, military operations.

Army's forecast inventory for the period ahead, by type and number, includes the following aircraft:

• **Approximately 3,500** new light observation helicopters, turbine-powered, to replace the Cessna L-19, Bell H-13 and Hiller H-23, and perform all standard observation, command and liaison missions for the lower units. By reducing the number of types from three to one, Army feels it will be making a significant gain in logistics simplification. New helicopter will be subject of an Army design competition later this year and two of these designs will be built for testing, with target date of 1964 considered for quantity production. Helicopter will be a high-density type and should be of relatively low-cost since this will be one of the first times that Army is procuring this type of item in sufficient quantity to achieve true assembly line procedures.

• **More than 2,500 Bell HU-1A** and HU-1B Iroquois turbine-powered utility and tactical transport helicopters are scheduled to replace the de Havilland L-20A Beaver, Sikorsky H-19 and H-34 and the Vertol H-21. The HU-1B, featuring wide-chord rotor blades, will have capability of carrying 10 soldiers. Each future Army division will have the capability of airlifting at least one infantry company with its organic aircraft, which will also provide essential battlefield evacuation.

• **Some 250 Grumman AO-1 Mohawks** currently are programed by Army by 1965. This twin-turboprop short takeoff and landing aircraft for the first time will give Army a limited penetration capability with a good chance for survival because of its light armor protection and self-sealing fuel tanks. Mohawk, in conjunction with a family of three drones, should greatly extend Army's surveillance capability and indicate, through actual field testing, what further systems are needed to bring Army's target acquisition capability up to its firepower strength.

•**More than 300 de Havilland** twin-engine Caribous and a similar number of Vertol HC-1B Chinook helicopters are in current procurement objectives. Army is studying another transport requirement for loads in excess of the Caribou's and Chinook's "payload" capabilities and expects to define this new need in the next year.

More exotic concepts in VTOL, such as ducted fans, convertiplanes, boundary layer jets, tilting rotors and tilting wings, have been considered as too immature to permit purchase at this time in sufficient quantity to meet the Army requirement under current budget limitations, and it was the consensus of the Army and technical agencies outside the service that only the helicopter could meet the entire light observation requirement in this time frame. Army will maintain a "strong" research program in V/STOL aircraft to determine which year it will appear feasible to move into a specific development program, Gen. Oakes stated.

Vice Adm. Robert B. Pirie, deputy chief of naval operations (air), stated that he could not visualize any aspect of naval operations, except Polaris submarine employment, which would not depend heavily on manned aircraft, whether conventional or nuclear weapons were utilized.

Carrier attack strike forces maintained both conventional and nuclear attack capabilities; each of the Navy's 14 operational attack carriers can, in an initial strike, deliver 45 to 60 nuclear weapons on target, plus hundreds of tons of conventional weapons, he noted.

Anti-submarine warfare forces also are built around manned aircraft, he said, their importance ever-increasing.

JetStar Lease

Washington—Pan American World Airways received Civil Aeronautics Board permission last week to go ahead with plans permitting the lease of Lockheed JetStar utility jet transports by the airline's wholly-owned subsidiary, Jet Executive Transport Services (AW Feb. 2, p. 34).

Contracts filed by the subsidiary, which plans to purchase 16 JetStars, offers customers a six-year lease with purchase option at an estimated cost of $1.2 million per aircraft. Purchase option would require payment of the factory list price per aircraft, plus a fee of $17,500 to Jet Executive Transport Services for service charges. Pan American told the Board that the manufacturer has agreed not to lease JetStars during the JETS contracts. In addition, Lockheed also agreed not to sell the aircraft for lease purposes on better terms than those offered to JETS without first offering them to the corporation.

Soviet Bombers Reconnoiter Japan

Tokyo—Russian jet bombers are making regular flights around perimeter of the Japanese islands for photo and electronic reconnaissance. Japanese Self Defense Agency sources confirmed that Japanese radars have picked up the Soviet bombers on a biweekly basis recently in formations of two or three planes. Japanese F-86D interceptors have been scrambled to inspect these flights but have been unable to reach the bombers' altitude.

Radar plots indicate the Russian bombers approach the northern Japanese Island of Hokkaido and then proceed down the Pacific coastline as far south as Tokyo Bay before turning back. They fly just outside Japanese territorial waters. Japanese Self Defense Agency source said the bombers were believed to be operating from bases deep in Siberia and are equipped with auxiliary fuel tanks. No specific type were identified, but they are believed to be four-jet Bison or four-turboprop Bear type.

Japanese radars made their initial sighting of the Soviet bombers early last year when single planes flew south along the Hokkaido coast to the tip of the main island of Honshu before turning back. Formation flights making the deeper penetrations began a few weeks ago and have continued on a regular biweekly basis. Other sources confirmed the Japanese report.

C-135, C-130B Asked for MATS

Washington—A $386 million, three-year program to provide Military Air Transport Service with an interim fleet of turbine-powered transports and to begin development of a new military cargo transport has been recommended by the special airlift subcommittee of the House Armed Services Committee.

This program was presented by L. Mendel Rivers (D.-S. C.), chairman of the military subcommittee of the House Appropriations Committee, and endorsed by that group in recommending a $250 million increase in the Fiscal 1961 budget for initial procurement of the interim transports (see p. 30).

The program recommended:

• **Procurement of 50 Boeing C-135** jet cargo transports at a total cost of $169 million and a unit cost, including spares and ground support equipment, of $3,390,000 each. Of this total, $124 million would be added to the Fiscal 1961 budget with an additional $45 million in new obligational authority programed for the Fiscal 1962 budget. Expenditures for this project would require $15 million in Fiscal 1961; $56 million in 1962; $62 million in 1963 and the final increment of $36.5 million beyond Fiscal 1963.

• **Procurement of 50 Lockheed** C-130B turboprop transports at a total cost of $167.6 million and a unit cost of $3.35 million, including spares and ground support equipment. Of this total, $110.6 million would be spent in Fiscal 1961 and $57 million in 1962.

Rivers said the C-135 would serve as a strategic support transport for military cargo requirements and the "Strategic Air Command post-strike recovery mission" while the C-130B with extended range would provide some strategic capability as a C-124 replacement and also meet the Army's tactical airlift requirements. Rivers said the improved C-130B version could carry a 12-ton payload 4,000 naut. mi. at a cruising speed of 300 kt. With approval by July, the first C-130B for this mission could be delivered a year later, with the first fully operational squadron available by January, 1962.

Only minimum modifications would be made in the basic Boeing KC-135 jet tanker now in production at Boeing's Renton plant for the C-135 MATS transport, Rivers said. In explaining why his group had recommended the C-135 as an interim transport he said:

"We have considered every other possible aircraft and the one that looked to be the closest competitor was the Douglas DC-8 with a turbofan engine, swing tail and extended range. As attractive as this airplane looks, and it would admittedly have some superiorities over the C-135, it would cost considerably more money, and the first operational squadron would not be available until approximately 11 months after the first operational squadron of the C-135. In addition, I have the basic fear that, if the DC-8 should be selected, that the development of the new uncompromised strategic aircraft would die right where it is. That simply must not happen."

Rivers cited an additional cost of $400,000 per plane to use turbofan engines instead of the regular Pratt & Whitney J57 turbojet engines on the C-135 and a price of $1 million more per plane if a swing tail were incorporated. He said both the C-135 and C-130B programs were designed to fill a MATS gap that will result from the current Douglas C-124 fleet beginning to phase out of the inventory by the end of 1964.

He said the development of the new transport design to meet MATS' Strategic Operational Requirement could not possibly produce the first operational squadron before January, 1964, and more likely would not be available until as late as the spring of 1965.

Rivers noted that the $50 million already in the Fiscal 1961 budget for initial development of the SOR transport had received complete support from every branch of the government concerned and should be retained in the budget "regardless of any other considerations."

"It has top priority in our thinking," he said. "The decision to move or not move on this will govern our future strategic airlift capability in the civil industry as well as the military."

NASA Budget Boosted By Senate Group

Washington — Senate Aeronautical and Space Sciences Committee has authorized an extra $50 million in emergency research and development funds for National Aeronautics and Space Administration's Fiscal 1961 budget because, it said, "it is apparent from NASA testimony that little or no provision has been made in the 1961 estimates for contingencies, cost increases, or unplanned program modifications."

The committee said the experience with Project Mercury—which now is estimated to cost $344,500,000 instead of the $200,000,000 estimated a year ago —"clearly demonstrates the great expense involved in making necessary changes to assure safety of personnel and system reliability."

The extra funds bring the total NASA budget authorized by the committee to $970 million. The committee developed testimony that NASA's detailed budget estimates, "submitted after six months of continuing review in the field and at NASA headquarters, totaled $1,048,300,000."

Administrator T. Keith Glennan told the committee he suggested $75 million of the $133 million cut from these requests, and that the Bureau of the Budget cut the remainder.

"It is clear . . . that no formal, written budget ceiling was established (for NASA)," the committee said. "It is not clear, however, whether the NASA programs and budget for Fiscal 1961 were considered on the basis of national needs, without reference to a preconceived dollar level."

In reporting favorably to the full Senate on the NASA authorization bill already passed by the House, the committee deleted a proposed increase of 30 "excepted" jobs, which would pay from $14,000 to $21,000 annually. It said NASA's reasons for the request were valid but that action should be deferred until the Senate Post Office and Civil Service Committee holds an investigation aimed at adjusting all government salaries.

News Digest

German Defense Ministry has placed a development order for a jet powerplant of up to 4,400 lb. thrust with Man-Turbomotoren GmbH., Munich. Propulsion unit is for VTOL aircraft which may be jointly developed by German, French and British industry.

Rear Adm. Daniel F. Smith, Jr., a naval aviator and now assistant chief of naval operations for fleet operations, will succeed Rear Adm. Charles C. Kirkpatrick in late July or early August as the Navy's chief of information. Adm. Kirkpatrick, chief of information since December, 1957, will become commander of Amphibious Group One based at Coronado, Calif.

French government is expected to announce shortly its approval of the acquisition by Air France of six additional Sud Caravelle jet transports and three more Boeing 707 Intercontinental jets. The French carrier currently has 24 Caravelles and 17 Boeings on order, all of which are scheduled for delivery before the end of this year.

Convair's 880 jet transport was approved by FAA for commercial airlines operation last week. Delta Airlines will schedule the jet between New York-Atlanta on May 16.

Indian government has ordered 15 French Breguet Alize anti-submarine warfare aircraft.

Airlines Seek Turbine Overhaul Accord

Compromise sought in FAA formula hinging authorized overhaul times to absolute engine failure rate.

By David H. Hoffman

Powerplant engineers of U.S. airlines and the Federal Aviation Agency this week are preparing for a second conference aimed at reaching agreement on how the timespan between turbine engine overhauls should best be extended.

At issue is an FAA formula that would hinge authorized time between overhaul (TBO) for an airline on the absolute engine failure rate it experienced during any consecutive three months of operation (AW May 2, p. 45).

Only by resorting to this formula can the carriers increase their turbojet TBOs. Late last month, the representatives of about 10 airlines met with the FAA in Washington, D. C., in an unsuccessful effort to draft a compromise plan that would be tried on a test basis for six months.

In essence, the disputed FAA formula states that air carriers operating turbine engines at or above their basic overhaul time limitations (1,000 to 1,200 hr.) may:

- **Increase overhaul times** by 200 hr. on the engine and 500 hr. on the essential engine accessories if recorded engine failure rate has been less than one per 10,000 engine hours.
- **Increase overhaul times** by 100 hr. on the engine and 250 hr. on the essential engine accessories if recorded engine failure rate has been greater than one but not greater than 1.5 per 10,000 engine hours. In this instance the carrier must disassemble a specified number of engines and present them to the FAA for inspection to qualify for TBO extension.
- **Keep current TBOs** if engine failure rate has been greater than 1.5 per 10,000 engine hours.

Should failure rates rise above two per 10,000 engine hours during any single month, however, the carriers must reduce engine TBOs by 100 hr. and accessory TBOs by 250 hr. after a two month "notification period." TBOs need not be reduced if, during this period, the carrier's failure rate drops to less than two per 10,000 engine hours. Engine failure, as defined by the FAA, means any loss of thrust or inability to control power or thrust while an aircraft is airborne.

Rather than grant FAA's formula informal recognition by using it, all U.S. operators of Douglas DC-8 and Boeing 707 series aircraft have elected to keep current TBOs on their Pratt & Whitney JT3 and JT4 turbojets.

Top engineers with American Airlines, Pan American World Airways, Trans World Airlines, Eastern Air Lines and United Air Lines—the five largest U. S. trunklines—told AVIATION WEEK that their objections to FAA's approach centered on these three points:

- **Reliability of an engine** cannot be controlled solely by shortening its time to overhaul.
- **Statistical sampling of engines** is not sufficiently broad to guarantee carriers with the same annual failure rates the same annual TBO increase or decrease.
- **Formula fails to consider** that different engines will have different failure rates throughout their operational life.

FAA officials, on the other hand, believe that there is a direct cause and effect relationship between overhaul time and engine reliability. In discussions with industry representatives they cite the experience of Capital Airlines which last year advanced TBOs on its Rolls-Royce Dart turboprop engines an average of 200 hr. per calendar quarter under a similar formula applicable only to turboprops. At the same time, FAA maintains, Capital's engine failure rate decreased sharply.

Ultimately, FAA is planning regulation status for its formula approach to TBO extension. Despite industry protests, it is determined to draft a workable formula that probably will be published under Parts 40 and 41 of the Civil Aeronautics Manuals.

Agreeing that a more precise means of advancing TBOs is desirable, the carriers feel that if a formula is to reflect accurately the effect of overhaul on reliability, it must accord more weight to engine failures occurring near the end of the engine's TBO, especially during the last 300 hr.

Consequently, they are recommending a formula that would plot the number of failures taking place during each 100 hr. increment of the engine's overhaul life. Such a formula would consider when the failure took place as well as changes in the rate of failures experienced with a particular engine.

To illustrate how the FAA formula might work in practice, several of the carriers queried by AVIATION WEEK posed this hypothetical situation: An airline with a fleet of 20 four-engine jet transports utilizing 250 hr. each month would log 60,000 engine hours in a calendar quarter. If such a carrier experienced nine engine failures during the three month period, it would become eligible for a 100 hr. TBO increase. But should the carrier record more than 12 failures in the quarter, it probably would be forced to move TBOs backward by 100 hr.

Operators of large jet fleets feel that the in-flight failure of three engines in three months should not play such a decisive role in determining authorized overhaul times. These trunklines argue that the timing of engine failures within a large fleet, of critical importance under the formula, often can be attributed to coincidence. A carrier fortunate enough to have them occur at an even rate of one a month, however, would be rewarded by the FAA with TBO increments, the industry explains.

In Pan American's opinion, reliability of an engine as a complex whole is the result of shop practices, company tolerances on parts, modifications carried out on components and the airline's individual operating limitations.

The carriers' key incentives to improve reliability, Pan American says, come from two sources—the company's reputation for safety in the air and its desire to keep costly jets airborne—and not from the threat of TBO cutbacks.

The economic value of a TBO increase lends significance to the current FAA-airline argument. The carrier with a fleet of 20 Boeing 707-120s each being utilized 8 hr. per day, for example, would save upward of $200,000 in annual overhaul costs if awarded a 100 hr. overhaul extension by the FAA.

Pratt & Whitney, which has sent a representative to the first FAA-airline conference in Washington, favors a streamlined procedure that would enable airline users of its JT3 and JT4 turbojets to advance TBOs more rapidly.

It feels that failure rates—one in 25,000 engine hours for the JT3 and one in 17,800 engine hours for the JT4—are sufficiently low to justify a more rapid approach to the problem, especially since the turbojets now have logged over 660,000 hr. in commercial service.

Specifically, the FAA formula is contained in the agency's "turbine engine time control program," which was presented to the air carrier industry late last fall. Under its terms, turbine-powered engines are divided into two categories: new model engines and substantial experience engines.

New model engines are taken up to their basic overhaul time limitation through a series of FAA sampling inspections of a specified number of powerplants disassembled by the air carrier. When basic overhaul time is achieved, usually after 200 to 300 hr. of service, the performance level formula comes into play and governs subsequent TBO increases.

The number of engines to be disassembled for inspection ranges from one, for airlines owning less than four operating engines, to six for airlines owning more than 101 operating engines. All substantial experience engines presented for these inspections must have been operated up to within 25 hr. of the carrier's currently authorized overhaul time limitation.

The FAA lists the following as substantial-experience turbine engines:

Engine Make/Model	Basic Overhaul Time Limitation
Allison 501-D13	1,000 hr.
Rolls-Royce Dart 510	1,200 hr.
Rolls-Royce Dart 511	1,200 hr.
Rolls-Royce Dart 525	1,200 hr.
Rolls-Royce Dart 528	1,000 hr.
Pratt & Whitney JT3C-6	1,000 hr.

In determining their performance level ratios, the FAA would allow the carriers to exempt engine failures caused by foreign object ingestion (not the result of maintenance personnel errors).

Electra Crash Study

Burbank—No single cause for the Electra crash at Tell City, Ind., has been isolated, but there are two or three probabilities which are "combinations of unusual forces and pressures on the powerplant and surrounding structures," Board Chairman Robert E. Gross told Lockheed Aircraft Corp. stockholders at the annual meeting last week.

"We believe," Gross said, "the problem lies in some new phenomenon, characteristic or condition not encountered or disclosed by exhaustive development, analyses and tests required by the government or by Lockheed. We believe clear air turbulence is involved.

"We believe that in a week or so we will have reached a conclusion in our own minds," Gross said, "and in a couple more weeks, we will know what fixes will be required."

The current Lockheed tests being conducted will cost the company approximately $2.5 million, Gross said, but only after analysis can the company reasonably estimate the total costs of the fixes.

Capital Employe Unit Organizes, Plans Fight to Control Airline

By L. L. Doty

Washington—In a major proxy battle virtually unprecedented in U.S. corporate history, the majority of Capital Airlines' employes had banded together as of late last week to fight for control of the company by overthrowing the present board of directors and at least part of management within the next 60 days.

The move, which began nine months ago but gained its first impressive momentum just last week, is aimed at mustering sufficient strength, through a nation-wide proxy solicitation, to oust the company's board and replace it with a slate of directors of the employes' choice. Each member of the movement, organized as a group known as the Capital Shareholders Assn., has purchased at least one share of Capital common stock. They now constitute an estimated 75% of the 7,500 personnel.

Meanwhile, management—staggered by another substantial loss in April and mounting criticism from the Civil Aeronautics Board and regular stockholders—was still waiting for an invitation from the company's British creditors for another chance to negotiate some solution to Capital's fiscal plight (AW May 2, p. 40).

Vickers-Armstrongs, British manufacturer of the Viscount turboprop transport and trustee for holders of chattel mortgage notes on the 60 Viscounts purchased by Capital, had filed a petition with a New York district court to foreclose on the equipment and appoint a receiver to take over the property (AW Apr. 18, p. 40). As of late last week, there were no overt signs that the British were ready to lift the foreclosure or extend today's deadline date when Capital must appear in court to answer its creditors' complaints.

Subsidy Bid Status

Capital's two requests for emergency subsidy totaling close to $13 million have been denied by the Civil Aeronautics Board. In addition, the Board has ordered a major investigation of the debt-ridden airline to determine whether the company should be allowed to stay in business as a trunkline. And, last week, it cracked down on the carrier for failure to provide adequate service on east-west routes serving two Michigan cities.

Thus, the airline has reached an impasse that could force it into bankruptcy. Fortunately, the company's shaky cash position has been slightly strengthened by a recent upswing in passenger traffic, but this reverse trend falls short of the upward traffic climb normally experienced at this time of the year. As a result, the airline is meeting current operating expenses, but other creditors are now beginning to press for some action.

Management has been in continuous contact with Vickers-Armstrongs' U.S. lawyers and financial advisers in New York in its drive to get together with officials of the British manufacturer. At the same time, heads of unions representating Capital employes visited the same lawyers last week in hopes of determining future course of events so that a plan of labor action can be mapped out. The Shareholders Assn. has made no contact as yet.

It is expected that Vickers' lawyers will request a summary judgment today which will allow Capital another 15 days in which to answer this complaint. The 15-day interim period is believed by Charles E. Beatley, Jr., head of the employe group, to be sufficient time in which to present to Vickers a full plan to put the company back on its feet.

Employe Plan

Here are the essential features of the Capital Shareholders Assn. program:

- **Meet with the British interests** and propose a plan for repayment of the debt and to ask for a deferral of foreclosure action.
- **Begin a proxy solicitation** that would enable the group to replace the present board with new directors. The group will employ professional solicitors for some solicitation but, in large cities served by Capital, employe-stockholders would conduct this work for the group under the direction of Beatley.
- **Ask CAB** for subsidy.

The Capital Shareholders Assn. first came into public attention last month during the annual stockholders meeting (AW Apr. 25, p. 43) when Beatley joined other dissident stockholders in protests against management and presented a "positive" plan of action, which, he said, would "increase public patronage and strengthen the airline's financial position."

According to Beatley, a veteran senior pilot with the company, Capital's board of directors took no action on any part of the plan and, as a result, the employe group decided to take its own action. Since then, the group has placed the blame for Capital's plight on "poor leadership."

The entire management group is not included in the group's charges and, in fact, there are a few junior

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officers who lean in support of the association's latest activities.

Chief targets of the employe group are Capital President David H. Baker and senior vice presidents J. B. Franklin and Walter Johnson. However, other high-ranking officers have borne some share of the over-all criticism, and both Franklin and Johnson are backed by a number of employe segments within the association.

Two veteran directors, C. Bedell Monro, president of Capital until 1947, and James R. Stockton, are believed to be in support of the association's program as it now stands.

Officers and directors as a group received $424,957 in salaries and other remuneration in 1959. Last month, in a voluntary action, the group voted to cut their own salaries by 10%.

Employes have been considering two wage reduction plans which would help rescue the company from its present financial dilemma. One calls for an 18-month wage deferral of 10% and another proposes the purchase of common stock on a wage deduction plan designed to strengthen the equity base of the company. Whatever course is followed, it is now evident that employes are disillusioned with operations under the current management and will follow Beatley in most any program he proposes.

A major reason for this loss in confidence in management was a statement by Baker in which he said Capital will continue to operate "even if it is forced into receivership." Beatley promptly accepted the challenge and charged that no airline, because of the technical nature of its operation, can serve the public properly "under the cloud of bankruptcy or receivership."

Beatley said such a situation would put the carrier at a competitive disadvantage because the normal psychological reaction to bankruptcy would drive many potential passengers to other carriers. He warned that receivers appointed probably would not be people knowledgeable in airline operations and added that the "freedom and flexibility of decision" essential to day-to-day airline performance "would be gone."

In a direct blast at management, he said the CAB provides a carrier with a franchise on the presumption that management will be "fit, willing and able" and added that bankruptcy creates the presumption that management is "lacking in one of these areas."

Meanwhile, the Board cut off any chances of Capital being granted an immediate temporary subsidy to tide it over the crucial days ahead. It bluntly set a policy for the Capital case and future similar cases when it said in its order:

". . . the Board's policy with regard to the award of subsidy on a temporary basis does not envisage that any or all carriers in financial straits shall be awarded subsidy simply upon filing a petition." In its original order denying the airline subsidy, the Board said there was a "serious question" as to whether Capital would be ultimately entitled to any subsidy at all.

Last week, it issued an order, which was stayed because of Capital's "increasingly critical" condition but which sharply criticized Capital's failure to provide adequate service to Flint and Grand Rapids, Mich. It established a minimum of round-trip flights daily which the airline must operate between the two cities and major markets on the East Coast and in the Midwest and ordered that all first-class flights on these routes be served by pressurized aircraft. Because of the Board's doubts of Capital's on-time performance, it ordered the carrier to submit monthly statements showing departure times of each flight serving the Michigan points.

American Airlines President Urges Abolishment of Trunkline Subsidy

Los Angeles, Calif.—Subsidy section of the Federal Aviation Act, as it may apply to U. S. trunk airlines, should be repealed, American Airlines President C. R. Smith said here last week.

"Subsidy is not a cure for the disease afflicting the industry," he contented, "but it is a disease itself." Smith said that until legislation repeals the subsidy section of the act, the federal government should establish and enforce the policy that it will not pay subsidy for operations over any specific route, if there are one or more carriers on the same route capable of operating adequate service without a subsidy.

Smith continued that today's route structure should be realigned to end what he called "wasteful" competition, which has eliminated opportunity for profit and hope for subsequent fare reductions.

Backbone of today's airline system, he said, is a basic route pattern inherited outright from the airmail system, to which has been added route after route, often in piecemeal fashion, over a period of more than 20 years.

This structure needs realignment to bring it up to date with the times, he added, noting that existence of individual carriers and the industry itself depends on sound development and a firm substructure on which to build.

Belaboring the airlines with layer on layer of competition, in spite of continued warnings that the economic integrity of the airlines would be endangered, has continued. Earnings reports for the first quarter of this year indicate that much of this concern is justified, Smith claimed. Calculations show that the trunkline industry's pre-tax loss for the first quarter of 1960 will approximate $24 million, compared with a pre-tax profit of $6 million in the same period last year, a deterioration of $40 million, not all of it due to the bad weather during 1960's first quarter.

Smith pointed out that in 1935, American Airlines sold $4 million worth of air transportation and in 1960, it expects to sell $400 million worth. In 1935, American's capital was less than $1 million; today it is about $150 million. Its total assets have more than doubled since 1955, but American's earnings have gone up only about 10% in the same period, he noted.

The building of a supersonic transport is not, at this stage of development, a "business decision," the American Airlines chief executive contended, since the decision cannot be made by the manufacturers or the airlines, or both, because cost is too much for their resources. Such a project will have to be sponsored by the federal government, he maintained. He believes that it would cost no more to be the leader in introduction of supersonic transportation than to catch up at some later date. In fact, it probably would cost less to lead, he indicated, provided technical solutions are developed in the North American B-70 program.

Smith also was critical of recent developments in the National Aeronautics and Space Administration which have tended to place aeronautical research on a much lower level than in previous years. Morale of the aeronautical department in NASA is not good, he declared, with some of the talented and devoted scientists having transferred to space activities and others leaving to join industry. The latest products of the U. S. aircraft industry demonstrate a lack of knowledge for best design and their problems highlight the areas yet to be explored.

Among the areas still requiring diligent research, Smith listed:

- **Noise**—causes, effects and control.
- **Airplane control and stability**—over the total speed and operational ranges.
- **Lowspeed takeoff and landing**—including crosswind problems.
- **Materials and structures**—weight, strength and fatigue resistance.
- **Meteorology**—including clear air turbulence.
- **Aerodynamics** – including boundary layer control.



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Jets Boost Chicago Helicopter's Traffic

By Glenn Garrison

Chicago—Boosted by a rapid rise in jet services at O'Hare Field, Chicago Helicopter Airways' traffic is expected to reach a record total of 330,000 passengers this year.

In 1959, its third year of passenger operation, the helicopter carrier's Sikorsky S-58s moved 204,389 passengers, an 87.6% increase over 1958 and a total far beyond CHA's most optimistic estimates (AW June 15, p. 49).

The Chicago airline thereby handled more passengers than the other two major U.S. scheduled helicopter operators —Los Angeles Airways and New York Airways—handled together. Total for all three was 366,000 passengers.

There were other impressive signs of CHA's booming growth: revenue passenger miles up 84.2% to 3,667,453; passenger load factor up from 37.8% to 51%; ton miles flown up 75.5% to 364,332; scheduled miles flown up 17.7% to 819,286. Operating revenues totaled $3,008,250, a 39% increase. Passenger revenues increased 94% to $1,213,504, and net income soared 170% to $230,344 including capital gains.

Jet Factor

Biggest factor in CHA's growth is the large-scale jet operation now handled at O'Hare, which has resulted in a rapid shift since last summer of airline schedules to that airport from Chicago-Midway. These time-conscious jet passengers offer a tailor-made market for CHA over its route triangle between the airports and between each airport and downtown Chicago.

By the end of 1960, this market will account for 60-65% of CHA's total passenger traffic, in the estimate of C. E. Liske, vice president-traffic and sales. Liske told AVIATION WEEK he ran a survey of last August's traffic, finding that 5,000 of the month's total of 20,000 passengers were traveling to or from jet transports. The proportion of jet passengers hasn't since been pinpointed by a survey, but it is increasing as more jet schedules are added by the airlines serving O'Hare, where all Chicago's jet traffic is handled. About half of last month's 28,002 CHA passengers were jet arrivals or departures, Liske estimated.

Heaviest traffic increase has been on the O'Hare-Chicago Loop segment of CHA's triangle (ground distance 23 mi. through traffic). Inter-airport traffic, though, accounts for about two-thirds of the total.

The helicopter airline's eighth and final S-58—a former New York Airways aircraft turned in to Vertol and reconditioned by Sikorsky—recently went into service and brought the daily trip total over the triangle to 188 as of May 1, an increase of 30 trips. Load factor last month, before this addition, was running about 53%.

Suburban Service

In addition to the 188 triangle flights, CHA operates seven daily-except-weekend schedules to Winnetka, Ill., and six to Gary, Ind. Plans to expand this suburban service are being slowed by the big demand on what the airline calls its own "golden triangle" routes.

Chicago Helicopter Airways expects delivery in mid-1961 of four Sikorsky S-61 turbine-powered helicopters of a total conditional order of six. These 25-passenger helicopters will greatly increase the airline's seat capacity, and a big objective now is to develop traffic to fill the new capacity, according to C. W. Moore, executive vice president. Along with this goal is that of developing the ability of CHA personnel to cope with such increased volume, Moore told AVIATION WEEK.

"Actually, we're ahead of the S-58," Moore said, adding that present frequency of service can be maintained with the bigger aircraft. He believes CHA's traffic next year may total 400,000 passengers.

Interline Traffic

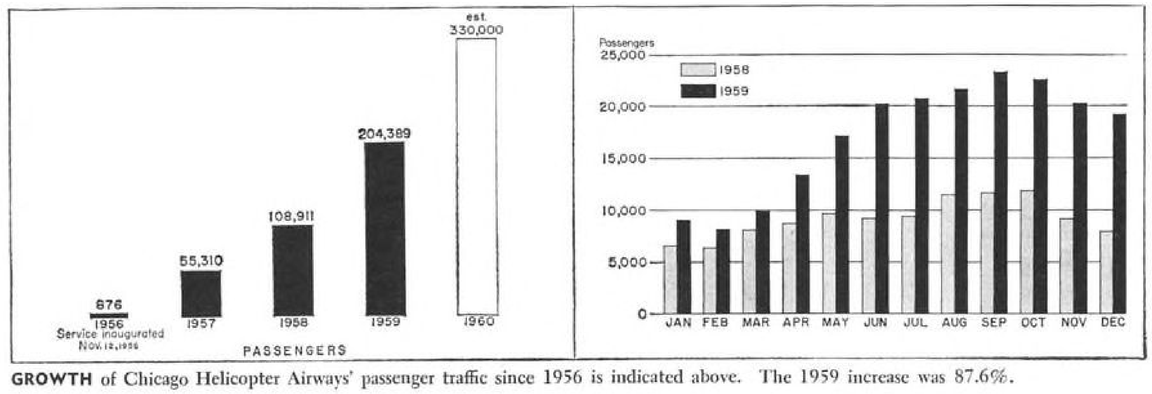
About 90% of the helicopter carrier's business is interline. In the works now is an agreement between CHA and three jet operators—American, TWA, and Continental—under which the fixed wing carriers will pick up half the $6 helicopter fare between Midway and O'Hare. Other airlines are expected to come in later.

More than 50% of CHA tickets are now pre-written by other carriers. There are no joint fares except with foreign-flag carriers serving Chicago, and these represent a small part of CHA's business. The helicopter airline isn't pushing the international joint fare business too hard, Moore said. With traffic levels as high as they are, it is not an unmixed blessing to sell a joint fare ticket which involves giving up 50 cents on a $6 fare.

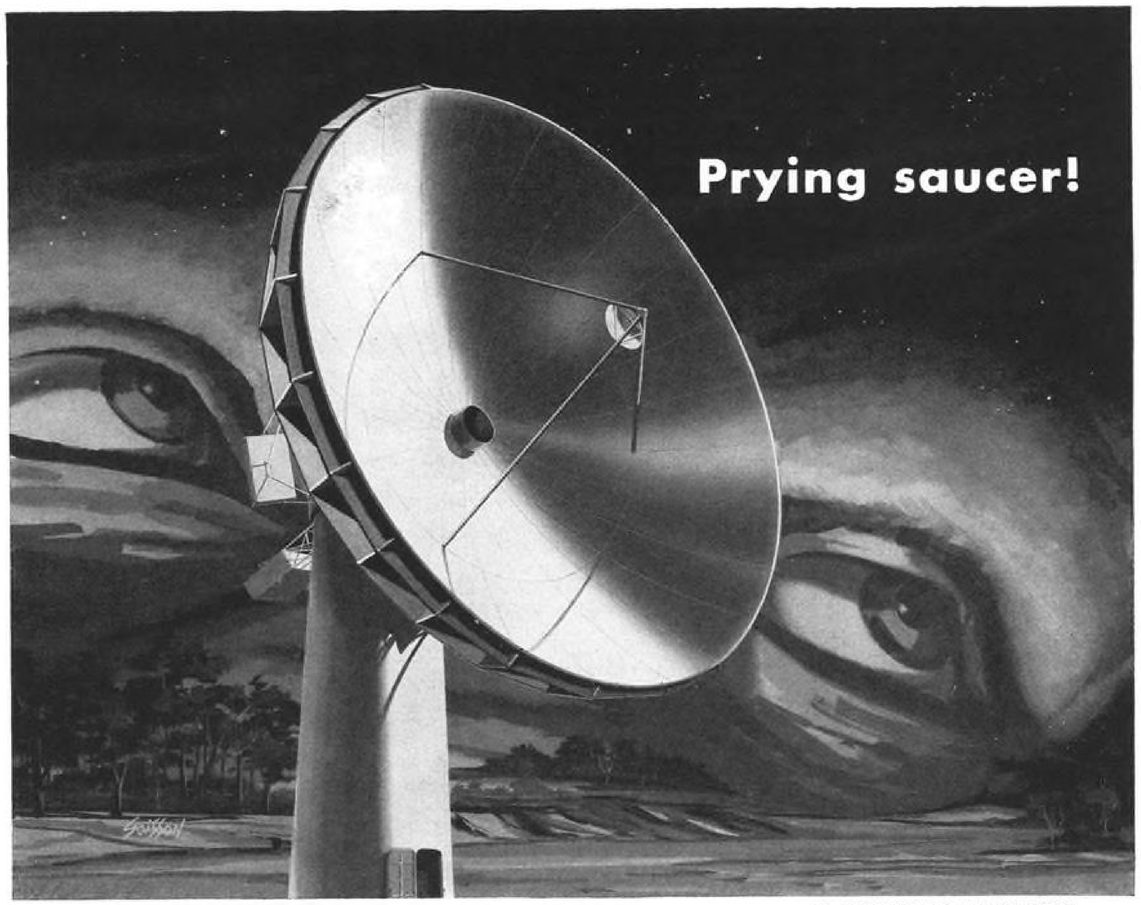
Chicago Helicopter Airways should be able to come off subsidy when the fleet of S-61s is in operation, according to Moore. Seat mile cost is expected to be about half that of the S-58. Operating cost per available seat mile with the present fleet is now about 30 cents. This is a fleetwide figure and includes the four Bell 47G-2 helicopters operated over CHA's mail routes.

Mail revenues and government payments for developing mail and passenger service totaled $1,786,726 last year, up from $1,536,391 in 1958.

Present average return on tickets is about 33 cents, Moore said. On the triangle routes alone, the S-58 operation probably would break even today, but the mail routes, regarded by CHA as highly important, and suburban passen-



GROWTH of Chicago Helicopter Airways' passenger traffic since 1956 is indicated above. The 1959 increase was 87.6%.



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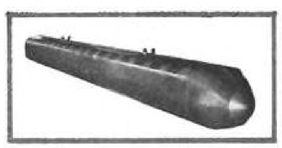
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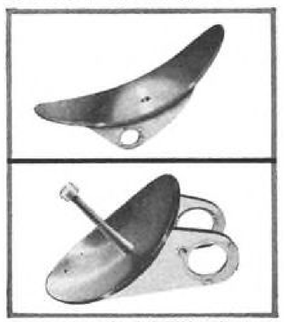
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A problem with the suburban passenger routes is directional imbalance, with big loads into the city in the morning and away from the city in the afternoon.

Subsidy need per passenger is now about $5, less than many Douglas DC-3 local service operations, Moore said.

The helicopter airline will offer about 650,000 available seat miles this month and fly 104,000 scheduled miles. Its enthusiastic officials see vast opportunities for further growth in a market which Moore said is expected to include 16 million passengers by 1965 using the two Chicago airports. By 1970, this total is expected to reach 22 million, and even 3% of this market, which is about what the helicopters have been carrying, is a lot of customers.

Jet Sales Tool

The helicopter/fixed wing jet combination is a two-way street, Moore pointed out, with the ground-time-saving rotorcraft providing a sales tool for the jet operators. Some airlines have mentioned this service in their advertising. CHA uses another angle in its billboard ads. They are located strategically along the ground route to the airports, where the susceptibility of a jet passenger tied up in traffic may be proportional to his irritation.

Other factors auguring well for future business include a new $550,000 terminal building being built by Meigs Field, the Loop point served by CHA, and a new convention hall planned for construction a quarter mile from Meigs. There also are plans for a big new hotel near the field.

In the passenger operation, there were only 20 mechanical delays last year that took a helicopter off a scheduled flight. Utilization of the seven S-58s operating last month was running about 1,400 hr. per aircraft per year, figured wheels-off to wheels-on, or about 2,100 hr. of time when the rotor was turning during a scheduled operation. Peak utilization was reached last September, when the fleet totaled five S-58s, at 1,663 hr. on the wheels-off to wheels-on basis.

Block speed now is running about 90 mph. off to on. In 1960, CHA expects to fly more than a million miles, about 86,000 mi. a month of it with the passenger S-58s and 18,000 a month with the mail-carrying Bells.

CHA's employe productivity has increased from 21.72 tons enplaned per employe annually in 1956 to 110.57 tons last year. Personnel now number about 180, including 38 pilots.

The carrier, which passes out $2 bills to employes every time a record is broken, believes employe morale has been an important factor in its successful growth.

Wheeler Sells Division

Wheeler Airlines, Ltd., Montreal, has sold its Heavy Transport Division, including 14 multi-engine aircraft, to Nordair, Ltd., Montreal, a subsidiary of Maritime Central Airways. Sale involves almost $4 million, not a cash figure.

Nordair will receive three Douglas DC-4s, five DC-3s, three Curtiss C-46s and three Consolidated PBYs. The firm will take over Wheeler's scheduled routes—Montreal-Val d'Or-Great Whale, Hudson Bay—and also Dew Line resupply.

Wheeler, in business 39 years and the oldest air service in Canada, gets several small aircraft from Nordair and with its current 28 single-engine aircraft—including Otters, Beavers, Norsemen, Stearmans, Avengers and one Cessna 180—will continue its spray and bush operations and retain its hunting and fishing camps.

F. H. ("Tom") Wheeler remains as president of the new company, which will be Wheeler Airlines (1960 Ltd.), and which will revert to its original headquarters at St. Jovite, Quebec.

Soviets Push Il-18 In Satellite Nations

Moscow—Soviet Union is pushing its campaign to establish the Il-18 turboprop transport as the standard prestige aircraft on major routes operated by its satellite nations before year-end.

Already delivered in small quantities to East Germany, Czechoslovakia and Communist China, the four-engine transport is slated for service with Hungarian and Bulgarian carriers in the "near future." Soviet officials claim that "other People's Democracies" also are in line for the Il-18s.

Russian production of Il-18s through the first quarter of 1960 apparently had not reached the point where it could readily furnish satellite countries with the number of aircraft necessary for efficient operations.

Nevertheless, the Soviets continue to push the new airplane. On a recent trip to Iraq, Soviet Deputy Premier Anastas Mikoyan offered three Il-18s to Iraqi Airways under terms calling for payment over 12 years at a 2.5% annual interest rate. De Havilland is also a contender for the Iraqi market with its Comet 4C turbojet.

The Russian's intensive Il-18 promotion has taken the Il-18 into Africa when it flew Guinea Republic President Sekou Toure home from an official visit to the USSR.

Meanwhile, Russia has expanded operation of the Il-18 on routes of its state-owned Aeroflot airline. The aircraft is used on trans-Siberian service between Moscow and Yakutsk near the Arctic Circle, covering the 3,500-mi. route in slightly over 10 hr. It will soon be placed into service on the USSR's most northerly trunk route—Moscow to Norilsk and Tiksi, the latter far above the Arctic Circle near the mouth of Eastern Siberia's Lena River.

Reduced Fare Ruling Extended by CAB

Washington—Civil Aeronautics Board has decided to continue its suspension of a ruling that would prohibit free or reduced fare travel for relatives of certain employes of air carriers until July 31.

The Board ruled in October, 1957, that travel by relatives of officers, directors and employes of the airlines and certain other persons at reduced rates or without charge violated the Federal Aviation Act. The airlines protested to the Board that these practices were of long standing and part of the carriers' public and labor relations structure. The Board then suspended its order until Sept. 1, 1958, and subsequently suspended the ruling until Sept. 1, 1959, and then to Apr. 30, 1960.

Legislation is now pending in Congress to amend the Act permitting such free and reduced rate transportation so that the Board has granted the further extension. Categories of persons affected by the Board suspension are:

- **"Members of immediate** families of airline directors, officers, employes.
- **"Retired airline directors,** officers and employes.
- **"Members of the immediate** families of persons injured or killed in aircraft accidents.
- **"Widows and minor children** of directors, officers and employes who have died while in the service of the air carriers."

KLM to Test Recorder

KLM Royal Dutch Airlines plans to install an Ampex tape recorder unit on one of its Douglas DC-8 turbojet transports to obtain a continuous in-flight record of a variety of engine and aircraft operating parameters to determine the possible value of such records for maintenance and statistical purposes.

After recording, the tape will be automatically analyzed by an IBM 705 computer which can be programed to seek out unusual operating conditions. Recorder will record fuel flow, pressure ratio and rpm. of each engine; roll and pitch angles of the aircraft, its heading, altitude, airspeed, Mach number, flap position, and static and ram air temperatures. Tests will be conducted for KLM by National Luchtvaart Laboratorium, an aeronautical research institute.

Instrument Systems Called Major Problem at IATA Technical Forum

By David A. Anderton

Lucerne, Switzerland—Basic requirement for improved instrument systems lies behind a major portion of the operational and engineering problems being aired at the 13th International Air Transport Assn. Technical Conference.

Seven out of the 11 items on the agenda for the two-week conference are related directly or indirectly to problems and progress made in instrumentation, instrument systems and presentation.

Judging by the comments, there wouldn't seem to be a single member airline satisfied with current accuracies and presentations. There is general condemnation of instrument systems that evolved slowly as a result of the development pace of piston-engine transports, and which have been adapted to jet transports with little or no change in design or concept. Two examples point this up:

• **Economically, airlines' fuel** bills are increased because of the inability to determine engine fuel consumptions with high accuracy. Knut Hagrup of Scandinavian Airlines System, chairman of the conference, said his company's Douglas DC-8 jet transports now flying between Copenhagen and New York arrive over New York with 30,000 lb. of reserve fuel. This weight could be reduced noticeably if instrument accuracy permitted more exact knowledge of fuel consumption rates.

• **Operationally, the available** airspace is further diluted by current instrumentation inaccuracies which make 2,000-ft. vertical separations mandatory above cruise altitudes around 30,000 ft. With some accurate altimeters now being used, this could be reduced to 1,000 ft., but member airlines are reluctant to make the recommendation until all of them are using the better systems. Airline technicians are critical now of errors that were acceptable last year; for example, a 5 kt. error in airspeed. With a piston-engine airplane, takeoff and landing were not so critical and 5 kt. one way or the other was not too important. The jet transport changed that overnight.

But if instrumentation is causing trouble now, it is nothing compared with what could happen in the supersonic transports, according to some delegates. Most of them look with inner horror at the possible introduction of supersonic transports before they have defeated the problems of the subsonic ones. But they take the realistic attitude that if they must come, now is the time to start working on proper instrumentation.

The major aim of this conference, which is IATA's biggest so far, is to exchange experience gained in the early months of turbojet transport operation by a few of the world's airlines as an aid to the rest of the operators who will be starting jet service this year.

The most conspicuous feature of this jet experience is that there are no complaints about the powerplants themselves. This probably is the first airline operators' conference anywhere that did not have to devote a large share of the agenda to the problems of engine operation and maintenance.

But while the engine as a trouble source has faded out of the picture, fuel for the engine has come strongly into focus as a potential source of real worry. IATA members, with one exception, now standardize on kerosene as the world-wide fuel for turbojet and turboprop transports. There is a current price differential of about 5% in favor of using JP-4 instead of kerosene, and some members are afraid that if the figure goes to 8 or 10%, they will have to shift to JP-4. With this, they foresee longer time for ground stops, primarily because they feel refueling will not be done with passengers in the airplane or while embarking.

There is a currently recommended IATA specification for kerosene used by the member airlines, but none for JP-4. One of the tasks of a conference working committee will be to hammer out a JP-4 specification in case the airlines have to make the switch in the future.

Cleanliness and water percentages acceptable in the fuel also are being considered.

Back of the increased interest in fuels is an economic reason. Gasoline costs for a piston-engine airline fleet represented about 16% of the total operational bill. For a jet transport fleet, this percentage nearly doubles; even small savings represent big money on the total costs for a year. One airline quotes a study figure for its DC-8s which shows that 1% saving in fuel consumption—which could be attributable to more precise cruise control, for example—would mean a saving of more than $11,000 per airplane per year.

Florida Route Petition

Washington—National Airlines asked the Civil Aeronautics Board last week to cancel or suspend Northeast Airlines' authority to serve Florida on grounds that the carrier's added competition in the area has cost taxpayers and investors an estimated $75 million since 1956.

Calling for immediate action on its request to "avoid further disastrous financial and economic consequences," National said it expects a pre-tax operating loss of over $5 million by the end of this fiscal year, primarily because of the competition from Northeast. The petition further contended that Northeast has experienced operating losses of more than $14 million since the airline was authorized to serve a New York-Florida route in 1956 on a temporary five-year certificate.

Northeast executives immediately replied that they would "take appropriate action" to protect the airline's interests and defended the carrier's position in the Florida market on the basis that it experienced a 300% growth in traffic over a three-year period.

Ratemaking Criteria Announced by Board

Washington—Civil Aeronautics Board last week took another step toward a final decision in the four-year-old General Passenger Fare Investigation with an announcement of standards that will be used in ratemaking.

Industry promptly filed tariffs calling for rate increases ranging from a $1 per ticket increase to increases of $1 per ticket plus 5% across-the-board. Board members admitted they were not in agreement on all ratemaking standards proposed.

In the brief announcement, the Board confirmed in all but a few minor details the recommendations set forth in the examiner's initial decision. It set a 10.5% rate of return on investment as a measure of fair earnings and noted that this standard was "based on a somewhat lower return for the Big Four carriers and a higher rate for the remaining eight trunkline carriers."

It said the rate of return would be computed on an investment base that includes equipment purchase deposits but excludes reserves for deferred income taxes and certain minor items.

The Board also set depreciation standards which will be used in ratemaking. Depreciation expenses on flight equipment will be based on the straight-line method computed over a seven-year life and a 15% residual value for piston-engine aircraft.

Airframes of turbine-powered transports will be computed over a 10-year period at a 15% residual value while depreciation of turbine engines will be based on a 5-year life and a 15% residual value.

The examiner recommended a zero residual value on turbine engines.

SHORTLINES

► **Civil Aeronautics Board** has ordered eight U. S. air carriers to increase the frequency of service into Baltimore's Friendship International Airport from a number of U. S. points. Airlines affected are American, Capital, Delta, Eastern, National, Northeast, Trans World and United. The eight carriers would provide Baltimore with service to various points in the U. S. with both daily one way and round trip frequencies.

► **Federal Aviation Agency** is ordering a new type radar traffic simulator for training of air traffic controllers which, it says, greatly reduces the time consumed in training. Simulator system, developed by Servonics, Inc., of Alexandria, Va., develops up to six controllable, simulated targets representing aircraft on the indicator scope. System will be installed in 26 FAA air route traffic control centers.

► **International Air Transport Assn.** will hold a special meeting as part of its 1961 IATA technical conference to cover the probable impact of supersonic transports. Manufacturers, air forces, research establishments and other organizations will be invited.

► **National Airlines,** Delta Air Lines and American Airlines have been granted temporary authority by the Civil Aeronautics Board to operate a three-way interchange route from Miami to New Orleans, New Orleans to Fort Worth and Fort Worth to Los Angeles. The order is effective until Apr. 29, 1961.

► **Trans World Airlines** has received an additional year-long Civil Aeronautics Board extension permitting it to eliminate Chicago and Detroit from direct service to Europe. TWA told the CAB that the load factor on flights from Chicago and Detroit directly to Europe averages only 54.8% from May 1 to Oct. 25, 1959, while the load factor on all other transatlantic flights was 70.6%. TWA also told the Board that it intends to provide single plane turbojet service between Chicago and Europe via New York, which, it says, will result in substantial savings for the airline.

► **Varig Airlines of Brazil** plans to begin nonstop Boeing 707-420 turbojet service on its New York-Brasilia route on June 14. Passengers continuing on to Rio de Janeiro will make connections at Brasilia and fly in Sud Aviation Caravelle turbojet transports.

AIRLINE OBSERVER

► **Pan American World Airways is in the process of creating a $10 million reserve fund for hull self insurance on its jet fleet because of high costs quoted for insurance in the early stages of jet operation. Situation is analogous to deductible collision insurance for automobiles, since any loss over $10 million is covered by insurance underwriters. Pan American appropriated $5 million from retained earnings and accrued $1,528,000 through charges to operating expense since Aug. 31, 1959. After losses of $31,000 last year, the fund totaled $6,497,000 at year's end. Accruals are taking place at approximately a half million dollars a month and, if loss rates continue as low as they have, the fund will be fully established before the year's end.**

► Watch for an early bid by Aeroflot, the Soviet state-owned airline, to join International Air Transport Assn. in connection with its latest move to open talks with the U. S. on a bilateral air transport agreement (AW May 2, p. 25).

► **Front-end noise of turbofan engines threatens to pose a noise problem, although exhaust noise is lower than that of a turbojet engine. On a decibel meter, there is no difference between the over-all noise level of the turbojet and turbofan. Compressor scream and fan noise of the latter is a larger component of over-all noise level and may be a source of complaint.**

► Handley Page will soon fly a large scale model of the sucked laminar flow wing scheduled to be fitted to the HP 113 jet transport. The model wing, which will be approximately one-third full size, or a span of about 24 ft., will be mounted vertically above the fuselage of a World War II Lancaster bomber and located near the center of gravity to minimize the yawing imposed on the aircraft by the wing lift. Two Budworth light-weight industrial gas turbines will provide the wing suction. Desired Reynolds numbers should be obtained despite the low speeds of the Lancaster by conducting the tests at low altitude.

► **Boeing has accelerated its 727 three-engine jet transport development program because of the Sud Aviation-Douglas Aircraft Co. move to produce the Caravelle jet transport in the U. S. The 727 is now entering the prototype stage and mockup has been built. Boeing also is studying a short-range version of the 707 transport.**

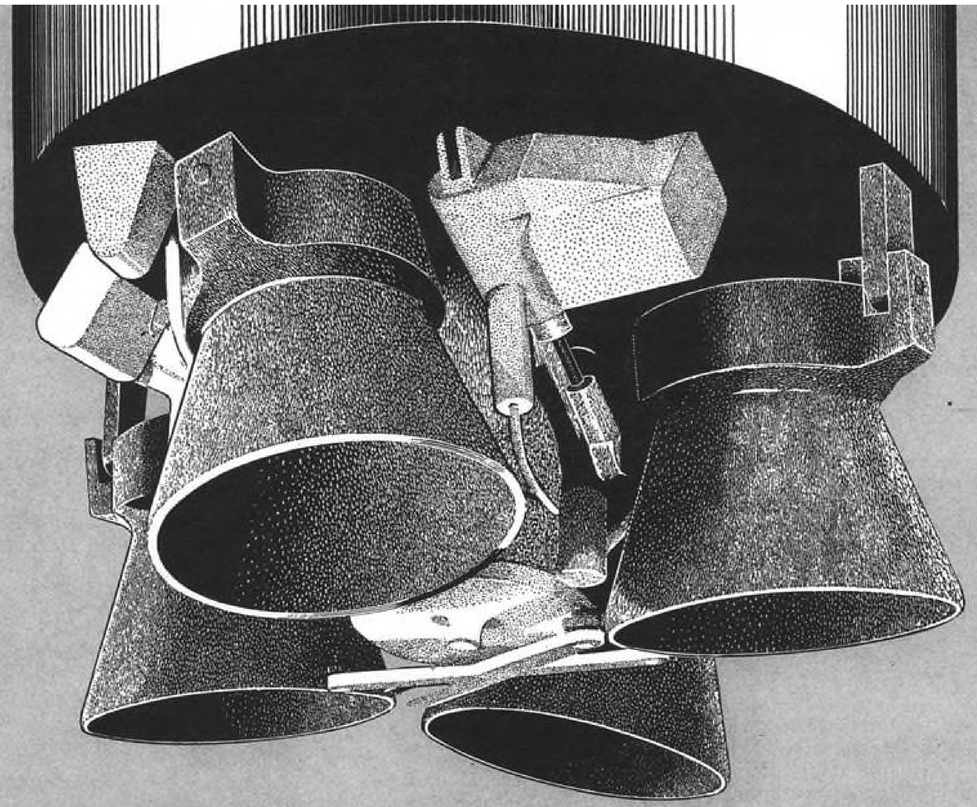
► Aeroflot is developing a 125-passenger "high-density" configuration for its Il-18 turboprop transport. Il-18s now in service seat from 73 to 111 passengers.

► **Federal Aviation Agency will commission the first of 18 new radar beacons this month at the Oakland, Calif., air route traffic control center. When the program is completed, FAA will have a total of 38 radar beacons in operation at 31 air route traffic control centers, some of which have beacon input from more than one radar site.**

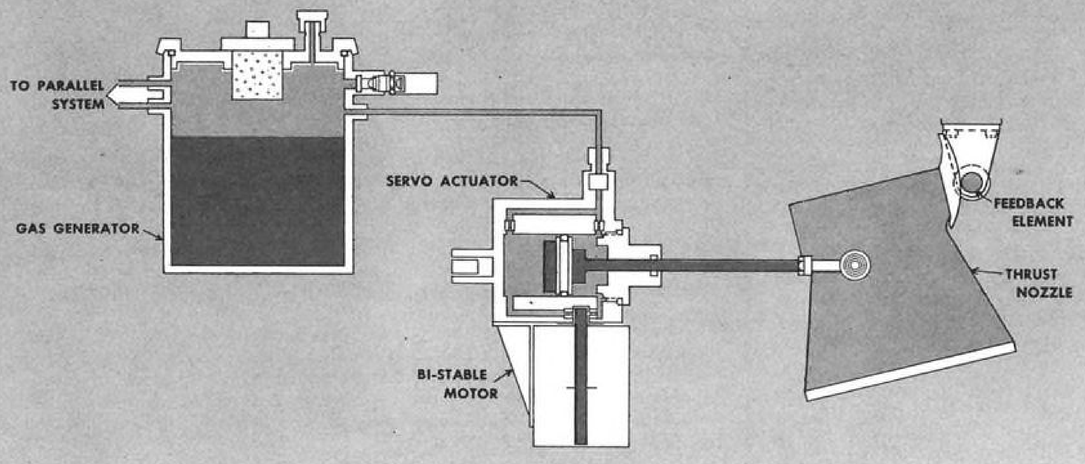
► Supreme Court has refused to review an appeals court decision that reversed the award of a Florida route to Trans World Airlines by the Civil Aeronautics Board in the Great Lakes-Southeast Service Case. The court of appeals ruled that the case should be remanded to the Board on grounds that the granting of a route between St. Louis and Miami to TWA amounted to an award of one-stop southern transcontinental rights when operated in conjunction with the carrier's West Coast-Los Angeles route.

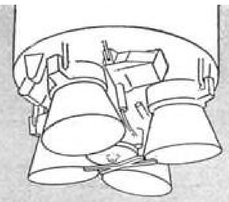
► **Federal Aviation Agency has awarded contracts totaling $67,000 to one foundation and three universities to conduct medical research programs on in-flight fatigue developing in jet aircraft flight engineers, effects of ozone exposure on pilot vision and the establishment of ratings that would set norms for the physiological conditions that can be anticipated at different ages.**

► Allegheny Airlines will lease 23 AVQ-50 airborne weather radar units for use on its Martin 202 and Convair 540 turboprop transports from Radio Corp. of America. RCA has completed a program under which airlines and business aircraft operators may lease electronic devices and weather radar equipment under rental contracts.



BI-STABLE SYSTEM HIGHLIGHTS
CECO HOT GAS DEVELOPMENTS





HOT GAS ACTUATION SYSTEM IN CECO'S BI-STABLE MODE IS

- **more accurate**
- **insensitive to solid fuel contaminants**

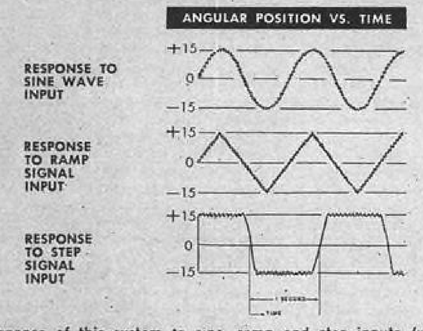
To position a mechanical load in response to an electrical command with minimum error, CECO has developed solid-fueled hot gas actuator systems operating in a bi-stable mode.

In a closed-loop arrangement, increasing the system gain to the point of *infinite* gain produces bi-stability, i.e., the servo valve can assume only two positions: fully closed in either direction. Maximum corrective torque is thereby applied to the load for all errors. With infinite gain, the system will sustain steady-state, limit-cycle oscillation, and the average steady-state error is zero. This is significant in systems with large stiction loads, since proportional controls of conventional philosophy permit larger errors before stiction torque is overcome.

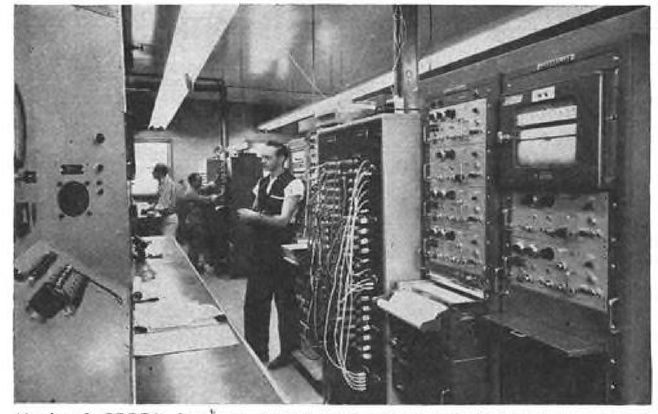
Among applications for CECO's limit-cycle, bi-stable philosophy is *thrust-vector* control. A representative portion of such a system is shown schematically at the left. This design utilizes push-pull actuators. The bi-stable motor, valving and actuators are an integral unit. One large servo-actuator positions the mechanically-linked pitch nozzles, while two smaller actuators position the remaining nozzles in response to yaw and roll commands.

CECO's experimental development program has demonstrated that because of its inherent accuracy and insensitivity to contaminants, the bi-stable control is more reliable than other proportional configurations for solid fuel applications.

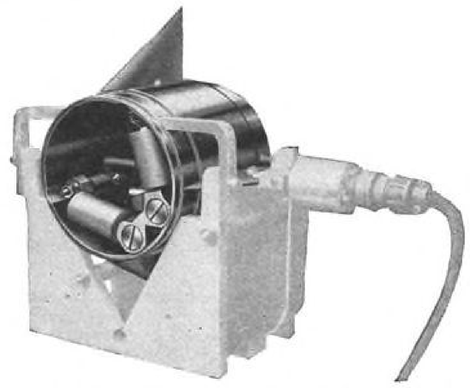
TYPICAL PERFORMANCE OF A BI-STABLE CONTROL



Response of this system to sine, ramp and step inputs (while using a conventional torquemotor) is illustrated. With new components being readied, limit-cycle amplitudes of one-tenth of one degree are expected.



Much of CECO's hot gas system and component development work is carried out in a special facility comprised of the above control room and its associated test cells.



Shown mounted in a test rig, this CECO hot gas system was designed for control-surface actuation.

Familiarity with systems engineering and with precision manufacturing for aircraft and missiles has served CECO well in its extensive work with hot gas servo control systems.

Both actuation and reaction systems have been designed, developed and produced for use with high-pressure hot gas generated from either solid or liquid propellants.

An up-to-the-minute, color-slide presentation containing technical data and a review of hot gas component and system hardware development activity at Chandler Evans is currently available. To arrange to have this presentation given before an engineering group in your company, call or write your nearest CECO Field Engineering Office.

FIELD ENGINEERING OFFICES

WEST COAST
William B. Gurney
7046 Hollywood Boulevard
Hollywood 28, California

MID-WEST
Kenneth L. Moan
Room 305
Spitzer Building
Toledo 4, Ohio

EAST COAST
Robert M. Campbell
Chandler-Evans Corporation
Charter Oak Boulevard
West Hartford 1, Connecticut

CECO® SYSTEMS CONTROLS

Airline Income & Expenses—February, 1960

(IN DOLLARS)

	Passenger Revenue	U. S. Mail	Express	Freight	Charter	Total Operating Revenue	Total Operating Expenses	Net Income Before Taxes
DOMESTIC TRUNK								
American	26,205,958	592,040	345,924	1,941,268	.....	29,512,111	31,466,981	−1,954,870
Braniff	4,963,625	151,653	71,452	156,676	5,498	5,421,695	5,714,806	−406,220
Capital	6,756,642	176,127	122,177	129,997	11,815	7,315,120	9,241,202	−1,926,082[3]
Continental	3,748,000	61,000	40,000	80,000	25,000	4,039,000	4,019,000	−206,000
Delta	8,761,000	155,000	137,000	322,000	.....	9,572,000	9,726,000	−282,000
Eastern	21,206,728	438,511	946,541[2]	.....	14,579	22,805,813	23,199,392	−42,340
National	5,844,532	102,088	30,544	154,581	14,995	6,330,761	6,643,789	35,140
Northeast	2,929,785	46,552	15,763	68,356	.....	3,148,191	3,484,643	−336,452[3]
Northwest	6,018,354	195,423	593,794[2]	.....	−310	6,863,407	7,038,392	−285,927
Trans World	16,481,834	540,550	1,207,625[2]	.....	134,002	18,529,149	22,673,279	−4,067,825
United	18,619,641	765,265	1,914,822[2]	.....	65,796	21,881,417	25,347,778	−3,029,232
Western	4,876,609	109,943	195,289[2]	.....	12,934	5,218,370	4,567,766	592,083
INTERNATIONAL								
American	610,137	8,634	86	39,699	.....	688,508	591,320	97,188
Braniff	614,755	13,305	.....	43,868	.....	734,770	842,928	−123,565
Caribbean Atlantic	300,829	2,513	14,992[2]	.....	1,328	324,417	258,983	64,809
Delta	236,000	4,000	.....	7,000	.....	258,000	358,000	−106,000
Eastern	1,952,012	45,472	80,950[2]	.....	13,260	2,097,540	2,041,276	33,730
Mackey	189,667	.....	600	3,796	.....	210,979	192,333	18,646[3]
National	103,223	1,149	431	2,179	.....	112,209	158,337	−46,128
Northwest	1,569,048	531,184	382,013[2]	.....	−231	2,561,095	2,940,005	−428,276
Pan American Combined	20,943,000	1,548,000	.....	2,855,000	479,000	26,896,000	28,378,000	−2,275,000
Alaska	190,000	14,000	.....	28,000	.....	233,000	442,000	−209,000
Atlantic	7,872,000	654,000	.....	1,080,000	166,000	10,225,000	10,829,000	−584,000
Latin America	6,673,000	192,000	.....	1,062,000	242,000	8,482,000	9,174,000	−747,000
Pacific	6,208,000	688,000	.....	685,000	71,000	7,956,000	7,932,000	34,000
Panagra	1,246,000	46,000	.....	185,000	12,000	1,632,000	1,638,000	346,000
Resort	.....	.....	.....	.....	376,722[4]	378,102	382,309	−4,207[3]
Trans Caribbean	190,074	.....	73,602[2]	.....	39,389	330,453	421,000	−53,068
Trans World	2,941,369	483,576	452,335[2]	.....	149,078	4,305,373	5,304,909	−1,012,758
United	793,095	37,103	20,901[2]	.....	.....	861,193	825,680	15,068
Western	426,882	4,874	9,418[2]	.....	.....	442,537	365,861	71,219
LOCAL SERVICE								
Allegheny	464,517	10,700	11,763	18,635	1,406[4]	779,772	1,036,942	−257,170[3]
Bonanza	377,597	3,940	2,370	6,372	3,710	584,088	591,029	−27,151
Central	158,631	6,806	2,260	6,112	3,729	400,747	474,884	−74,137[3]
Frontier	430,949	12,793	4,311	24,298	4,631	959,085	1,114,659	−171,410
Lake Central	191,367	4,500	7,273	.....	.....	347,118	391,095	−43,976[3]
Mohawk	619,813	9,216	7,853	14,925	13,958	833,129	969,357	−136,357[3]
North Central	843,037	28,116	18,000	18,203	15,146[4]	1,368,218	1,696,599	−345,542
Ozark	500,715	12,815	10,123	16,645	.....	816,297	997,305	−181,008[3]
Pacific[1]	.....	.....	.....	.....	.....	.....	.....	.....
Piedmont[8]	429,643	8,047	4,864	8,055	22,634[4]	708,263	968,225	−286,332
Southern	261,232	9,255	7,112	8,046	.....	499,026	612,876	−113,849[3]
Trans-Texas	329,965	11,879	5,255	14,670	5,989	609,264	675,888	−67,081
West Coast	436,329	8,247	2,096	7,117	565	755,857	930,200	−174,342[3]
HAWAIIAN LINES								
Aloha	306,342	1,764	.....	5,663	6,375[4]	336,143	367,292	−31,149[3]
Hawaiian	463,609	2,707	.....	61,427	71,989[4]	615,286	727,487	−132,415
CARGO LINES								
AAXICO	.....	.....	.....	.....	826,387	876,987	756,453	120,534
Aerovias Sud Americana	.....	.....	.....	104,770[5]	143,569	248,339	239,403	8,936[3]
Flying Tiger	.....	23,550	821,099[4]	.....	847,201	1,701,136	2,204,925	−592,211
Riddle	.....	.....	.....	453,050	.....	463,611	562,362	−98,751[3]
Seaboard & Western[1]	.....	.....	.....	.....	.....	.....	.....	.....
Slick	.....	.....	.....	.....	1,153,842	1,211,885	1,136,481	75,404[3]
HELICOPTER LINES								
Chicago Helicopter	120,134	106,490[6]	.....	.....	.....	226,627	238,525	−13,793
Los Angeles Airways	15,302	11,792	10,241[7]	.....	.....	110,251	113,332	3,070
New York Airways	71,534	4,290	4,584	3,626	.....	258,523	258,024	2,649
ALASKA LINES								
Alaska Airlines	152,564	50,824	859	35,220	237,511	651,287	663,566	−23,568
Alaska Coastal	52,454	10,667	.....	5,656	2,688	137,700	160,827	−23,127[3]
Cordova	9,131	7,395	.....	5,811	12,939	83,518	90,609	−11,582
Ellis	43,645	7,248	.....	5,949	174	104,929	99,484	4,951
Northern Consolidated	48,819	44,572	.....	23,324	6,447[4]	223,835	236,042	−12,247[3]
Pacific Northern	312,865	59,364	1,524	55,789	673	663,466	836,118	−172,246
Reeve Aleutian	107,916	38,240	29,004[2]	.....	20,922	196,451	170,706	22,303
Wein Alaska	42,383	57,178	.....	20,477	25,019	278,797	343,788	−64,981[3]

[1] Not available [2] Property figure [3] Net operating income/loss [4] Non-scheduled transportation [5] Common carriage
[6] Includes federal subsidy [7] Express & excess baggage [8] Airline division figures
Compiled by Aviation Week from airline reports to the Civil Aeronautics Board.

NEW

e·m·r SUBCARRIER DISCRIMINATOR

ALL SOLID STATE...PHASE-LOCK-LOOP DETECTION... MINIATURE... FOR TELEMETRY AND DATA REDUCTION



MODEL 167A Solid-State Discriminator (half-rack width)

The new **e·m·r** Model 167A Subcarrier Discriminator is a precision instrument designed for demodulating FM subcarrier signals with exceptional linearity. The new Model 167A employs phase-lock-loop detection in completely solid-state circuitry to achieve outstanding characteristics of performance and durability in a miniature package. The new discriminator has a true 60-db dynamic input voltage range. Amplitude of each subcarrier signal can be as great as 5V rms in a multiplex of up to 18 subcarriers. Amplitude modulation effects such as tape dropouts are virtually eliminated by dynamic limiting, effective over a true 60-db voltage range.

The design is such that phase-lock-loop characteristics are automatically optimized regardless of channel selector used and output filter chosen. The channel selector delay network provides fine tuning to allow tape-speed wow-and-flutter compensation of better than 100:1. The Model 167A is available with all standard IRIG center frequencies, frequency deviations, and intelligence frequency outputs.

The new Discriminator is packaged in less than half-normal-panel width. Two can be mounted side by side in a 19" rack, using a simple fastener.

CONDENSED SPECIFICATIONS

Center Frequency: IRIG standard; up to 300 KC available
Frequency Deviation: IRIG standards; up to ±40% available
Intelligence Frequency Output: IRIG standards; up to 60 KC available
Input Dynamic Range: 60 db, 5 mv to 5V rms
AM Rejection: less than 0.3% peak bandwidth change for 20 db input step change
Unwanted Signal Rejection: 60 db rejection of f. s. modulation on adjacent channel having 16 db greater amplitude
Linearity: ±0.05% of bandwidth with respect to best straight line
Tape-speed Compensation: greater than 100:1 reduction of wow-and-flutter up to ±10%
Output Stability: ±0.2% of bandwidth in 24 hrs. after 5 min. warm-up
Output: cal. output control adjustable ±1.0V to ±10V at 500 ma load (to 10 kc intelligence)
Power Consumption: 30W at 120V rms.
Size: 3½" x 8" panel; over-all depth, 18"
Meters: two cal. meters provided—Subcarrier Volts and % Output

See the Model 167A in Booths N1, N2
National Telemetering Conference

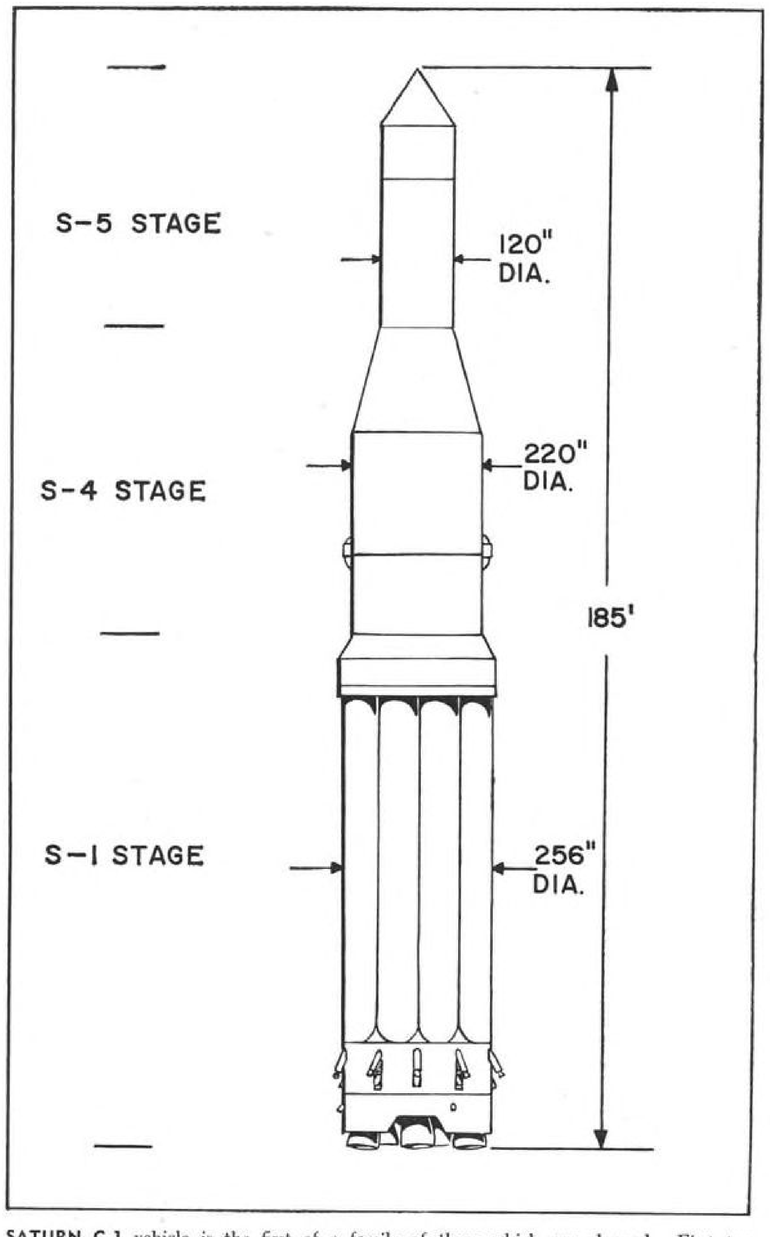
For complete information contact:

emr ASCOP

Electro-Mechanical Research, inc.

P. O. Box 3041, Sarasota, Florida

Safety, Simplicity Stressed in Saturn Design



SATURN C-1 vehicle is the first of a family of three which are planned. First two stages of the C-1 can be used to place a glider of the Dyna-Soar type (about 15,000 lb. gross weight) into orbit. S-5 stage probably will not be used during the boosting of large winged vehicles because its currently planned airframe is too light. Flight testing of the first nuclear rocket can be accomplished with the first two stages of the Saturn C-1. The nuclear engine would be placed in orbit and then started. Booster is due to fly in mid-1961; complete C-1 vehicle will fly late in 1963.

By J. S. Butz, Jr.

Huntsville, Ala.—Conservatism and simplicity are stressed in the detail design of National Aeronautics and Space Administration's Saturn booster in an effort to counteract the reliability-reducing effects of its great size and the clustered engine concept.

Five major conservative design features were considered necessary in the Saturn first stage by the vehicle's designers, the Development Operations Division of the Army Ballistic Missile Agency, headed by Dr. Wernher von Braun, which will be absorbed into NASA July 1. These conservative features provide maximum assurance that the Saturn will perform its vital mission of increasing U. S. space payload capability to 15 tons and more. The features are:

• **Reduction in performance accuracy** required of the Saturn 1.5 million lb. + thrust booster as compared with that of the first stages of current space vehicles. Saturn booster cutoff velocity and position along the trajectory at burnout may vary within wide limits to reduce the need for precise propellant management controls on the eight engines in the cluster and to eliminate the requirement for small vernier engines. First stage of the Saturn will boost the upper stages to Mach 4 or 5 and somewhere above 100,000 ft. on most missions under study. Precision trajectory will be achieved by the upper stages.

• **Structural safety factors** on the Saturn booster are approximately 20% above those normally used on large rockets. This increase in strength puts the Saturn in approximately the same class as commercial transport aircraft from a structural safety point of view. This decision was made because the Saturn specification calls for it to boost manned vehicles into space. The weight increase does not impose as severe a performance penalty on very large rockets as it does on those the size of present ICBMs. The added strength was also attractive because of the recovery requirement for the Saturn booster.

• **Capability of completing** a mission if two of the eight engines malfunction and stop. One engine may stop a fraction of a second after liftoff, and a second may stop firing about 60 sec. later with no adverse effect on the mission. It is necessary, however, that three of the four gimbaled engines function properly throughout the flight if control is to be maintained. Tankage of the booster is interconnected so that, even if two engines are shut down, the tanks will empty together.

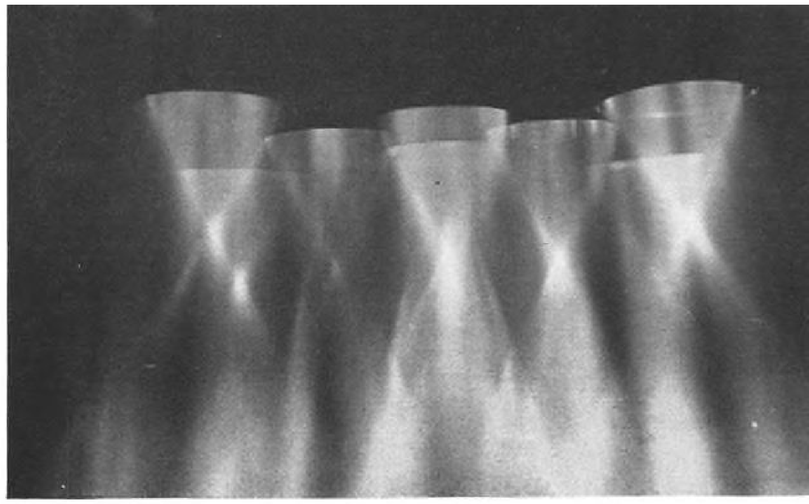
• **Simplified design** of the eight clustered Rocketdyne H-1 engines eliminates the customary electro-pneumatic multi-valve starting system. Engine starting and stopping are accomplished through a single electrical signal and do not require a system of relays and pressure switches on the separate engines. Improvements also were made in the bellows arrangement on the propellant lines running out of the high pressure side of the turbopumps, which, along with relays, have been one of the most frequent causes of engine trouble in the past in the view of Army Ballistic Missile Agency personnel. The turbopumps were mounted on the side of the combustion chamber so that those bellows that move the most and are under the most strain during engine gimbaling would be on the low pressure propellant lines from the tankage into the pumps. Previously, the turbopumps were attached to the airframe above the engine, and the high pressure lines to the gimbaling chamber combustion had to move through large angles and were subjected to more severe vibrations than they are on the new design.

• **More than 600 telemetering** channels will be used to monitor temperature, pressure, vibration, stresses and other conditions at many points on the booster during flight tests. This is approximately double the maximum number of channels that were monitored during the development of previous rockets, but it is considered necessary if the current program goal of using only 10 development vehicles is to be met. Approximately 1,200 vehicles were fired during the development of the German V-2 missile, and about 40 were launched before Convair Atlas was operational.

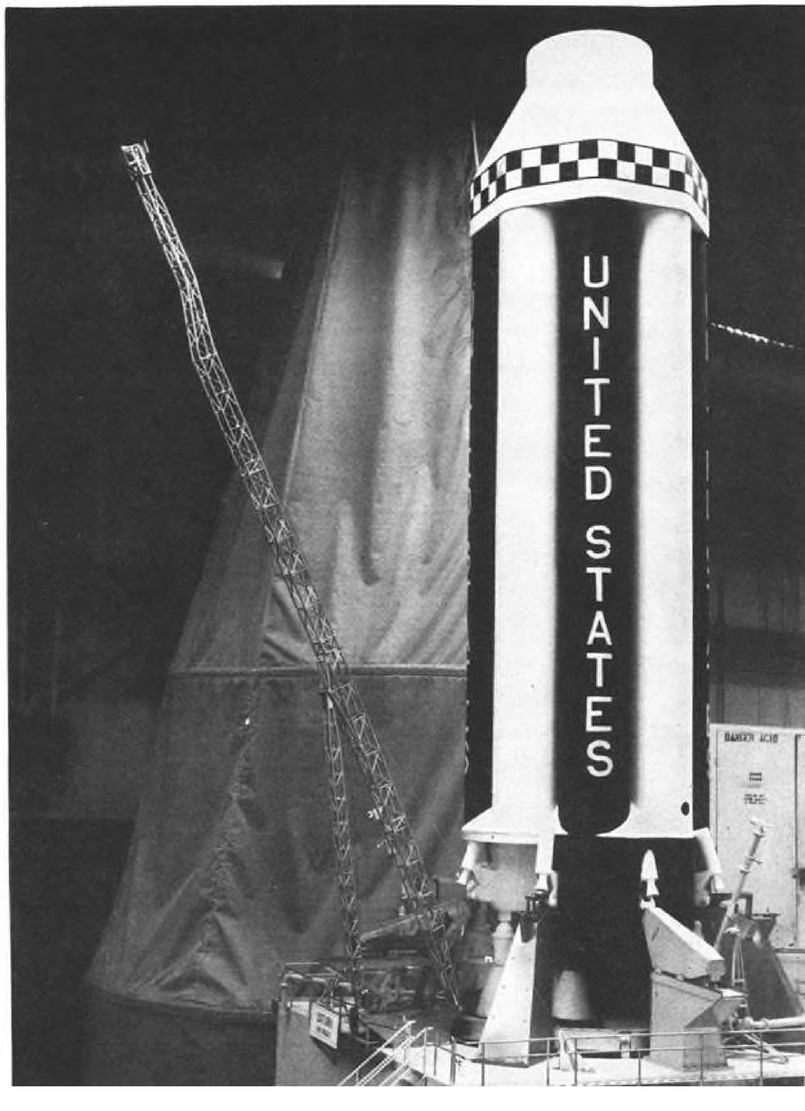
Start and Launch Sequence

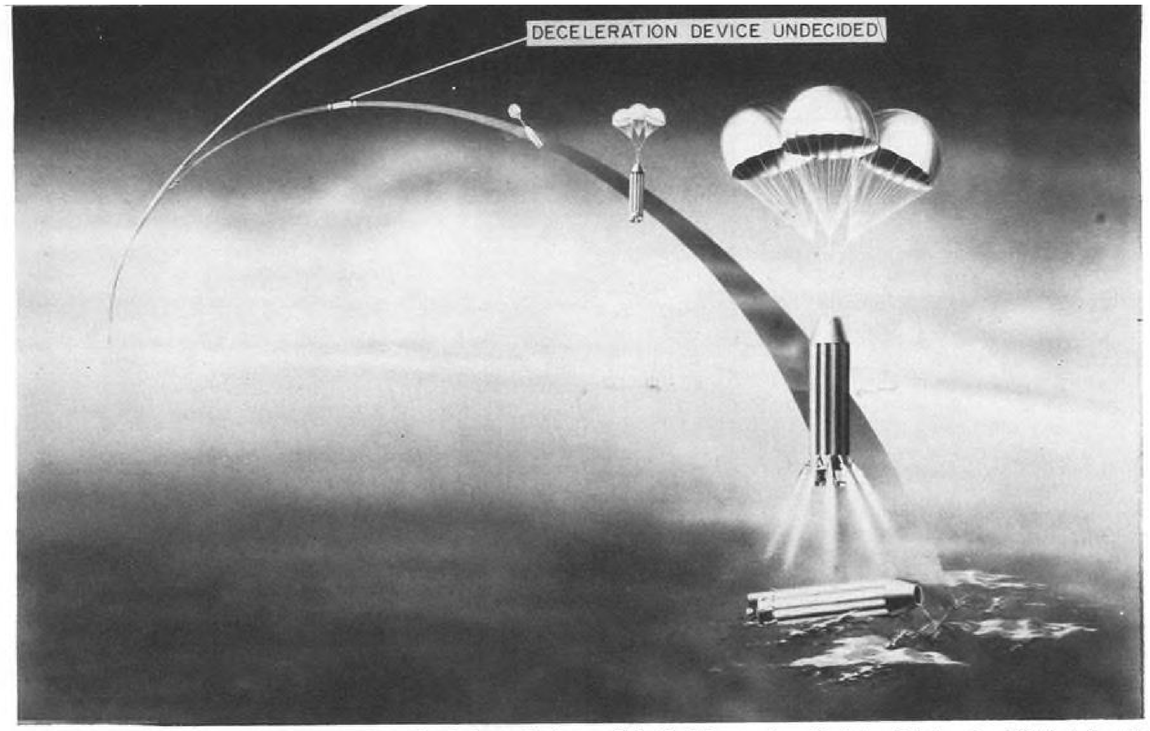
Saturn C-1 vehicle (see drawing, left) will be the first of the Saturn family to reach flight test. The C-1 is a three stage vehicle using the S-1 booster as the first stage, the S-4 stage as the second and the S-5 stage as the final stage. Powerplants for the S-5 stage will be two Pratt & Whitney XLR-115, 15,000 lb. thrust liquid hydrogen rockets and its airframe will be designed and built by Convair. Engines for the S-4 stage will be four XLR-115 rockets

Approach

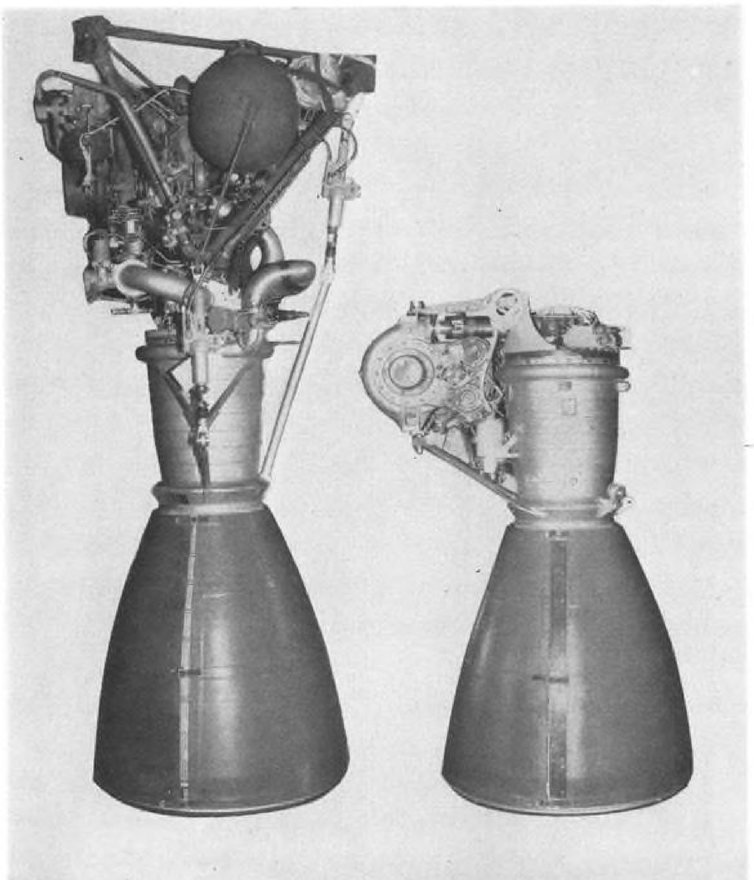


SMALL SCALE tests of the base heating to be expected on the Saturn booster were run with a cluster of 250 lb. thrust engines in the wind tunnels at NASA's Lewis Research Center (above). One-tenth scale model of the Saturn launch stand, its tall unbilical tower and hold-down mechanism is below.





OPERATION of the Saturn recovery system is outlined above. Rockets will be fired by a water-activated switch hanging 100 ft. below the booster. The rockets will allow the booster to enter the water at almost zero velocity. Rocketdyne engine for the Jupiter missile (below, left) is compared with the company's H-1 engine for the Saturn. Simplified start system, turbopump and auxiliary equipment for the H-1 are mounted on the side of the combustion chamber.



uprated to 20,000 lb. thrust and Douglas is the airframe contractor.

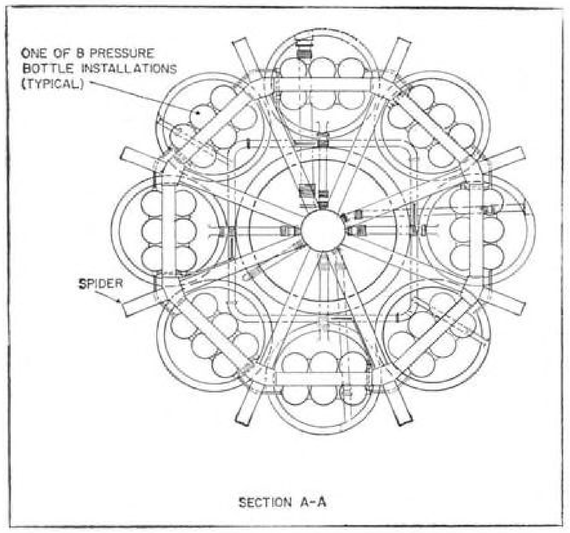
The Saturn C-2 four-stage vehicle will be identical to the C-1 except that the S-3 stage will be mounted in between the S-1 booster and the S-4 stage. Two, 200,000 lb. thrust hydrogen fueled rockets will power this stage. The contractor for these engines and for the S-3 airframe have not been selected.

The five stage Saturn C-3 will be the C-2 vehicle with the S-2 stage added between the S-1 booster and the S-3 stage. The S-2 stage will be powered by four of the 200,000 lb. thrust hydrogen engines of the same type as used in the S-3 stage. Airframe for the S-2 stage probably will not be contracted out for many months.

Simplicity of the Saturn booster operation is also illustrated by a rundown of the starting sequence for its eight engines and the operation of its launch stand.

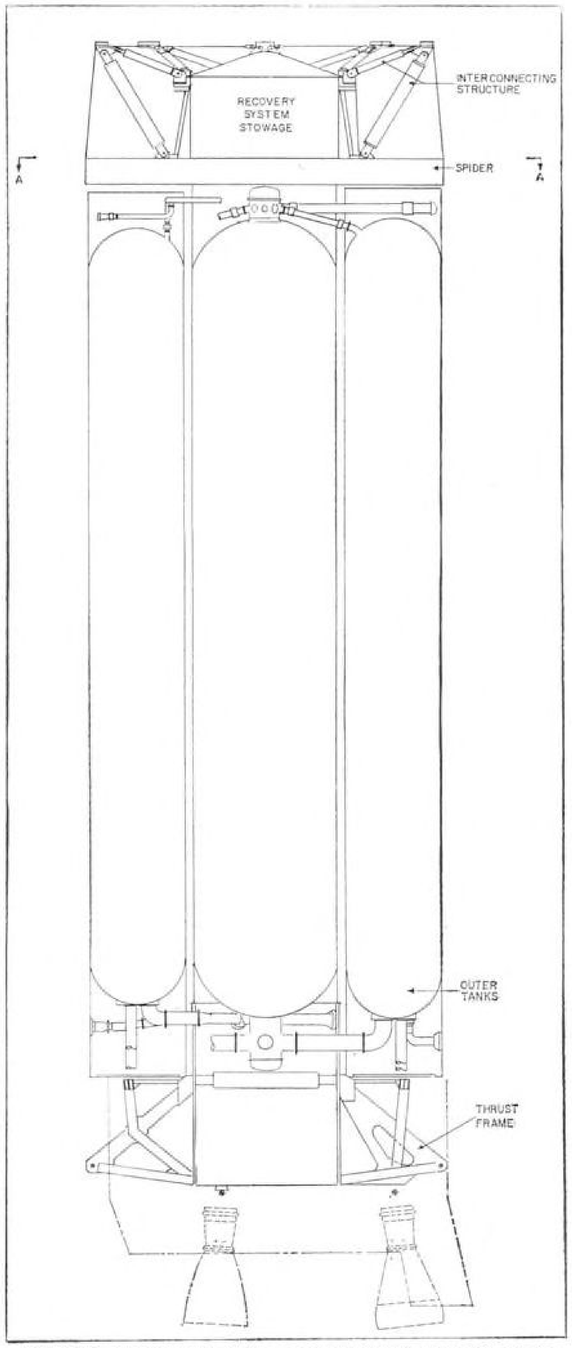
Once the propellant loading operation has been completed, a single signal will start the eight engines almost simultaneously. The engines are started in facing pairs, with a built-in 250 millisecond delay between each pair so that the structure will not receive an asymmetrical load or the full 1.5-million-lb.-thrust at once.

Starting signal to each engine ignites a solid propellant cartridge which brings its turbopump up to speed. When the pump builds the proper delivery pres-

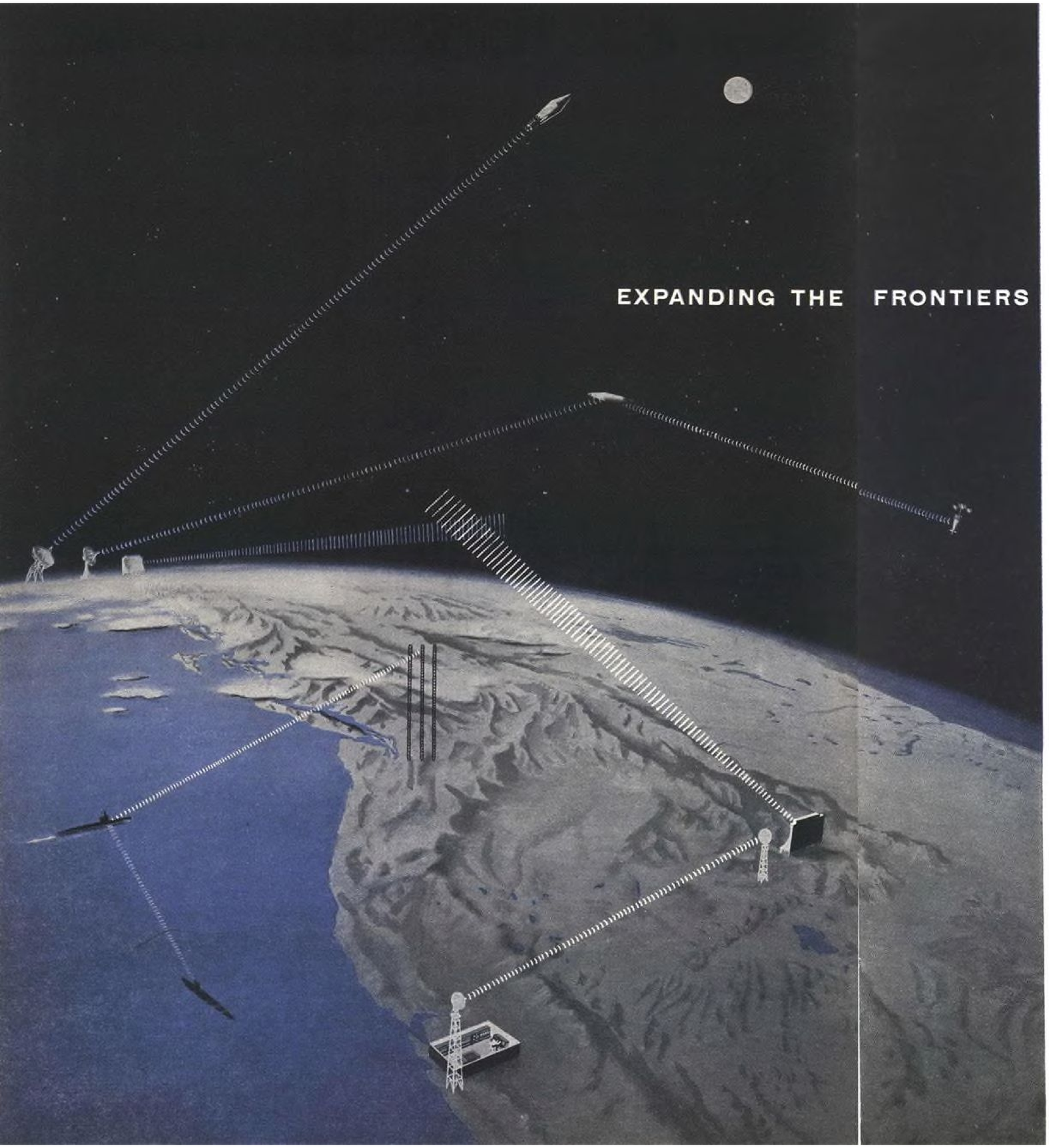


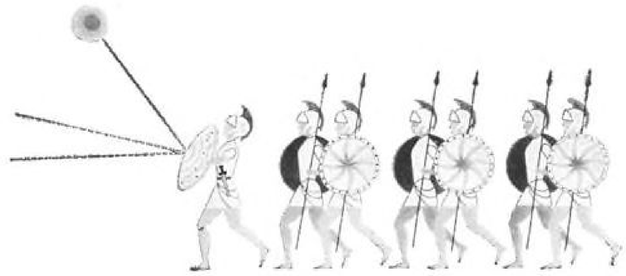
WIND TUNNEL model of the Saturn S-1 booster used for hot firing tests at the Lewis Research Center has cluster of 250 lb. thrust engines. Pressure rakes on the base of the model (near the technician's hands) measure the flow velocity and boundary layer thickness in that area. Skirt of the booster has been indented around the outer gimbaled control engines to reduce the dead air region and heated area on the base. Type of solid firewall across the base of the full scale booster is different from the test configuration on the model above and it is located near the rocket engine nozzle throats.





GENERAL arrangement of the main structural elements of the Saturn S-1 booster are shown above. The engines are attached to the thrust frame at the base. Propellant tank configuration is shown in section A-A (above, left). The center tank holds liquid oxygen, as does each alternate tank in the cluster of eight which surrounds it. All structural loads are carried by the thrust frame, the five liquid oxygen tanks and the "spider" at the top of the tanks which ties into the connecting structure to the stage above. Most of the telemetering equipment on the S-1 will be located above the "spider."





Herodotus, the historian, records (490 B.C.) the use of burnished shields for military signaling. This was the forerunner of the heliograph, invented by Sir Henry C. Mance, which came into wide use centuries later.

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sure in the lines on its high pressure side, a hydraulic valve pops open to permit the propellants to flow into the injector system in the combustion chamber. The sudden pressure rise in the injector system ruptures a diaphragm and releases a charge of aluminum triethyl into the combustion chamber.

This liquid reaches the combustion chamber at the same time as the propellants, and their reaction is hypergolic, causing ignition. Build-up of thrust is very rapid in the H-1 engine since the elaborate start controls have been eliminated. Engine starting and launch will take place in about 1.5 sec.

The eight-point hold-down mechanism on the launch stand will be triggered by instruments which measure the chamber pressure on the eight engines. When the chamber pressure of all of the engines reach full thrust value, four of the hold-down arms will slide back from the booster for about three feet. As these arms reach the limit of their travel along their tracks, they will strike a switch which, in turn, will release the final four hold-down clamps that operate on a flip-back principle.

If the chamber pressure on any of the engines fails to make the normal rapid thrust acceleration to maximum pressure, the stop sequence, rather than the launch sequence, is automatically engaged. This stop sequence consists of just one signal to each engine which triggers a solid propellant cartridge that stops the turbopump. When the pressure in the propellant lines is lowered in this manner, the spring-type valve in the lines close.

Thrust regulation in each engine is accomplished simply by placing orifices in the fuel lines to the gas generator which powers the turbopumps and, in the high pressure propellant lines, to the combustion chamber.

These orifices restrict the flow to that required to produce a given thrust. Thrust of the eight engines in each cluster will be closely matched through test running and calibration to select the proper-size orifices for their lines. This calibration procedure takes about two short firings for each engine.

Liquid rocket engines on most of the large missiles now in use have a more elaborate fuel control system, although they cannot be considered to be throttleable. These engines have the same orifices on their lines but also have a control loop for the turbopump to regulate propellant flow to match any fluctuations in combustion chamber pressure and other engine operating parameters. The state of the art has progressed to the point where such control systems are not necessary on the Saturn's H-1 engines to damp out rough burning or other engine instabilities.

After a successful flight by the

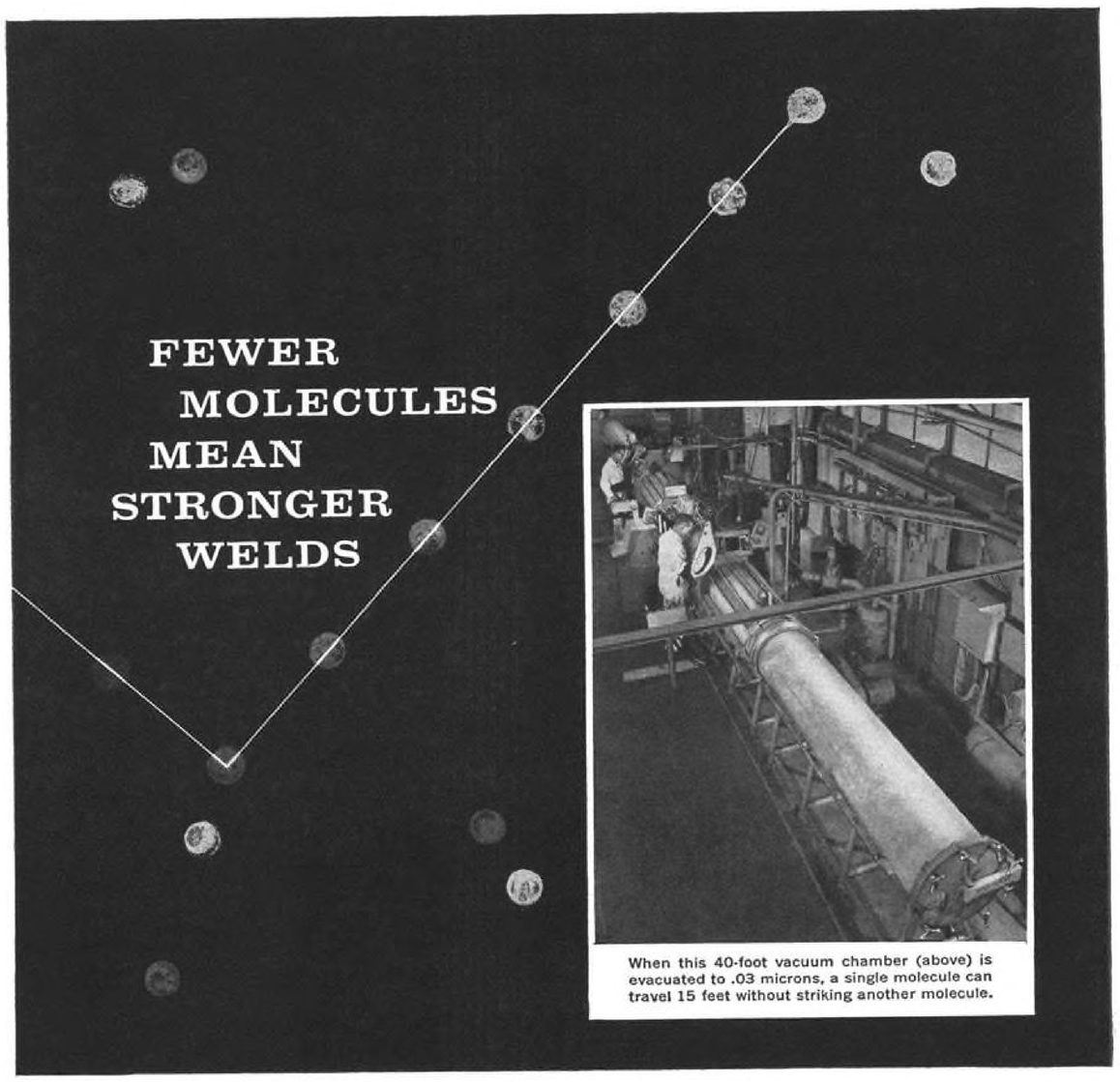


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SPACEATOMICS Budd DIVISION

Saturn booster, the engine stop sequence can be triggered simultaneously for all engines, either by command from the ground or automatically through instruments that measure the amount of propellant left in the interconnected tanks.

First phase of the Saturn recovery sequence has not yet been firmly established. Ideas under consideration for the first deceleration phase include plans to either trail a large balloon or a solid-type speed brake behind the booster by cables. The cover of the instrumentation and control system compartment on top of the booster above the propellant tanks also has been considered for possible use as a speed brake.

During the first phase of the recovery, the booster will have to be slowed down from Mach 4 or 5 to a speed between Mach 1.5 and 1. Then, the first phase deceleration device will be dropped, and a single ribbon-type parachute will be used to reduce the booster's speed to Mach 0.8 or 0.7, according to present plans. This parachute will then be dropped, and three 105 ft. dia. chutes will be deployed to slow the booster's descent to 80 or 90 ft. per sec.

This final vertical velocity will be removed by eight solid propellant rockets that will burn for slightly more than a second so that the booster will theoretically strike the water at zero speed if there is no wind to give it a horizontal velocity component. The eight solid-propellant deceleration rockets are ringed around the base of the booster just above the main engines. They will be triggered by a water-activated switch suspended below the booster on a 100 ft. line. Design of the recovery system is being handled under contract by Cook Electric Co., of Chicago.

Water Impact

On most missions, the booster will enter the water about 200 mi. downrange from the firing point at the Air Force Missile Test Center, Cape Canaveral; it will float easily through the buoyancy of its propellant tanks. A crane on a Navy Landing Ship-Dock will be used to lift the booster from water and place it on the barge that transported it from the Marshall Space Flight Center in Huntsville.

Disassembly and cleaning of the booster engines will begin immediately in order to prevent corrosion damage. These engine parts, if they pass inspection, will then be returned to the parts' inventory and used in the assembly of new engines. It is predicted now that almost all these parts, which represent a large portion of the booster cost, will be reusable.

It also is believed that the propellant tanks, booster thrust structure and other parts of the airframe will sustain little damage and will be reusable. The tanks are being made of 5456 aluminum alloy which welds and repairs easily, although it is not the optimum metal from a strength-to-weight ratio standpoint.

The Saturn booster and its transport barge may both be loaded aboard the LSD and taken to New Orleans to start the river journey back to Huntsville if any acceleration is required in the program. Several days may be saved in this way out of the predicted 17-day barge trip around the tip of Florida and up the Mississippi, Ohio and Tennessee rivers from the recovery area to the Marshall Center.

Booster Assembly

Current plans call for the assembly and most of the parts fabrication for the 10 Saturn development vehicles to be carried out at the Marshall Center. If any subcontracting of the booster airframe begins prior to the construction of the first operational vehicle —No. 11—it probably will involve the propellant tanks. NASA's primary concern before phasing-in industry contractors for the fabrication of Saturn booster parts will be to make sure that the configuration is finalized and that there will be no further changes to raise manufacturing and tooling costs.

A large percentage of industry contracting is planned for the manufacture of the operational Saturn boosters. Final assembly of the operational boosters and tests of their functional systems probably will be conducted at Huntsville to reduce the load on the checkout and launch facilities at Cape Canaveral.

Major portion of the development testing of the upper stages of the Saturn vehicles will be conducted by the industry contractors in charge of their design. A small liquid hydrogen facility probably will be constructed at the Marshall Center, however, to permit government personnel there to become familiar with the problems of handling the propellant which will be used in all of the Saturn upper stages. Marshall Center officials believe that they must have personal knowledge of the technical problems facing their contractors if they are to retain their competence as managers. The liquid hydrogen fueling capability at Huntsville will allow the NASA personnel there to make a small contribution to the development testing of the Saturn upper stage engines.

Structural design of the Saturn booster is of the rigid-wall-type in contrast with the thin-wall, balloon or internal pressure structure used on the Air Force-Convair Atlas ICBM. Saturn upper stages probably also will use this rigid design, with relatively heavy walled propellant tanks that have closely spaced internal ring frames to prevent local buckling of the tank skin. Two



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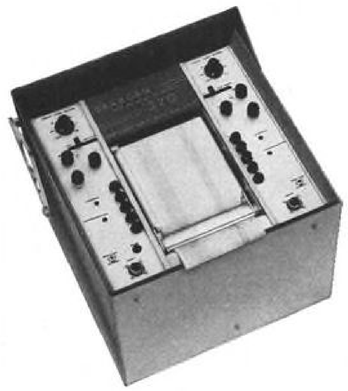
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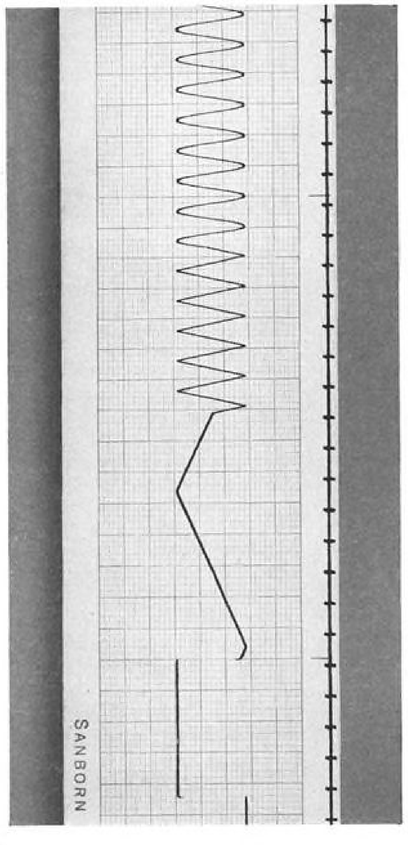


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primary considerations influenced this basic structural decision for the Saturn:

• **Exact types of manned vehicles** that will be carried on the front end of the Saturn have not yet been determined. If any of these vehicles have large wings, the bending loads on the Saturn structure will be substantially increased over the loads experienced when the payload has a non-lifting shape. Rigid wall construction should permit a wider variety of payloads. Installation of the heavy connecting structure between the stages required during the boosting of winged vehicles will be simplified by the rigid wall construction.

• **Weight savings** also may be possible through use of the insulation material on the liquid hydrogen tanks as load-bearing structure. Several materials are under study which apparently have good strength and insulation qualities. Glass-fiber-type materials are among those being considered. Until recently, it was believed that a double wall tank with a vacuum space between them would be required to get the degree of insulation necessary to maintain liquid hydrogen fuel aboard a rocket.

Ring frame supports inside the Saturn tanks also will serve as attach points for anti-slosh baffling. The propellant slosh problem increases markedly as vehicle size is increased.

Load-Carrying Members

Saturn first-stage booster consists basically of a heavy thrust frame to which the eight engines are attached; eight 70-in.-dia. propellant tanks grouped around a center tank of 105-in.-dia., and a heavy eight armed "spider" frame on top of the tanks that will tie into the structure connecting the first stage to the second. The center tank and each alternate outer tank will carry liquid oxygen, the four remaining outer tanks will hold RP-1 fuel.

All of the structural parts listed above will carry a portion of the thrust and bending loads, except for the four fuel tanks, which have a wall thickness of .090 in. and will be unloaded except for the forces imposed by the fuel. More than 60% of the thrust load will be carried by the center liquid oxygen tank which has a wall 0.25 in. thick.

The diameters of the propellant tanks were selected to allow the use of the 70-in.-dia. Redstone and 105-in.-dia. Jupiter tooling and welding machine installations at Huntsville. The Saturn tanks are longer, however, than those of the two missiles. The Redstone tank is approximately 40 ft. long, for instance, and the outer tanks on the Saturn are about 52 ft. long.

Two major aerodynamic problems with the Saturn C-1 vehicle are base heating and stability. These problems are expected to be more severe as stages are added and the vehicle becomes longer in the C-2 and C-3 configurations.

Flow pattern around the base of a missile has proved to be almost impossible to predict for all combinations of forward speed and altitude, even when only one rocket engine is used to power the missile. The rocket exhaust interacts with the shock wave system trailing behind the missile and forms unpredictable dead air regions and turbulent mixing zones.

The air trapped in these regions is heated by the exhaust and heats the base of the missile. In some cases fuel-rich exhaust flow from the rocket engine turbopump is caught in these areas, creating a fire and explosion hazard. The base flow and heating problem has been most unpredictable with missiles powered by several rockets. The eight-engine cluster behind the Saturn adds a new complexity to the problem.

Design of the Saturn booster base region was accomplished at ABMA primarily through theoretical studies, cold flow tests with small models and hot firing tests of a booster model with eight 250-lb.-thrust engines in a wind tunnel at NASA's Lewis Research Center at Cleveland.

As a result of these efforts, the Saturn booster design includes the fol-



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TITANIUM ACCESS PANEL which covers engine in DC-8, complete with titanium details, measures 102" by 76" and weighs 80 pounds. Cumulative tolerances are controlled so closely at Ryan that each door is interchangeable with any pod built for a specific airline. 600 pounds of titanium (TMCA grade Ti-75A) are used in DC-8's pods and pylons

DOUGLAS AIRCRAFT COMPANY, INC., *has never built an airplane that failed to show a profit for its operators. Based on the experience of United Air Lines, the first carrier to fly the airplane, the latest Douglas ship, the DC-8 jetliner, indicates it will push this record forward. Here's how use of titanium contributes to the total efficiency of the airplane and what that efficiency means in dollars and cents.*

The flyaway airframe of the DC-8 jetliner provides its operators a basic economy almost anomalous in current design: payback on every flight without research or development costs to be amortized. That's how Douglas engineers state the value of titanium in achieving a minimum weight airframe structure.

Primarily an aluminum ship, the DC-8 offered few possibilities for weight savings during design. But where weight could be reduced – in pods and pylons, rip stoppers and door doublers–titanium was selected: –600 pounds of commercially-pure grade Ti-75A for pods and pylons; 330 pounds of Ti-6Al-4V titanium alloy grade for rip stoppers and door doublers; 15 pounds of miscellaneous titanium forgings. Metal is supplied by Titanium Metals Corporation of America.

The net result is elimination of a half-ton of needless airframe weight for the 5,000 flights each DC-8 is expected to make during its seven-year write-off.



TITANIUM ACCESS DOOR, through which DC-8 engine will be serviced, is installed on the aircraft by two Douglas Aircraft Company, Inc. employees. Pods of the DC-8 have been so designed that titanium will completely seal off any engine fire



TITANIUM RIP-STOPPERS play essential role in Douglas fail-safe approach to airplane construction. DC-8 uses 330 pounds of Ti-6Al-4V alloy titanium produced by Titanium Metals Corporation of America



Interpretations of the value of weight savings include:

- DOUGLAS AIRCRAFT: "The 1,000 pounds (of weight saved) are equivalent to five passengers and their luggage for the entire life of the airplane."
- UNITED AIR LINES: "At the very least, the weight saved by titanium is equivalent to a half-ton of cargo. At mail rates, this would amount to a potential of $525 for each coast-to-coast flight."

Why titanium?

Titanium, with a density of 0.163 lb/cu. in. is produced in strengths equal to or surpassing steel on a strength-weight basis. Its resistance to atmospheric corrosion is permanent.

The reliability of titanium has been established with demonstrated clarity. Examples:

- DOUGLAS has employed titanium in every commercial transport since its first DC-7, where titanium in firewalls, nacelles and landing gear doors yielded 200 pounds of weight savings.
- PRATT AND WHITNEY AIRCRAFT reports that more than one million flight hours have been accumulated by more than 5,800 P & WA JT-3 and JT-4 engines using titanium components without a single failure of any titanium part, either through corrosion or mechanical damage. Both engines have been specified for the DC-8.
- Alluding to titanium's reliability as its "sleeper property," W. Stuart Lyman, Principal Metallurgist, BATTELLE MEMORIAL INSTITUTE, made this comment in a lecture in Los Angeles March 19:

  "We have talked with metallurgists from three large users of titanium recently. To a man, they reported that once titanium passes receiving inspection, gets fabricated, passes final inspection, and gets assembled into the airplane, it is usually never heard from again."

Is titanium competitive in price?

RYAN AERONAUTICAL COMPANY, which fabricates the bulk of the titanium assemblies employed in the DC-8, commands industry-wide respect for its skill of craftsmanship and the attention to detail it brings to every job. Example: To guarantee maximum cleanliness, Ryan's DC-8 final assembly building in San Diego has been so constructed that no doors or windows open in the direction of prevailing winds.

While overlooking no opportunity to impress upon employees' minds that titanium metal costs more than steel, Ryan has developed manufacturing techniques to fabricate titanium at prices roughly equivalent to steel's. The spread between "input metal" and completed assemblies is thus drastically narrowed since fabrication costs are, of necessity, far greater than raw material costs.

Highlighting titanium's fabricability is Ryan's production of the access panels which cover the DC-8 engines. These panels –literally the doors through which engines will be serviced for life – are made from three sections of 0.016" Ti-75A, 36" x 72", hot stretch-formed and welded together to form the skin of the completed door. Details, such as stringers, channels, ribs and frames, are then welded or riveted to the skin. The completed product weighs 80 pounds and measures 102" long by 76" in the curvature. Control of tolerance (cumulative tolerances are ±0.005") is so highly developed at Ryan that these massive-appearing access panels are interchangeable with any pod built for a specific airline.

Where does titanium belong?

Titanium metal, built into the DC-8 as a basic design material, has been used in a variety of civilian and military applications in a direct volume-for-volume substitution for heavier materials to capture weight savings sufficient to permit improvements in systems or payload capacity.

Although such weight reduction programs and the attendant dollar value must be viewed in relation to the specific application, titanium's permanent resistance to atmospheric corrosion yields dividends immediately apparent to operators of commercial carriers. It means 8 to 10 trouble-free hours operation each day when maintenance means not only repair costs, but also downtime of expensive equipment.

In pods, pylons, landing gear doors, bulkheads, stringers, and a host of similar parts, titanium's weight savings are measured in *payback*. In projects such as solid and liquid propelled missiles, titanium's weight savings are measured in *payload*.

Why Titanium Metals Corporation of America?

Titanium Metals Corporation of America, the nation's only organization devoted exclusively to development, production and sale of titanium metal, has wide interest in establishing titanium metal only in those areas where it is of value to you.

The interest arises from the basic belief that a satisfied customer is a steady customer.

This interest is manifested in TMCA's genuine efforts to meet your delivery schedules; to provide you with whatever information you need concerning properties of titanium and manufacture of finished assemblies; and to pass on to you the price advantages gained through TMCA's technological progress.

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lowing features to minimize base heating effects:

• **Skirt around the engines** was indented considerably between the four gimbaled control engines on the outside of the cluster. This directed large streams of high energy air around the four center engines to prevent dead air regions near them.

• **Heavy firewall** was placed across the base of the booster at approximately the throat sections of the engines. This highly-reflective gold-plated firewall does not fit tightly around the engines and loose, bellows-like skirts made of quartz-fiber cloth and attached to the firewall and the engines keep hot air from flowing back around the turbopumps and the propellant feed lines. A small firewall also has been placed between the nozzles of the four rigidly-mounted center engines at the nozzle exit areas. This prevents over-heating in the small space between the nozzles.

• **Turbopump exhaust flow** from the four center engines is piped to the outside of the booster skirt and dumped into an area of constant high velocity air flow. Aspirators are used on the nozzles of the gimbaling engines to mix the turbopump exhaust with the engine's main exhaust flow. If this system had not been used, the turbopump exhaust pipe would require a bellows joint which would allow the pump to gimbal with the combustion chamber.

It is possible that flight tests will show that the present design will not completely protect the base of the booster from excessively high temperatures. One of the fixes that probably will be tried if this situation arises will be the use of air scoops near the bottom of the propellant tanks to direct more high speed air flow in around the center engines. Use of air scoops is difficult, however, because the inlet area required for maximum flow changes with speed, altitude and pressure at the exhaust point. It is entirely possible to have reverse flow through such duct systems during some flight conditions.

Lenin Space Prizes

Moscow—Lenin prizes have been awarded to Soviet physicists Sergey Vernov, Aleksandr Chudakov, Shmaya Dolginov and Nikolay Pushkov for discovering and studying earth's outer radiation belt and compiling a picture of the distribution of charged particles; and for discovering that the moon has no magnetic pole, according to the Russian news agency Tass. They discovered that there is an area near the earth's poles that is free of radiation particles, Tass said.

Extremely large rockets such as the Saturn vehicles are highly unstable. The center of gravity of the Saturn C-1 is located on the heavy booster, and the center of lift under most flight situations is several meters forward of the center of gravity on the light upper stages.

Problem of controlling a large unstable vehicle of this type with gimbaling engines is more complicated than for the ICBM-size vehicle. The natural frequency of the big vehicle is low and approaches the natural frequency of the avionic control system for the engines. When the control engines move slowly to correct the motions of the vehicle, it is possible for them to get out of phase with the signals that control them so that the motions are amplified rather than damped out.

If the control engines move too rapidly, it is possible for the mass effects of their movement to cancel out the control effect of the change in thrust vector direction. Mass effects can get ahead of thrust vector effects.

These problems are typical of those facing the designers of the servo control system for the gimbaled engines on the Saturn booster. This control system will have to be of a more advanced type than the other servo control systems used on aircraft and missiles and these circuits are now in design.

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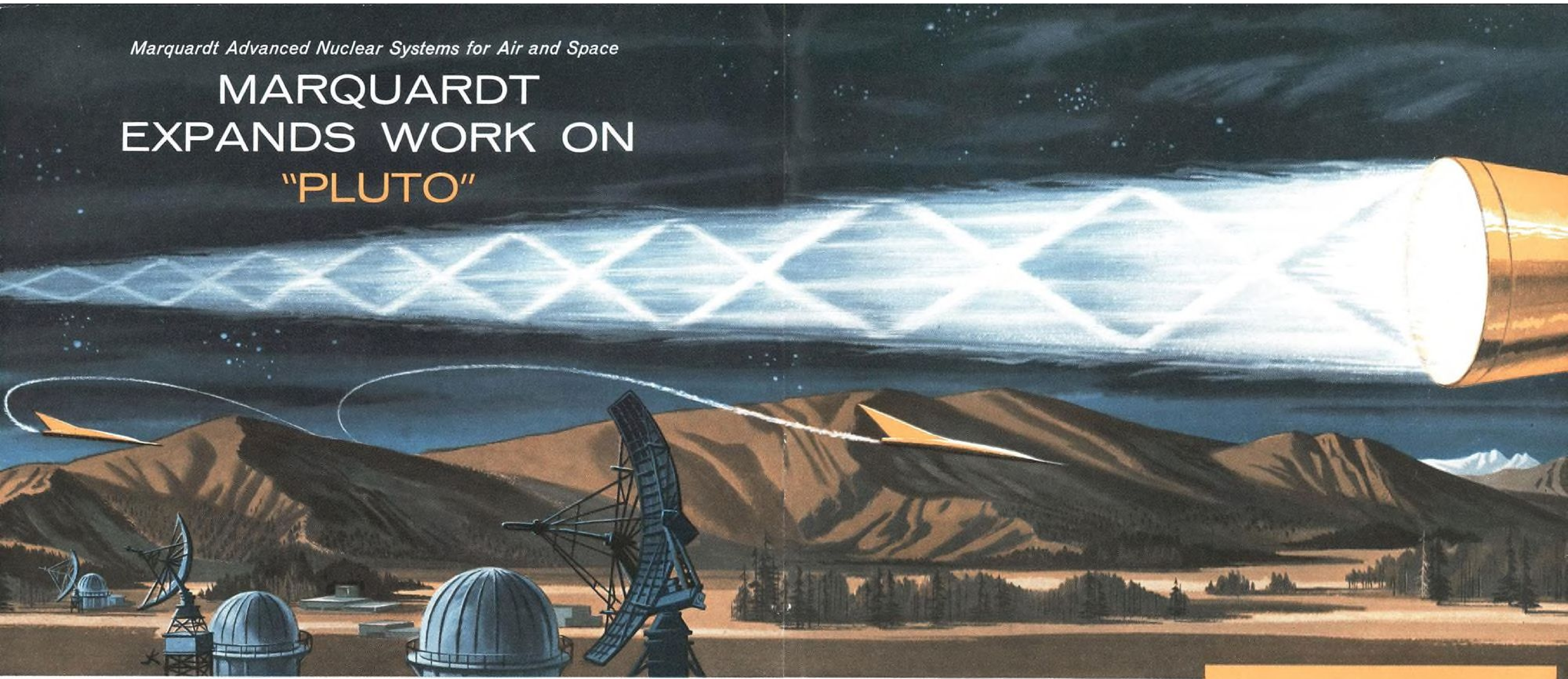
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Marquardt Advanced Nuclear Systems for Air and Space

MARQUARDT EXPANDS WORK ON "PLUTO"



Broadened team effort with University of California's Lawrence Radiation Laboratory aims toward early feasibility demonstration of a nuclear ramjet reactor (Project PLUTO).

A supersonic, low-altitude missile capable of weaving, feinting and dodging unobserved by conventional radar while seeking out selected targets — this is to be the mission of the Air Force's proposed nuclear ramjet-powered vehicle of virtually infinite range.

As an integral part of the team which is contributing to this country's all-out race for supremacy in weapons, Marquardt is working with the University of California's Lawrence Radiation Laboratory on the nuclear ramjet program, known as Project PLUTO.

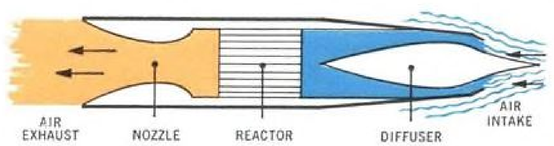
Marquardt's basic PLUTO effort concerns preliminary design of the nuclear ramjet and development of airborne reactor controls and other components for severe temperature and radiation environments. The multi-million dollar program supports a multi-phase corporate effort headed by the Nuclear Systems Division.

Other aspects of Marquardt's PLUTO effort include: support of LRL's feasibility tests on the non-flyable Tory IIA reactor; design and fabrication of significant portions of the reactor's control system, air ducts, flow instrumentation and remotely operated disconnects; fabrication and test of reactor core structural components; architect-engineering on the test air supply system; participation in a supporting program of environmental tests; and preliminary design of test facilities for full-scale power-plant development.

Highlights of the Corporation's other current nuclear programs include: exploration of both military and non-military applications for transportable reactors of advanced design, including their use for space power; development of the engine control system for the G-E nuclear turbojet; research studies of advanced space propulsion devices utilizing nuclear concepts; materials and processes work with molybdenum, other refractory metals and ceramics; and development of original nuclear instrumentation.

For a copy of Marquardt's new "Nuclear Systems" brochure, write to Mr. Aikman Armstrong, Chief Applications Engineer-Nuclear Systems, The Marquardt Corporation, Van Nuys, California.

THE NUCLEAR RAMJET



Nuclear Systems Division of The Marquardt Corporation is engaged in a continuing search for engineers and scientists capable of contributing advances in nucleonics state-of-the-art. Current expansion within this division creates challenging opportunities for: REACTOR PHYSICISTS • CERAMICISTS • NUCLEAR ENGINEERS • METALLURGISTS.

Qualified men are invited to contact: Mr. Floyd Hargiss, Manager, Professional Personnel, The Marquardt Corporation, 16555 Saticoy St., Van Nuys, Calif.

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16555 SATICOY STREET, VAN NUYS, CALIFORNIA

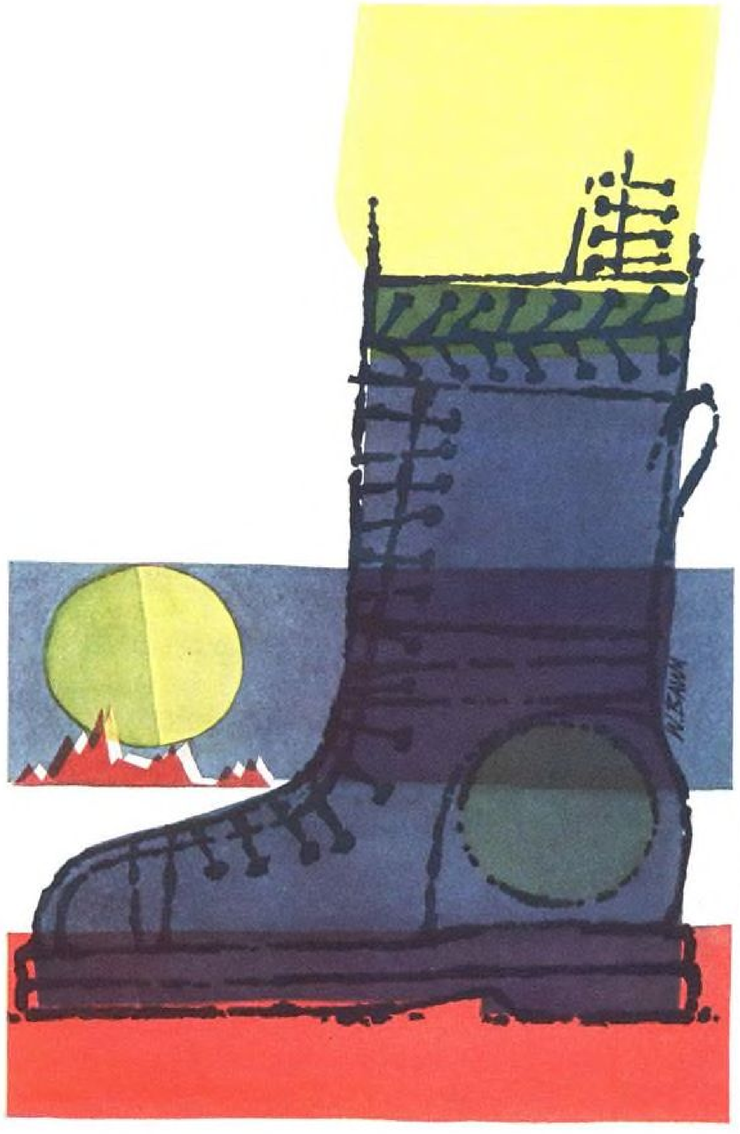
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Machining Improvements Cut Man Hours

By Michael Yaffee

New York—Improvements in machining over the next decade are expected to cut man-hour requirements in half and enable aerospace manufacturers to work high temperature, high strength materials with speed, precision and low cost not now possible.

In the fabrication of high speed aircraft, missiles and space vehicles, aircraft manufacturers are using a host of new, high strength metals and alloys that are proving difficult, expensive and, in some cases, impossible to work by conventional machining processes.

To overcome these drawbacks, industry and the Air Force, particularly the Air Materiel Command's Manufacturing Methods Division, are carrying out an extensive program aimed at the development of new machining techniques and equipment. This program has now begun to pay off in a number of promising new developments.

Among the more prominent of these new material removal developments are the following:

• **Hot machining.** Conventional tools, such as carbide cutters, are used. The work material is heated (probably by induction heating) just ahead of the cutter so that it is much weaker than the parent metal. This method can be used on high strength steels, super alloys and the refractory metals. In addition to enabling fabricators to machine the "unmachineable" high strength metals, the technique has already tripled cutting speed and, over the next 10 years, may increase permissible cutting speeds by another 100%. Still in the research and development stage, hot machining is being investigated by The Cincinnati Milling Machine Co. under an AMC contract.

• **Ultra high speed machining.** Normally, as cutting speeds increase, tool wear also increases. But there is some indication—highly disputed and defended—that beyond a "valley of death" (a cutting speed range in which tool temperatures and cutting forces become abnormally high) that tool temperatures and wear begin to decrease. Since 1958, Lockheed Aircraft has been investigating machining speeds above the currently accepted limit of 15,000 fpm. under an AMC contract. The approach has been to use guns which shoot work pieces across fixed tools. Some acknowledged machine tool authorities say this program is a wasted effort because the original idea didn't take into account the buildup of inertia forces. Others, such as Cincinnati Milling's Dr. Eugene Merchant, believe the idea is worth investigating for possible long-range payoff. As Dr. Merchant reported at the recent Society of Aeronautical Engineers National Aeronautic Meeting, the only way to find out what happens at these ultra high machining speeds is through experimentation, since there is no experience to use as a guide.

• **Chemical milling.** This technique, in which chemical etchants are used to remove metal, is now being used extensively in the aircraft industry in the fabrication of aluminum and magnesium airframe components. Although a comparatively slow method of removing metal, it offers the advantage of being able to work precisely over a broad expanse of material at one time. Because there are no cutting tools involved, there is no tool wear as such. Too, chemical milling is not limited by the strength of the material. To some extent, it is being used on high strength steels and super alloys. But the use of chemical milling on high strength materials is still more of a development effort than a production operation and will be until such problems as embrittlement and uneven etching can be solved.

• **Electrolytic grinding.** In this process, which is now a commercial operation, a metal-bonded abrasive wheel is used along with an electrolyte. The abrasive wheel and work piece are connected to a current source and a potential is established between them. The bulk of the metal is removed by electrolysis (deplating) with the abrasive serving primarily as a scrubber and spacer to remove waste and to prevent shorts. Essentially a cold operation electrolytic grinding does not produce any thermal effects. Forces on the work piece are reduced and tool life is increased. Also, the process offers a higher metal removal rate than conventional grinding and will work on high strength metals, as long as they are electrically conductive.

• **Electrochemical machining.** Like electrolytic grinding, this process removes metal by electrolysis or deplating, but it does so without the use of a grinding wheel and so is not limited by the geometry of the grinding process. This process, which can be considered either as an electrical assist to chemical milling or a simplification of electrolytic grinding, is closer to a universal machining process, says Dr. Merchant. It also possesses the potential of a higher metal removal rate. This rate is directly related to the amount of current used but in practice would be limited by the amount of heat generated. Electrochemical machining will work well on very high strength materials that are conductive; and its rate of penetration is expected to jump at least fourfold in the next decade. At the present time, this process is essentially still in the development stage. Among other things, there is a need for controls to give the process preciseness, for suitable electrolytes and for an improvement in surface finishing.

• **Electron beam machining.** This is a

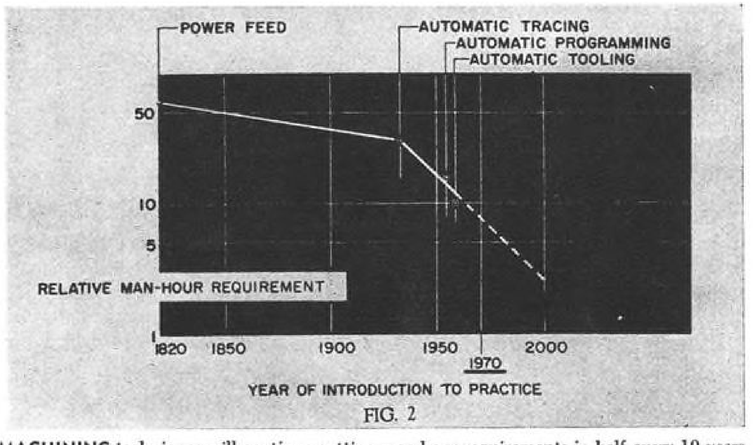


FIG. 2

MACHINING techniques will continue cutting man-hour requirements in half every 10 years.



How the Navy gives its Jet Cadets a leg up

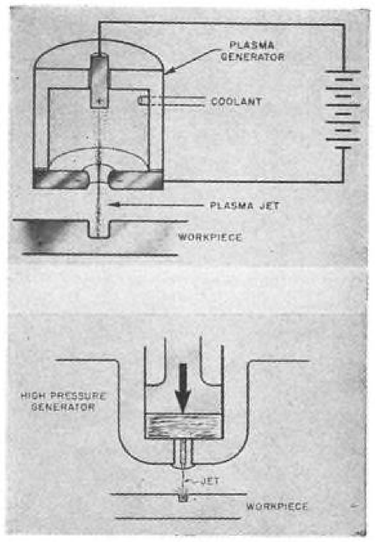
Today's jet cadets can receive more flight training in less time than ever before in history thanks to the most efficient jet trainer ever devised. It is the T2J Buckeye, developed for the Navy by the Columbus Division of North American Aviation.

The T2J is built around one idea: the idea of covering all phases of cadet flight training with one airplane so that there is no time lost in becoming familiar with the characteristics of a succession of trainers. From primary right through carrier indoctrination, the Navy is now able to train pilots for Mach 2 aircraft in the same time that it took to train them for the 360 mph aircraft of World War II. And do it more safely.

T2J statistics: top speed 500 mph, landing speed 85 mph, dives safely at Mach 0.85. Ceiling 40,000 ft., range 840 nautical miles. Jet engine can be removed in 7 minutes, replaced in 20. Electronic systems shelf-mounted for prompt replacement, AC consoles on one side, DC on other. Rocket-catapulted seat ejection functions from deck level to any altitude, and has already saved lives of naval personnel.

The T2J is the only trainer designed to give Navy pilots the versatile training they need to command the Navy's future manned weapons systems.

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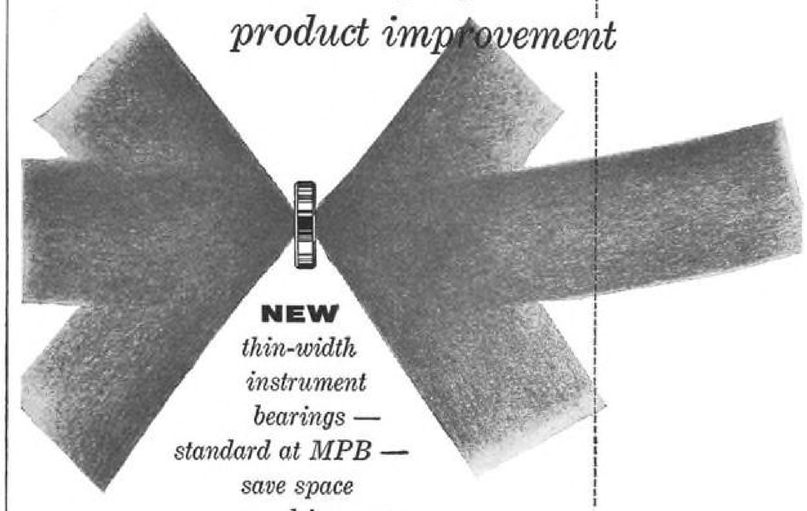
PLASMA jet (top) and fluid jet (below) machining hold promise for the 1970 period.

commercial process that has just recently been introduced in this country. There is no cutting tool involved in this operation, only a concentrated beam of high energy electrons which vaporizes metal away at the impact point of the beam on the workpiece. Stock removal rates are comparatively low, but the method will work on all materials regardless of strength or other properties. Also, it will do very intricate machining with a very high degree of accuracy. Consequently, says Dr. Merchant, it may well be the forerunner of specialized devices having important application in the intricate precision machining problems entailed in the fabrication of future aerospace vehicles.

• **Electro-discharge machining.** In this operation, the work piece and tool electrodes are separated by a rapidly circulating dielectric fluid. Voltage between the two is increased until sparking occurs at the rate of 20,000 to 300,000 discharges/sec. Each spark removes a small piece of material that is swept away by the dielectric, resulting overall in a fairly rapid and large amount of erosion or metal removal. An established commercial process, electro-discharge machining works well on electrically conductive, high strength materials and can produce intricate shapes with no forces on the work piece. The process is not as fast as electrolytic grinding but is reported to be five times faster than conventional machining in removing stock from high strength materials such as tungsten, carbides, cobalt and high speed tool steels.

• **Ultrasonic machining.** This now is a commercial process. Although slow in comparison to electrical machining

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Data Processing and Display Systems

Sylvania leadership in digital data processing is typified by its most recent achievement: design and development of MOBIDIC. This solid state, mobile computer will give field armies real-time solutions to many intelligence and reconnaissance problems, almost instantaneous answers to operational problems involving logistics, inventory control, etc. Sylvania has also pioneered in developing electronically driven electroluminescent display equipments and systems. SYLVANIA ELECTRONIC SYSTEMS has subsystem management and development responsibility for the data processing portion of the Air Force BMEWS program, including new and advanced concepts of 3-dimensional data take-off circuitry and equipment.



Detection and Tracking Systems

SYLVANIA ELECTRONIC SYSTEMS has an advanced capability in high resolution, electronically scanned radar. Example: Sylvania has management and development responsibility for the Army's AN/MPQ-32, a mobile artillery detection, tracking and fire control system.



Intelligence and Reconnaissance Systems

In recent years, Sylvania has developed numerous types of broadband receivers, signal analyzers, and sensing devices across the entire spectrum. Advanced anti-intrusion devices are now under development. In addition, Sylvania is developing and managing several other highly classified programs in this area.



Electronic Warfare Systems

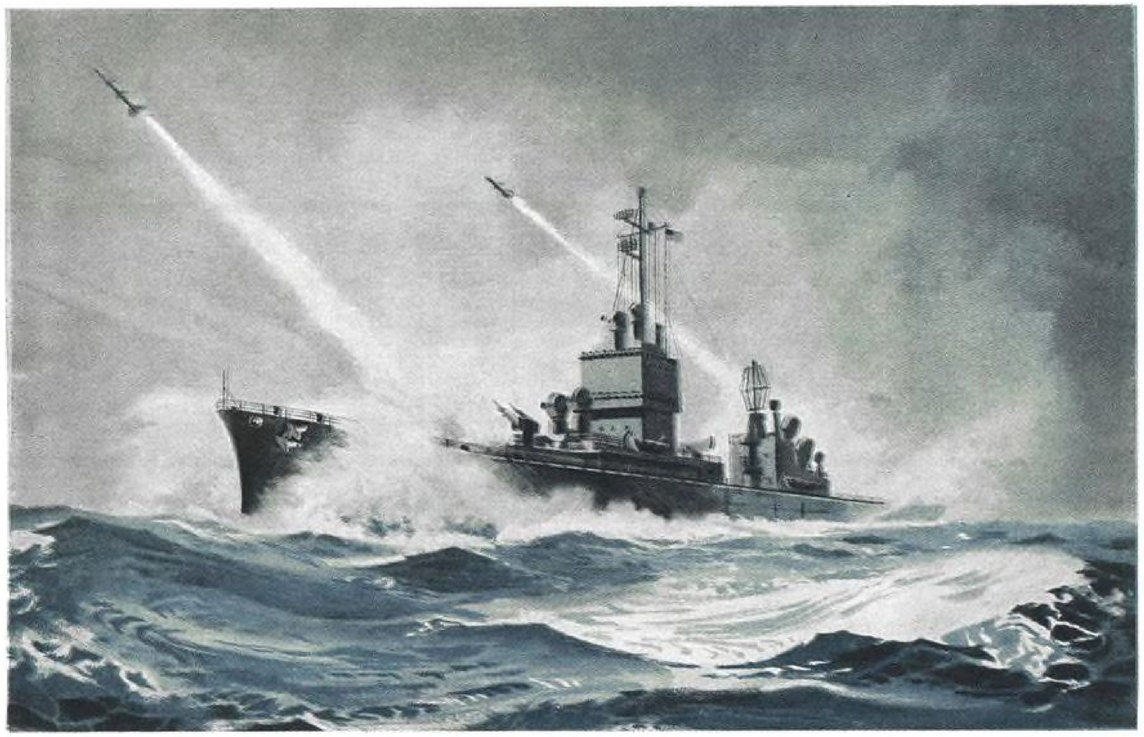
Sylvania leadership in electronic warfare is typified by its advances in countermeasures and counter-countermeasures against all known types of electromagnetic radiation. Sylvania manages the passive defense system for the B-58, and maintains a quick-reaction capability and facility for Army ground-based electronic warfare activities.

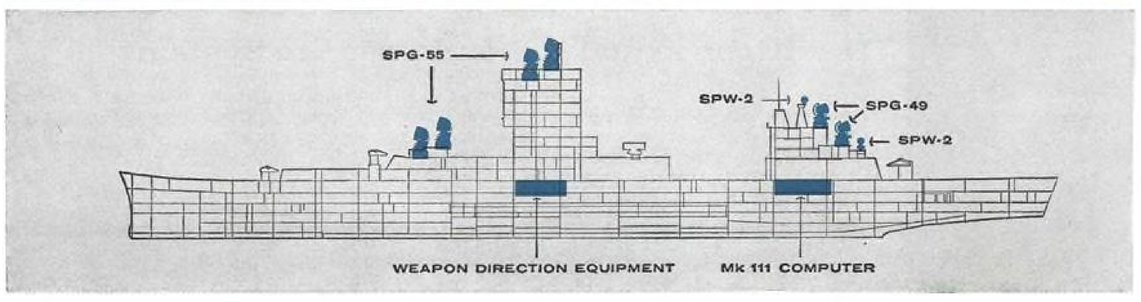
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...aboard the Navy's first nuclear-powered cruiser, the Long Beach





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When the Navy's first nuclear-powered surface ship—the USS LONG BEACH—joins the fleet, she will have a cruise capability of better than 30 knots, with virtually unlimited range, and she will be armed with the surface-to-air Talos and Terrier missiles. The most advanced ship of her kind, the "CGN-9" will have the most advanced shipboard missile control equipment: Sperry.

Forward, Sperry SPG-55 missile-guidance radar directs the Terrier missile. Aft, Sperry SPG-49 super-radar controls the longer range Talos missile. Amidships, and in the protected below deck region, are the brains of the systems, the computer complex. The Sperry Weapon Direction Equipment (WDE) evaluates target threat and decides which missile to fire at the selected target. The Sperry Mk 111 computer reads target position data from the SPG-49, calculates the best missile-to-target flight path, and positions the guidance beam generated by the Sperry SPW-2 Radar. Then it evaluates "kills."

With her combination of speed, range, firepower, and advanced Sperry fire control and navigation equipment, the LONG BEACH will make a formidable argument for peace when she joins the fleet.

SPERRY

SURFACE ARMAMENT DIVISION, *SPERRY GYROSCOPE COMPANY, DIVISION OF SPERRY RAND CORPORATION, GREAT NECK, NEW YORK*

methods, it offers the advantage of working on non-conductive materials as well as on those that are conductive. Also, it works well on brittle materials. Basic elements in ultrasonic machining are a shaped tool and an abrasive slurry. The surface of the tool is vibrated at high frequency and low amplitude and drives the abrasive at the work piece. The abrasive nicks particles out of the work piece, following the pattern of the driving force or shaped tool itself.

Jet Methods

For the future, two machining methods that now appear to hold much promise are the plasma jet and the high velocity liquid jet. While it is still to early to evaluate these techniques, Dr. Merchant and others believe that they merit feasibility studies to explore the full potential they offer in themselves or as forerunners of new machining methods for the 1970 period and beyond.

The plasma jet basically is a highly constricted beam of ions. An arc is struck between an anode and a cathode. The fluid, gas or liquid, surrounding the cathode cools the outer area of the arc and forces the current flow into a narrow beam in the center of the arc. In effect, the fluid also serves as an insulating and stabilizing tube around the constricted arc that in one application comes out through an opening or nozzle in the cathode. As it emerges, the plasma jet is at temperatures above 10,000F, sufficient to vaporize any known material. The jet cuts through metal plates rapidly and reportedly produces a much cleaner cut than conventional flame cutting. As a cutting (and plating) tool, the plasma jet is already being marketed by Linde Co., a division of Union Carbide. But this technique is believed to have a machining and metalworking potential well beyond its present application.

High Velocity Jet

The high velocity liquid jet, still in the early exploratory stage, is a mechanical approach that appears to have promise for machining non-conductive materials, particularly the ceramics. Scientists, following the lead of nature in the effects produced by raindrops on high speed aircraft, have demonstrated that water driven at supersonic speeds against high strength steel will pit and erode the metal. The question, says Dr. Merchant, is whether the rate of metal removal can be raised to a commercially useful level by, say, injecting abrasive into the water jet.

In evaluating any machining method, the rate of stock removal is generally accepted as the most important parameter. This relates directly to overhead and labor costs. More specifically, as

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Series 4205

Smallest and newest addition to Pacific's line—it delivers 2% accuracy over a —10 to +30G range. Features silicon fluid damping for unsurpassed shock and vibration immunity. Overall size 1.1"W x 1.5"L x .8"D. Potentiometer pick-off.

Series 4206

For Increased Accuracy to 1% or less under rugged environmental conditions. Originally designed for use in an anti-missile missile, this unit features temperature compensated damping mechanism using silicon fluid.

Series 4201

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Only a few process steps and time-proved TI mesa production techniques permit a high degree of process control in *Solid Circuit* network fabrication. The result of these facts: *reliability is built into* each *Solid Circuit* network.

If you need to reduce equipment size and weight — or to design a more complex system in the same size — investigate *Solid Circuit* networks for your missile, satellite, space vehicle, and other microelectronic programs. TI engineers are ready to custom design this concept to your requirements. Contact your nearest TI Sales Engineer today. The TI Type 502 *Solid Circuit* network is immediately available for your evaluation.

SEMICONDUCTOR NETWORK CONCEPT

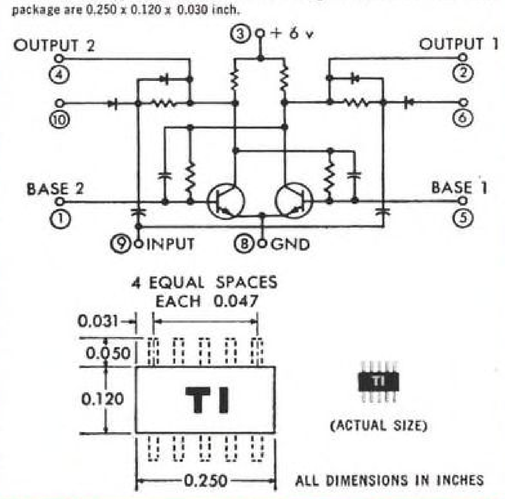
The concept of a semiconductor network is the relation of conductance paths in a semiconductor to the classical circuit elements, establishing an orderly design approach based on circuit knowledge. In this manner, semiconductor networks may be designed to perform the functions of a wide variety of existing circuits. Through the proper selection and shaping of semiconductor conductance paths, it is possible to realize such electronic functions as amplification, pulse formation, switching, attenuation, and rectification.



An assembly of 13 **Solid Circuit** networks, actual size, performs a full serial adder function, replacing 85 conventional components with a 100:1 size reduction. Weight: 1.5 gm. Volume: 0.02 cubic inch.

*Trademark of TEXAS INSTRUMENTS INCORPORATED

TI Type 502 silicon **Solid Circuit** network is intended for binary counter, flip-flop, or shift register applications. The dimensions of the glass-to-metal hermetic-sealed package are 0.250 x 0.120 x 0.030 inch.



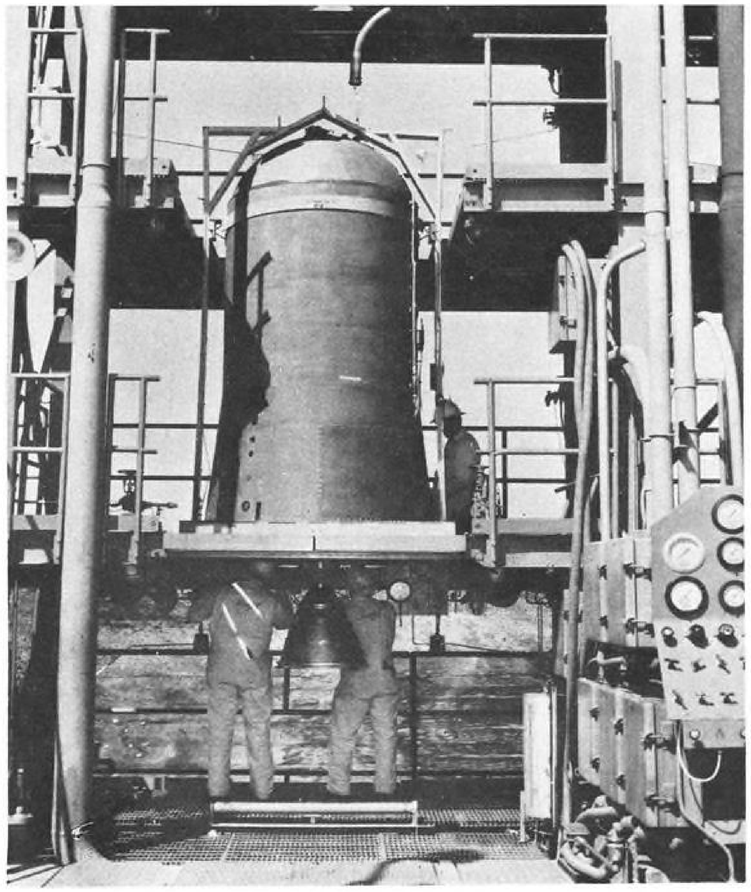
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INCORPORATED
SEMICONDUCTOR-COMPONENTS DIVISION
POST OFFICE BOX 312 • DALLAS, TEXAS

pointed out in Lockheed's report on ultra speed machining, if present methods of machining are not improved, it would take four to 10 times the amount of machines, floor space and manhours to build a high performance airplane out of high strength, thermally-resistant alloys as it now takes to work aluminum alloys. At the present time, aluminum and magnesium alloys are the most easily and rapidly machineable of all aircraft materials. In some instances, of course, where the job can't be done another way or as well—for example, drilling with an electron beam—cost becomes a secondary consideration.

While these new machining developments are of value to many industries, their greatest importance is generally agreed to be for the aircraft and missile field, where the number of fabricating problems are getting bigger and the production runs smaller. This and the importance of the work to future United States space and military efforts are the main reasons for government—Air Force, in particular—sponsorship of much of this work.

Without the many development contracts from AMC's Manufacturing Methods Division, declares one industrial machinery representative, some of today's advanced flight systems might have to be built largely by hand, if they could be built at all. While information out of Russia is spotty, it is generally felt that machining developments in the Soviet Union are at least on a par with the work in this country.

The outlook for continued improvement in machining methods here is an optimistic one. Beginning with powerfeed in 1820, Dr. Merchant points out, the trend of manhour requirements has moved steadily downward. From approximately 1935 on, required manhours have been cut in half every 10 years and shows no sign of leveling off.



Able Star Propulsion System Prepared for Firing

Aerojet-General technicians prepare the Able Star propulsion system for test firing at the company's Liquid Rocket Plant, Sacramento, Calif. The liquid-fueled second stage was used with the Thor missile to orbit ARPA-Navy Transit satellite. Able Star is the first propulsion system to employ precision guidance and an engine with restart capability.

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For toughness and flexibility over the wide range of —90°C to 250°C, as well as chemical inertness, nonflammability, abrasion resistance, zero moisture absorption—and of course superior electricals—you know to choose TEFLON* tubing. And for precision manufacturing and inspection, Teflon and other tubings bearing the FLEXITE label conform to Markel's high standards of excellence. Ask for samples.

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Three generations of ARMA computers:
THE SECOND GENERATION



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an intellect that can think anywhere

The systems of tomorrow will require digital computers that can think *anywhere*—intellects that will remain superior in any environment.

ARMA—already producing inertial guidance systems for the ATLAS ICBM—has accepted the challenge and developed a lightweight, second-generation digital computer applicable to *all* types of navigation. It can be used in space, atmospheric, surface, subsurface and ground navigation, making possible programming flexibility.

This all-solid state computer, with *no moving parts* and using silicon semiconductors exclusively, has a memory that is non-volatile and has non-destructive readout. And this computer has substantially fewer parts than ARMA's first-generation production model, which has a test performance unequalled by any other digital computer.

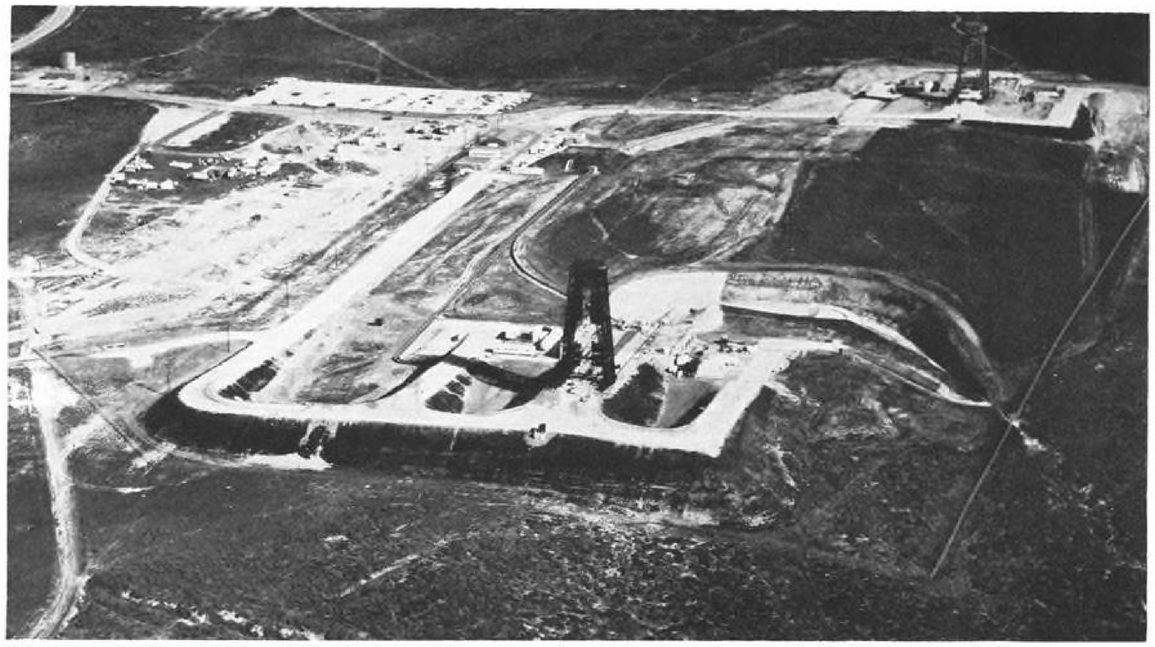
An even more sophisticated third-generation computer, surpassing the reliability of the first two with still less weight, will be produced in the future by ARMA. The reliability of all three generations will be assured by thorough testing in ARMA's environmental facilities—the most complete in the industry.

ARMA, Garden City, N. Y., a division of American Bosch Arma Corp. . . . the future is our business.

Attention, Engineers: Write to E. C. Lester, Emp. Supv., about career openings in R & D programs.

7255-B

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Atlas Agena for Project Midas will be fired from this pad complex at Navy's Pt. Arguello Pacific Missile Range facility.

Atlas Agenas Will Be Fired From Pt. Arguello

Work is being completed on a launch pad complex at U. S. Navy's Pt. Arguello, Calif., facility for eventual firing of the Atlas Agena vehicles for Midas infrared ballistic missile early warning system and Samos advanced reconnaissance system satellite projects. Navy facility, part of Pacific Missile Range, is located adjacent to and south of Vandenberg, AFB. Launch complex consists of two gantries and pads, almost identical to those used for the operational Convair Atlas ICBM. Complex, on Navy property, is under operational control of U. S. Air Force. An attempt to launch Midas from Complex 1 into a polar orbit will be made here later this year.

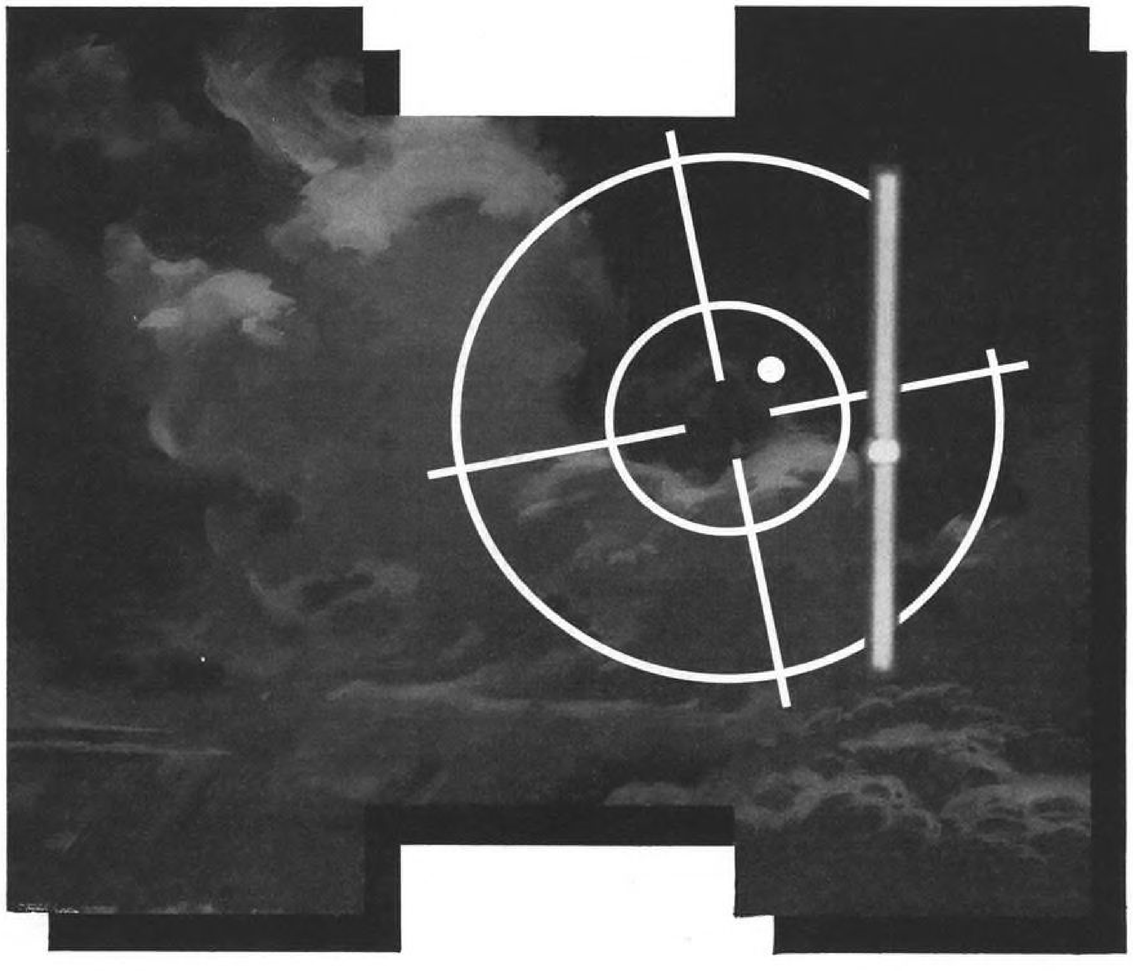
Navy spokesman at Pt. Arguello said that the facility also is the site for Project Sunflare launches to study the effects of solar flares (AW Apr. 4, p. 26) and for upper atmospheric sounding rocket firings for Atomic Energy Commission's Project Tumbleweed. Firings for Project NERV (nuclear energy research vehicle) also are scheduled to be made from this site. NERV vehicle is a three-stage, solid propellant rocket which will reach altitudes of 1,200 mi. and travel 1,200 mi. downrange, where an attempt will be made to recover the nose cone. Pacific Missile Range, of which Pt. Arguello is a part, will have over-all responsibility for firings.

Navy radar site is below; at right is high altitude sampler rocket on its launcher.

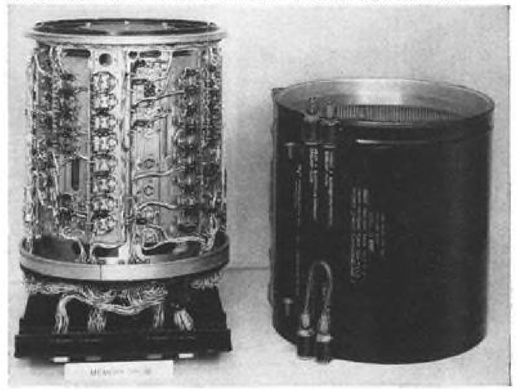




How to take a longer look at air space



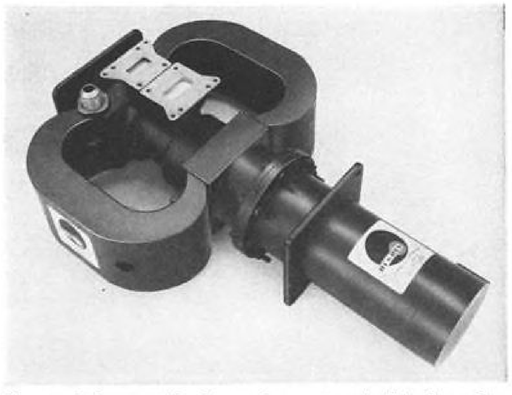
One of the vital "innards" of the new Hughes system is this miniaturized (1.3 cu. ft.) Hughes memory drum which can store over 1 million bits of information.



Tomorrow's manned interceptor aircraft – and even faster ones of the future – require radar navigation, target acquisition, armament control and electronic counter-measures systems of vastly greater scope and dimension than ever before.

To fulfill this critical requirement Hughes has developed a new advanced radar system which embodies many significant state-of-the-art advances. One of the most significant is a unique and highly advanced Traveling Wave Tube developed in the Hughes Laboratories. This tube's two outstanding advantages: 1) higher power to provide greater range; 2) broader frequency band width for operational flexibility.

In addition, this new Hughes radar system will discriminate against ground return and will detect targets at extreme ranges. Designed to operate in a "hard" counter-measures environment, the system is radar augmented by infrared detection and tracking.



Heart of the new Hughes radar system is this Traveling Wave Tube which provides greater power and a broader band width.

This radar system is the latest of a series of pacesetting Hughes systems. The Hughes E-1 was the *first* all-weather interceptor radar system ever developed. The Hughes E-4 system *first* made possible the rocket lead-collision attack. The Hughes E-9 and MG series systems were *first* to automatically stage and fire advanced air-to-air guided missiles. And the Hughes MA-1 system *first* provided complete control of aircraft from take-off to touch down.

Although over 16,000 all-weather interceptor systems have been produced to date. Hughes' radar experience is not limited to interceptor systems. For the Army and Navy, Hughes is producing surface-based 3-dimensional radar systems which utilize electronic, rather than mechanical scanning methods. And the Hughes TARAN system utilizes a high-resolution radar which makes it possible for pilots to fly tactical missions at low altitudes, in any kind of weather!

Foreseeing the needs of the future – and being the *first* to provide for them – is a deeply ingrained tradition at Hughes. Perhaps we can help you solve some of *your* radar system problems. Please write: Hughes Advanced Program Development, Marketing Department, Hughes Airborne Systems, Culver City, California.

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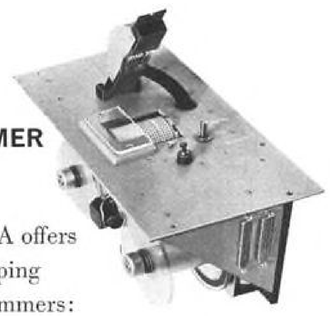
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Joint R&D Effort Made On Hybrid Rocket

Grand Central Rocket Co. and the Marquardt Corp. are conducting a joint research and development program on the hybrid rocket motor. The company-funded program is concentrated on the development of a high-performance, flexible propulsion system, a combination of the solid and liquid fuel.

Grand Central has cast 32 solid propellant hybrid motors and transported them to Marquardt where they were combined with the liquid oxidizers and successfully test fired. The hybrid motor combination consists of three major parts:

- **Liquid oxidizer storage tank.**
- **Solid propellant grain.**
- **Ignition throttling device.**

Gas is transmitted under pressure to the liquid oxidizer storage tank. The atomized oxidizer flows from the storage tank into the combustion chamber, enabling hypergolic ignition and stable burning of the solid propellant grain in the chamber.

An off-on control system regulating flow of the liquid oxidizer permits thrust and maneuverability of the rocket to be controlled.

SAC Fires Atlas ICBM From Horizontal Pad

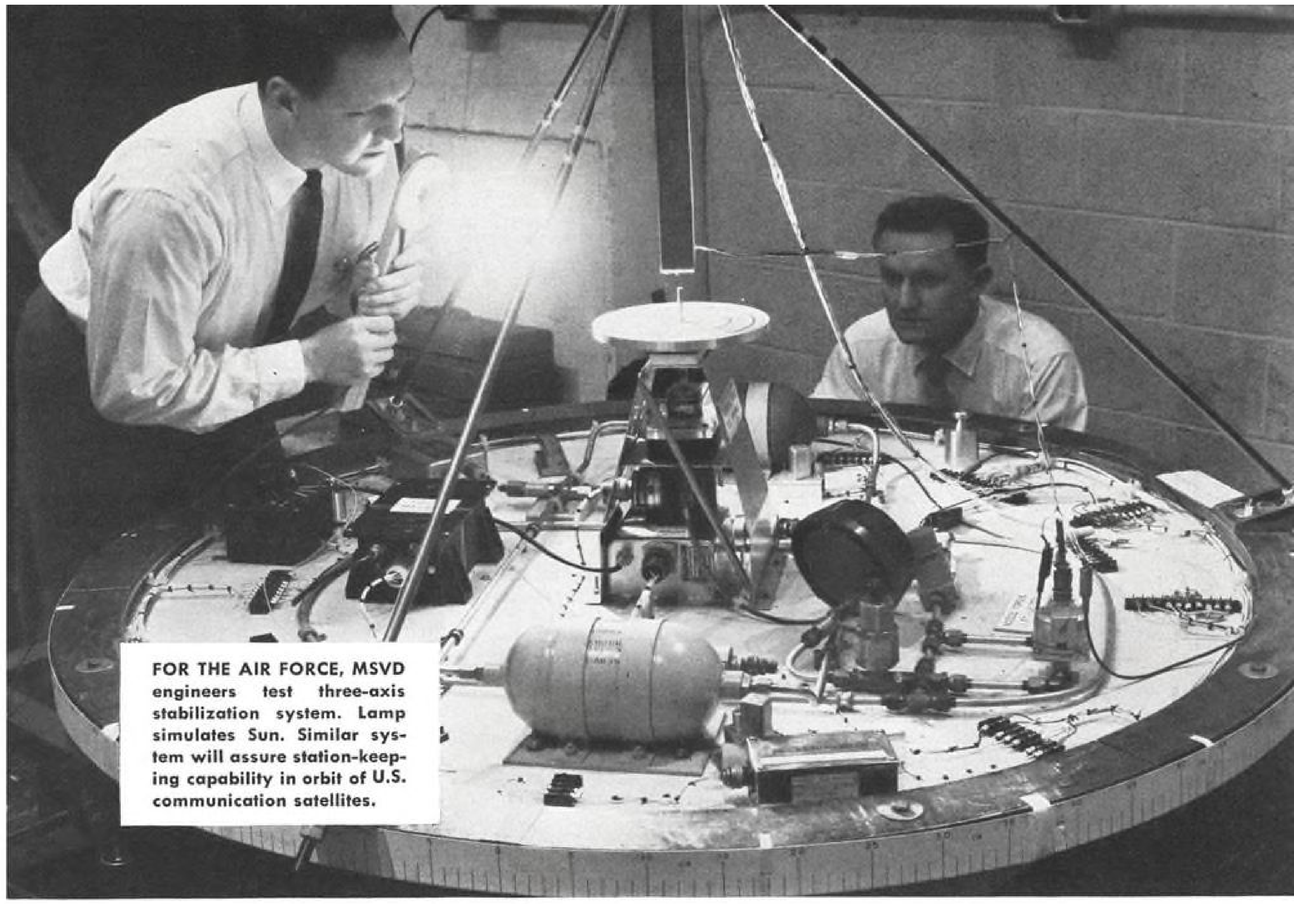
Vandenberg AFB, Calif.—Operational Atlas intercontinental ballistic missile has been fired in the first Strategic Air Command combat training launch to be conducted from a horizontal storage pad.

The storage pad resembles a coffin and is a rectangular-shaped concrete building with a steel sliding roof.

The Atlas ICBM was launched by a SAC crew from a Vandenberg-trained class of missilemen who will man the 564th SAC Missile Sqdn. at Francis E. Warren AFB, Cheyenne, Wyo. The shot also was the first to employ the refined MOD III radio inertial guidance system which will be used in horizontal launch complexes.

Rocketdyne Has Achieved Controlled Thrust Motor

North American Aviation's Rocketdyne Division at McGregor, Tex., has achieved controlled thrust variation of a solid propellant rocket motor in a company-sponsored research program. Engineers with the division's solid propulsion operations have designed and test fired a new controllable nozzle that effectively varied the thrust of a solid propellant motor 70%. Thrust was first lowered, then increased over the approximate range of 700 to 1,200 lb.



FOR THE AIR FORCE, MSVD engineers test three-axis stabilization system. Lamp simulates Sun. Similar system will assure station-keeping capability in orbit of U.S. communication satellites.

MISSILE AND SPACE VEHICLE DEPARTMENT

...center for missile and space technology research and development at General Electric

Progress in space vehicle navigation

As space vehicles probe further and further away from the Earth, and as their missions become more and more complex, the need for accurate, high-precision space navigation and control becomes increasingly vital.

General Electric Missile and Space Vehicle Department engineers are now developing and testing space vehicle control equipment for the 24-hour-orbit communication satellite program. They have already designed and flight-tested on space vehicles a three-axis stabilization system as well as orbit computation and correction techniques. Using the Earth and Sun as reference points, this MSVD three-axis system successfully controlled the attitude in space of U.S.A.F. *Atlas* and *Thor* re-entry vehicles during a major portion of their ballistic flights. The control accuracy attained on these flights could be duplicated on flights further into space, using other planets and stars as check-points.

For more information about MSVD's space navigation and control work for the Air Force and its other contributions to U.S. space technology progress, write to Section 160-73, General Electric Missile and Space Vehicle Department, Philadelphia 4, Pennsylvania.

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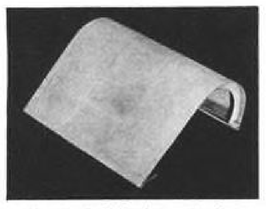
A Department of the Defense Electronics Division

Scientists and Engineers interested in career opportunities in Space Technology, contact Mr. T. H. Sebring, MSVD

Report on Developments of

New Fansteel 82 Metal in Hypersonic Vehicle Prototypes

Design and development work on hypersonic flight vehicles by Boeing Airplane Company and other missile and airframe manufacturers has indicated some important use-possibilities for Fansteel 82 Metal. This new columbium-tantalum-zirconium alloy was among the materials fabricated into prototype leading edges for materials capability evaluations at 2000°F and over. Results verified Fansteel's own tests proving the metal's high strength-to-weight properties at elevated temperatures.



Excellent Oxidation Resistance

Exhaustive tests in the Fansteel laboratories prove Fansteel 82 Metal far superior in oxidation resistance to pure columbium. Calculated on the basis of weight gain during exposure at 2000°F in air, 82 Metal is ten times as resistant as the pure refractory metal. Sixteen-hour, 2000°F test in flowing air showed remarkable low scaling of 0.01 cm.

Tensile Properties of Sheet

The encouraging results of Boeing's prototype tests indicate 82 Metal's suitability for airframe and missile material. Average tensile properties are shown below.



Fansteel 82 Metal Easily Formed

In addition to its high temperature properties, 82 Metal has excellent fabricating characteristics. Ductile welds are made with little or no tendency to fracture in heat affected zones. It is easily fabricated at room temperatures, as worked or annealed. Its melting point is 4550°F and density 10.26 grams per cc (0.371 lb. per cu. in.).



Welding the Boeing prototype in an inert atmosphere chamber using tungsten inert gas process.

Design and Engineering Help

Fansteel engineers and metallurgists are now working with many other firms in adapting Fansteel 82 Metal to specific areas. They will be glad to cooperate with your own designers and production people in studying and applying this useful new metal. Just send us your print or part sample, or call in the Fansteel representative.

Available From Stock

For experimental purposes . . . Fansteel 82 Metal is available from stock in ingots, forgings, bar, rod, plate and sheet. Let us keep you informed of developments concerning this new alloy as they occur. Write for the latest technical bulletin.

TENSILE PROPERTIES OF SHEET

TEMPERATURE Degrees F	ATMOSPHERE	ULTIMATE TENSILE STRENGTH, psi.	YIELD STRENGTH .2% offset, psi.	ELONGATION % in 1 in.
70-80	Air	76,000	65,000	12
1800	Argon	59,000	53,000	1.5
2400	Argon	19,000	15,000	14

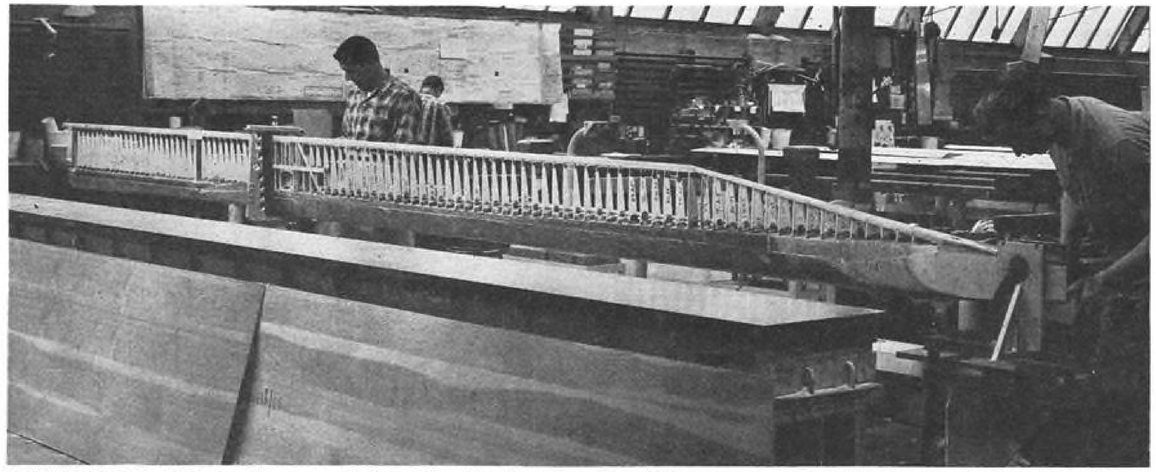
Photos Courtesy of Boeing Airplane Company

FANSTEEL

FANSTEEL METALLURGICAL CORPORATION

NORTH CHICAGO, ILLINOIS, U.S.A.

K602



CONSTRUCTION of all-glass fiber rotor blades utilize thin glass fiber ribs which are spaced about 3 in. apart and have ¼ in. flanges top and bottom to pick up thin glass fiber skin. Servo blade used to change rotor blade pitch will have similar glass fiber construction.

First Glass Fiber Rotor Blades Tested

By Michael Yaffee

First all-glass fiber rotor blades will be flying within a year, most likely on an Umbaugh U-18. Other airframe candidates expected to follow shortly are the Kaman H-43, Vertol H-21 and the Bell H-40 helicopters.

Parsons Corp., source of the Umbaugh, Bell and Vertol rotors, has been working on glass fiber blades for six years and is ready for flight production. Kaman has been testing its new all-glass fiber rotor blade for a year and says that it could start producing prototype units within another year. Sikorsky, on the other hand, which has made and tested glass fiber blades in the last year and a half, plans to stay with its aluminum rotor. Sikorsky is finding increasing use for the glass fiber in other, semistructural applications where the loads are non-critical, such as the helicopter's auxiliary floats, and is experimenting with the use of glass fiber in the tips and trailing edges of its all-aluminum rotor.

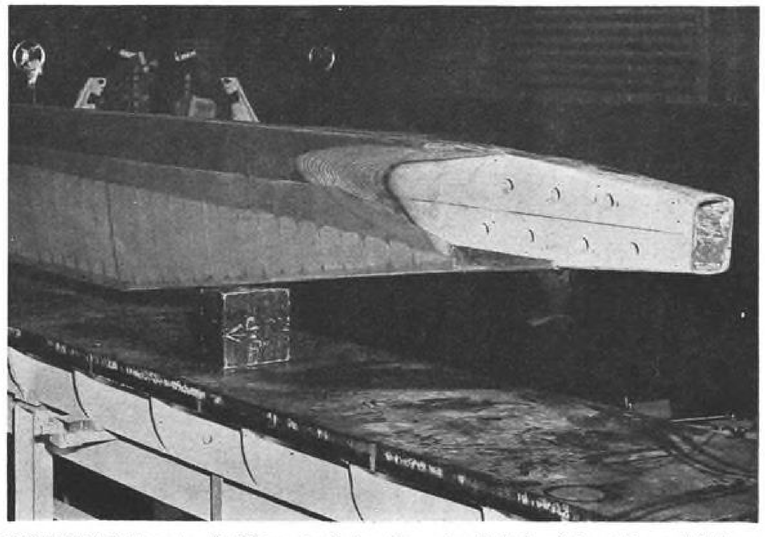
Expected Advantages

Expected advantages of the new glass fiber rotor blades are lower cost, lighter weight and longer life. The latest step in an evolution that has seen the growing replacement of wood and metal rotor blade components by reinforced plastics, the new blades now use reinforced plastic for structural as well as non-structural members, from root to tip, except for the rubber or steel abrasion strip on the leading edge, protecting the glass fiber from rain erosion. Parsons' rotors will also use a metal plate on the root end where the blade attaches to the hub.

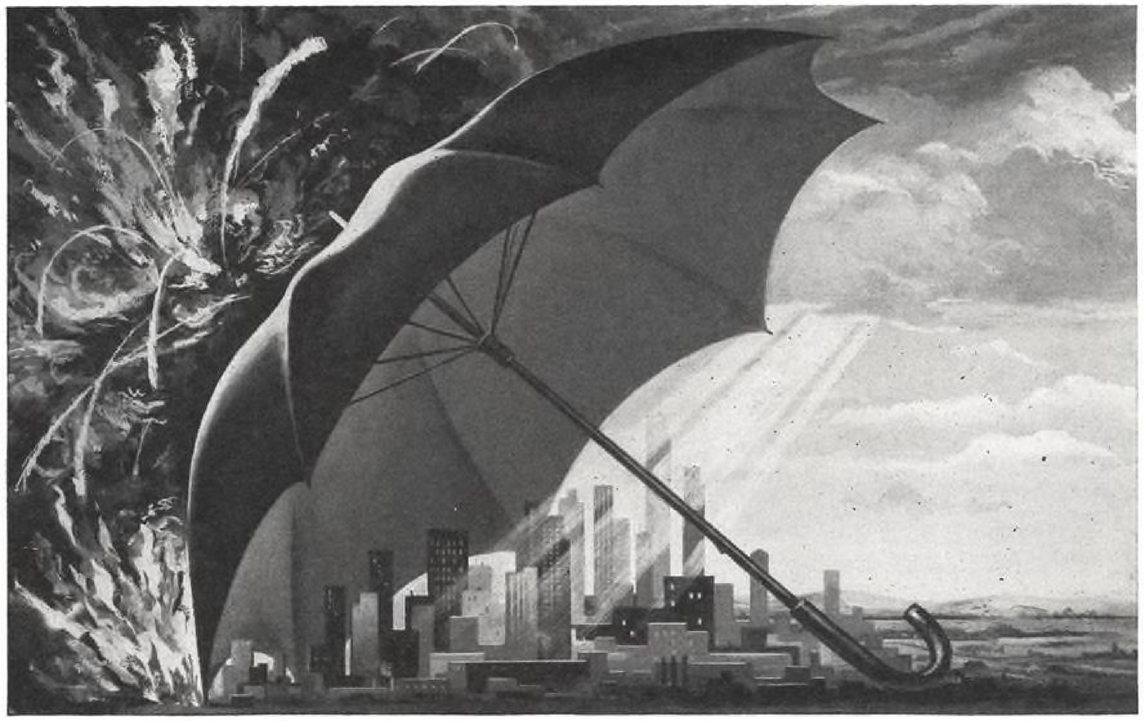
Successful demonstration of the use of plastics in structural rotor applications, where the oscillating airloads are the highest of those on any aircraft structural member, has opened the door to the use of plastics in other parts of the helicopter. Kaman's chief engineer, Norman Stone, believes that large airframe panels made from glass fibers would be at least competitive with those now made from sheet metal. Stone admits that it is still too early to determine the practicality of making large plastic sections on a production basis. Many engineers feel that it will not prove feasible.

Production Problems

Chief drawback to production of plastic components is the hand lay-up involved. Each unit must be set up by hand on individual molds and cured. There is little opportunity to take ad-



THICK-WALLED root end of Kaman's all-glass fiber rotor blade is reinforced top and bottom with glass fiber cheekplates. Holes are for the grip retention bolts. Blade radius is 23½ ft.



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MILITARY ELECTRONICS DIVISION CHICAGO 24, ILLINOIS

URGENT PROBLEMS RELIABLY SOLVED

vantage of the benefits offered by high speed, highly automatic machining. On the other hand, as Stone points out, helicopter production still requires many manual operations. When machining or finishing of glass fiber components is necessary, the resulting dust also presents a problem. The workers must wear masks for protection against silicosis; generally they are given bonuses and benefits such as shower time for this work.

More important than the dust problem are the processing pitfalls to be avoided.

Chief among these, according to Parsons engineer John Carson, are the selection and application of the glass fibers from the thousands of types available, the selection and mixing of the bonding resins, and finally the problem of maintaining structural uniformity from one lay-up to the next. Also, although not a disadvantage, the plastics do not offer any advantages in raw materials cost.

Advantages

Glass fiber rotor blades do offer numerous and significant advantages compared with present metal and wood blades, which far outweigh the material's drawbacks, says Kaman.

Most important of these are the following:

• **Less weight.** Glass fiber rotor blades are expected to be about 10% lighter than comparable present blades. This should result in a gain of 4-5 hp. which can be used to increase payload, speed and altitude performance. On a strength-to-weight basis, according to the company, glass fiber is better than aluminum, magnesium, titanium, steel and even the honeycomb structures now used in some rotor blades.

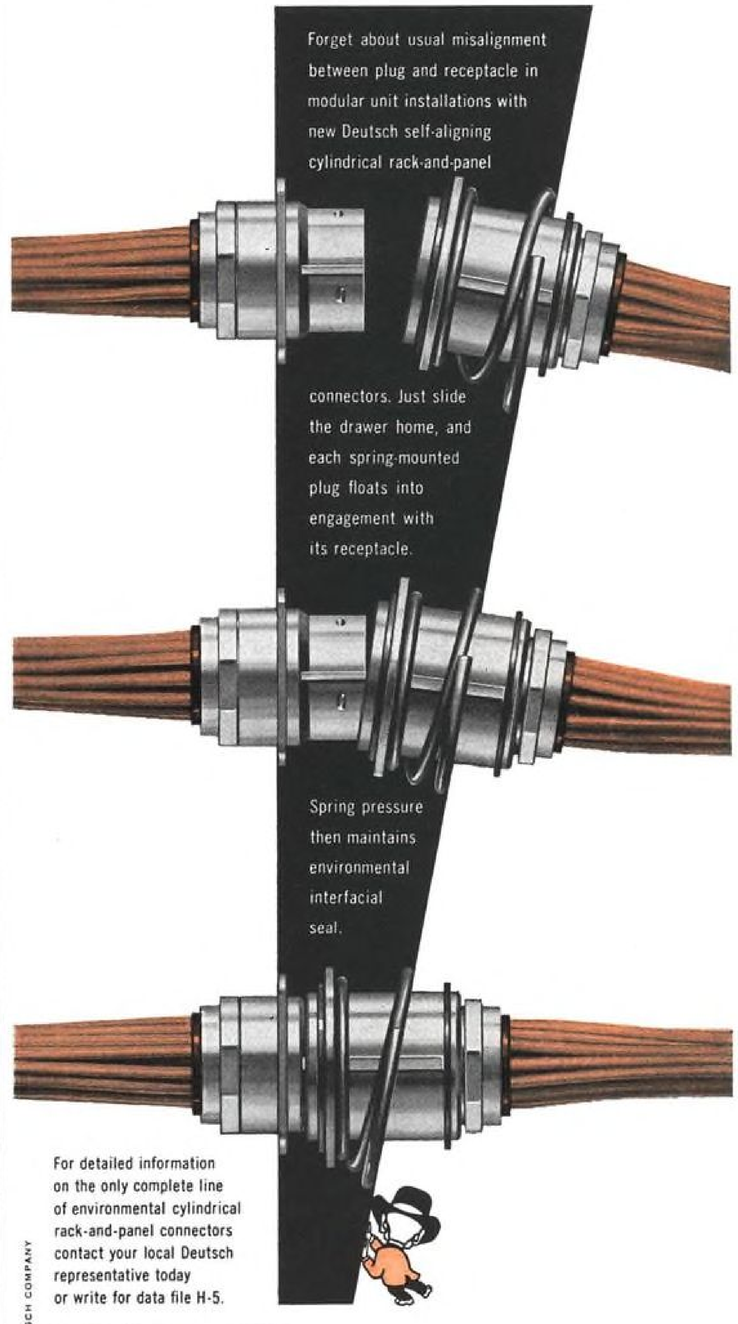
• **Lower cost.** Primarily as a result of savings in development time and tooling costs, glass fiber blades are expected to run 10% or more under present blade costs. During development, for example, modifications can be made quickly simply by laying on additional glass fiber cloth. Long delays for new and expensive forging and extrusion dies used in fabricating aluminum blades are unnecessary.

• **Longer life.** Owing to their greater resistance to fatigue, chemical corrosion and fretting, glass fiber blades will have a longer useful life than most current blades, says Stone.

• **Greater safety.** Every strand in a glass fiber cloth acts as an independent load carrying unit. When fatigue occurs, a few strands may break, but there is not an immediate failure of adjacent fibers, i.e., there is no immediate crack propagation as in metal structures.

• **Easier inspection.** Before glass fibers fail, they change color. A complete visual inspection can be made while the

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TAPCO POWER SYSTEMS



MINIAPS is only slightly larger than a beer can. It is shown here actual size: 2¾" x 3¼" x 8⅜".

MINIAPS

solid-fuel turbogenerator weighs only 4½ pounds

This miniature solid-fuel turbogenerator was developed within 4 months by TAPCO for such functions as fuzing, telemetering and guidance. It is a compact, lightweight, self-contained and self-regulated secondary power system. It operates reliably in temperature ambients from −65° to +160°.

MINIAPS uses hot gas generated by solid fuel to power a turbine that drives an electric generator at 60,000 rpm. Turbine and generator are on a single shaft. Five outputs of AC and DC are produced, with AC frequencies strictly governed by transistorized speed controls.

The version pictured weighs only 4½ pounds, yet produces 60 watts of power for 90 seconds duration. Other versions produce up to 200 watts. Duration of outputs can be varied by increasing or decreasing size of propellant grain.

TAPCO's many years of experience in the design and manufacture of turbo-machinery was an important factor in the development of MINIAPS. Other TAPCO power systems, now operational or under test, include classical missile APU's, hydraulic actuators, hot-gas actuation systems, solar and nuclear systems, solid-fuel and hydrazine gas generators, and re-entry turbines.

TRW

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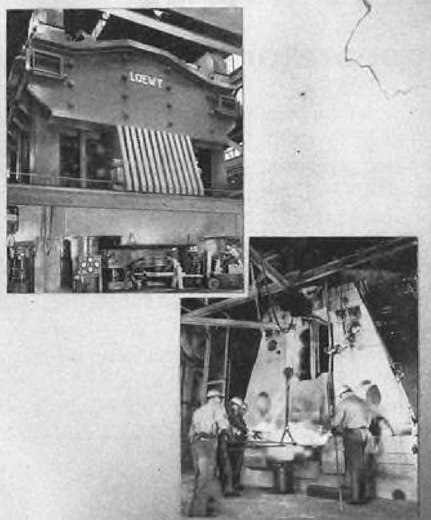
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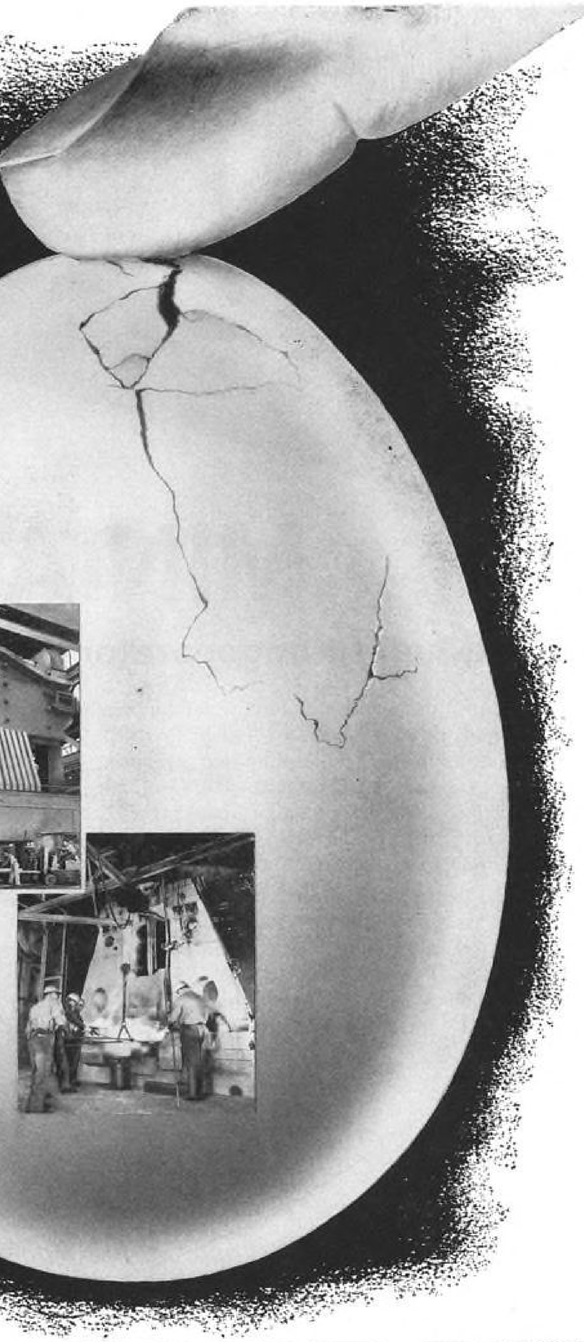
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rotor blade is still on the helicopter without sending it back to the shop for a complete metallographic inspection. This again means a savings in man-hours and money.

• **Greater impact resistance.** Glass fibers' higher modulus of resiliency should result in less damage to the blade from the impact of foreign objects such as stones and hangar walls.

• **Easier repair.** The ease of fabricating glass fiber structures will permit crew chiefs to make many minor repairs that now necessitate removal of the rotor blades and return to the factory for overhaul. Kaman will supply repair kits with uncured glass fiber cloth and instruction manuals.

Several types of glass fiber materials, varying widely in the orientation of the fibers within the fabric, have been available for several years. But before rotor blade manufacturers could use the glass fibers, they had to determine which materials offered the fiber orientation best suited to the loads imposed on a rotor blade, how to load-orient the fabric in lay-up, and which resin mixtures would best bond the glass fiber fabric layers.

Structure of New Blade

Basically, Kaman's new blade consists of a hollow D-shaped laminated glass fabric spar, thin glass fiber ribs, a thin transluscent glass fiber skin, phenolic dowels, a neoprene rubber coating for the leading edge, and its own bonding resin formulations based on epoxies and polyamides.

At the root end, where the vibratory and static loads are greatest, the spar has a wall thickness of .5 in. This tapers gradually to .15 in. at station 90, continues at this thickness to station 180, and then tapers down to .09 in. at the tip.

The thick root end of the spar consists of 50 layers of glass cloth. Number 181 glass fabric, which has equal strength in longitudinal and transverse directions, is used for the outermost and innermost layers. For the majority of plies—those in between—No. 143 glass fabric which is strongest in its longitudinal direction is used.

In the root retention area, the structure is reinforced top and bottom with glass fiber cloth-glass fiber roving (fibers are unidirectional, not woven as in cloth) cheekplates, increasing the over-all root wall thickness to approximately .63 in. The phenolic dowels are used inside the hollow root end as spacers for the grip retention bolts. Over-all length or radius of the rotor blade is 23½ ft.

Glass fiber ribs are spaced approximately 3 in. apart. They are made from No. 181 glass fabric and are two and three plies thick, with ¼ in. flanges to pick up the 2-ply, No. 181 glass fabric skin.

Servo flap used to change the pitch of the rotor blade will have similar glass fiber construction.

Current Tests

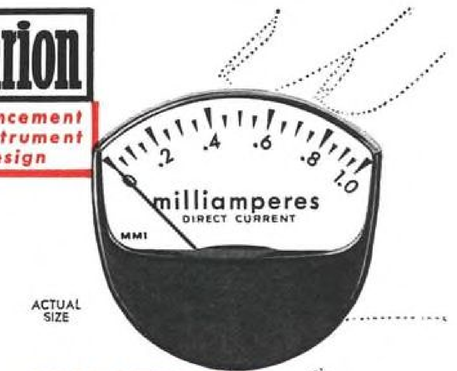
Kaman's all-glass fiber blade uses many of the same fiber orientation and construction techniques now used on one of the company's current production blades, which has a glass fiber main spar with a wood core. Several years of tests and operation of the combination rotor blade, says the company, have yielded a great deal of data that is highly applicable to the new, all-glass fiber blade.

At present, Kaman is testing its new blade on a whirlstand in which it is matched, on the other side of the hub, to a current production model rotor blade.

This will enable the company to determine quickly the dynamic differences between the two blades as well as modifications needed to make the glass fiber blade equal to the present production blade in performance, since it will be designed to meet the same specifications. Results so far have been promising, says Stone; the company feels that the all-glass fiber blades will more than do the jobs now being done by any of the rotor blades presently in use.

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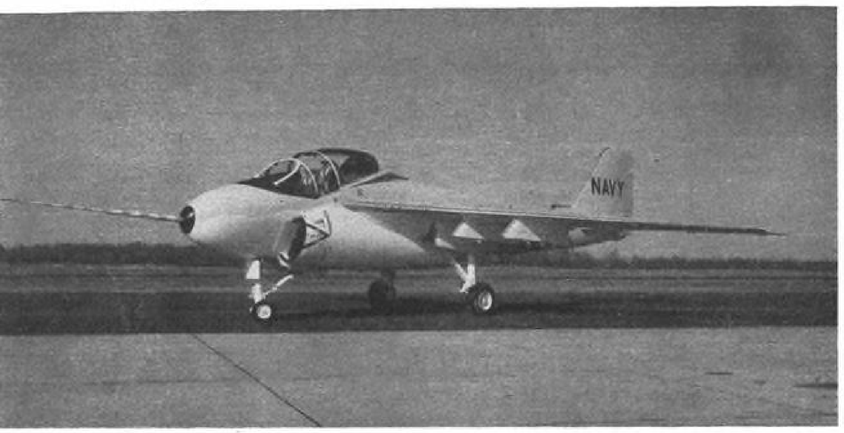
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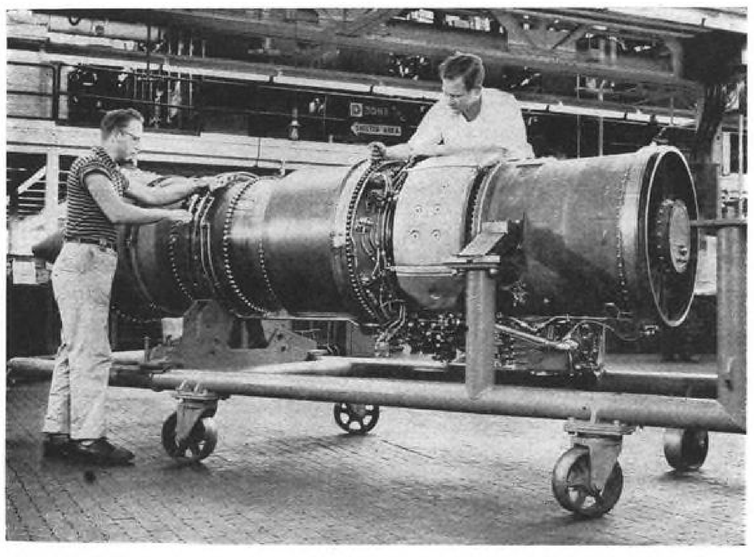
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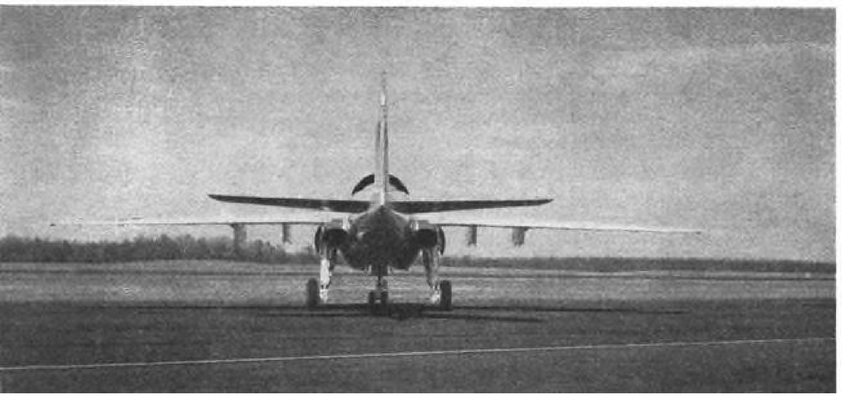
Navy Tests A2F Low-Level Attack Bomber



A2F-1 INTRUDER, Grumman's 17th combat model, has flown from 80 kt. (stall) to Mach .9 at sea level. Empty weight is 24,000 lb. Maximum gross weight is 54,000 lb.



POWERPLANTS for the A2F-1 consist of two Pratt & Whitney J52-P6 turbojets (above), each delivering 8,500 lb. thrust. Variable tailpipes (below) can be lowered 30 deg. for STOL effect during takeoffs and landings. Pattern speed approximates 105 kt.



Calverton, N. Y.—Grumman's new side-by-side two-place, twin-jet A2F-1 Intruder, the 17th combat model the company will deliver to the Navy, is a carrier-based low-level attack bomber capable of maintaining Mach .9 at sea level (AW May 2, p. 31).

The A2F-1, a swept-wing long-range aircraft, is powered by two Pratt & Whitney J52-P6 turbojets, each of which delivers 8,500 lb. thrust. Variable tailpipes (adjustable) can be lowered about 30 deg. for STOL effect during takeoffs and landings, giving a 10-kt. speed reduction under the norm.

Navy, which has eight A2F-1s on order, took delivery of the first during ceremonies here Apr. 29th. Four aircraft will be delivered this calendar year and four the next, all for test purposes. The first Intruder made its eighth flight during acceptance ceremonies, at which time it had flown 8 hr.

Slow-flight capabilities were evidenced during a fly-by by Grumman test pilot Robert Smyth. Empty weight of the Intruder is 24,000 lb. Maximum gross weight is 54,000 lb. At a fairly light weight, Smyth had the A2F-1 airborne after a roll of approximately 1,200 ft. Rotation speed was reported at 100 kt.

Intruder demonstrated a good rate of climb and a slow-speed, close-in, 105-kt. pattern wth tailpipes deflected about 30 deg. Flaps have been most effective at 40 deg. extension.

Though optimum speeds have not yet been reached, the A2F-1 has been stalled, clean, at 125 kt. With power, gear and flaps down, the aircraft has stalled at 80 kt. Controls are similar to those of Grumman's F11F-1F.

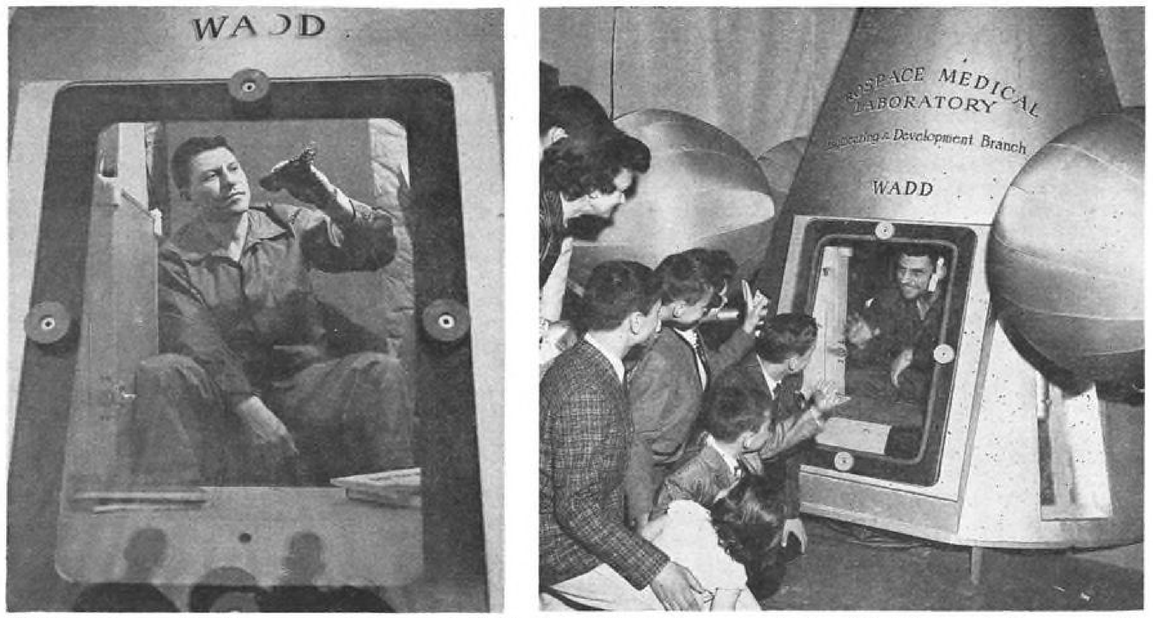
During static display at Calverton the A2F-1 was fitted with external stores. Three Mark 84, 2,000-lb. GP bombs were mounted outboard on each wing and under the belly. Two Martin ASM-7 Bullpup missiles were mounted inboard on each wing. Armament probably will include the Temco Corvus XASM-N-8 air-to-surface missile.

Design of the Intruder meets Navy requirements that included capabilities for extended range, low-altitude nuclear missions, including limited brush-fire war. Completely obscured targets are visually represented to the pilot and radar operator through the aircraft's electronic integrated display system.

The integrated display system also provides data for the A2F-1's digital integrated attack navigation system (DIANE).

A2F-1 is being developed under the first "cost-plus-incentive-fee" contract totaling $101,701,000, to be administered by the Navy.

HUMAN FACTORS



FIRST test of a complete life support system was made by Courtney Metzger, shown preparing to eat food from a plastic squeeze tube at left. He was observed around the clock during the seven day test. On completion, he was greeted (right) by his wife and children.

Hermes Tests Zero-G Capsule Equipment

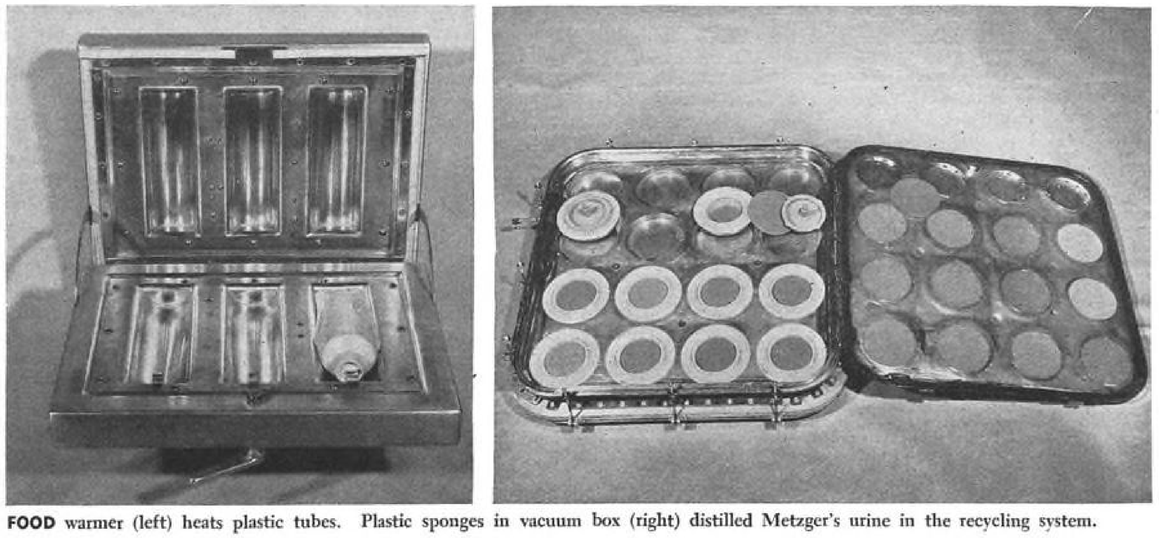
By Evert Clark

Dayton—Seven-day manned test in a sealed capsule has demonstrated that a life-support system capable of operating in the weightlessness of space could be built now, Air Force researchers believe.

Project Hermes, completed recently at Air Research and Development Command's Wright Air Development Division here, was the first combined test of a number of life-sustaining subsystems designed and engineered on operating principles that would be valid under zero gravity conditions.

Hermes also was the longest simulated space flight in which a man has remained for seven days in an almost completely self-sustained, or "closed," environment.

The project was conducted by what was the Engineering Development Branch of the former Aerospace Medi-



FOOD warmer (left) heats plastic tubes. Plastic sponges in vacuum box (right) distilled Metzger's urine in the recycling system.

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cal Laboratory. Under the current reorganization of WADD, the laboratory has been renamed the Aerospace Medical Division, with three separate laboratories—biomedical, behavioral sciences and life support. The life support laboratory is now divided into a sustenance branch, a cabin equipment branch and a protecting branch.

Courtney A. Metzger, 40-year-old laboratory engineer who coordinated the project, also served as the subject for the simulated flight. The capsule was a conical shape approximating that of an Atlas missile nose cone and measuring nine feet high and seven feet at its base.

Since the test was intended to prove technical feasibility of the principles designed into the equipment, concern with size and weight of the subsystems was secondary.

Major Objective

Perhaps the most important objective of the test was to see whether a system with no moving parts could perform the task of regenerating oxygen and removing water vapor and odors. Researchers chose potassium superoxide, a canary-yellow powder that is commercially available in quantity.

Potassium superoxide has been used as an air purifier in USAF and Navy firefighters' masks, but always in an open system with forced ventilation. In Hermes, ventilation was not forced. Only air movement and the partial pressure differential between the carbon dioxide level in the capsule's air and carbon dioxide level in the cabinet containing the potassium superoxide caused the filtering action to take place.

The filtering system caused one abort of the test after 24 hr. Originally, the screen and glass-cloth-covered filters containing the superoxide were placed in three cabinets along one wall of the capsule, near Metzger's head. But the slight amount of dust from the superoxide formed potassium hydroxide when it combined with the water from Metzger's eyes and nose. The solution was to move the filters to another cabinet, further away from Metzger, and to seal this cabinet with masking tape except for an opening at one end which was covered with glass cloth.

The filtering system performed well, keeping carbon dioxide down to about one-half of one per cent of the air content during the test. It also absorbed water efficiently and kept odors down so well that the only one remaining in the capsule when it was opened after seven days was the perfumed smell from wash-and-dry cloths of the type used on commercial airliners.

Metzger's concern over the danger of dust from the filters caused one of the two critical moments in the test. The first came after 24 hr., apparently because this was the first test to run beyond that time. The second came on the fourth day when Metzger donned glasses, face mask and gloves to change the filters. Space limitations prevented the filter cabinet from holding enough filters for the full seven-day test. Researchers who monitored the test 24-hr. a day said he showed "considerable anxiety" as he removed new filters from sealed plastic bags and placed them in the cabinet.

Filter Tests

A considerable amount of work remains to be done on the filtering system. Centrifuge, vibration and other tests will be made on the ground to determine how the chemical bed would stand the stresses of booster liftoff, what the implications of the dust problems are, etc.

Water recycling system, which also worked well, used a simple vacuum distillation principle. Urine was collected in a polyethylene bellows developed by American Machine and Foundry and transferred by Metzger to a 38 lb., 36 x 36 x 7 in. vacuum box containing a number of plastic sponges. Capacity was about 1,500 cu. cm., approximately a normal day's output.

Vacuum was maintained by an electric motor and pump outside the capsule. In an actual flight, the vacuum of space would be used, and the bellows and vacuum box would be built as one unit, eliminating the need for the pilot to transfer the urine.

Although urine of a healthy person is sterile, and actually can be drunk without recycling, iodine water purification tablets were used to ensure sterility and remove unpleasant odors before the urine was transferred.

Water System

As a test of the system, Metzger drank the recycled urine. His capsule contained a drinking water system which employed a balloon that could be pumped to expel water through a nozzle into the plastic squeeze bags from which he drank. Metzger found that the recycled urine tasted better than drinking water after the latter had been stored for several days and placed in the vinyl squeeze bag.

Solid body wastes were collected in a container encased in a plastic bag with drawstrings. Because of the problems weightlessness will add to the function of evacuation in a spacecraft, the toilet had a seat belt, and the container had a pump system to ensure as clean an operation as possible. Danger is that bacteria, most of which are carried from the body by the feces, might be transferred to the urine container.

Pump creates a partial vacuum in the waste container. Air from the capsule then forces itself through open-celled sponges ringed around the opening of the container, and the flow of air carries solid wastes with it. The sponge opening is springed to ensure a close fit. Waste containers are placed inside white, opaque bags and stored in the compartment of the food freezer from which the previous day's food has been taken.

Freezer, developed by Westinghouse, was divided into seven compartments, each containing a day's supply of meals in squeeze tubes, and a chiller section for tubes of fruit juices. Freezer is thermoelectric, avoiding liquid refrigerants which would complicate the operation in zero gravity.

Food-warming unit, developed by REF Manufacturing Co., also was electric and incorporated a temperature control, timed heating cycle and switch allowing heating for an indefinite period.

Freezer and oven required 700-watt power supply. Although units with lower power requirements can be developed, and the sun's heat might be employed in a space capsule to supply this power, researchers concluded that "this Waldorf-Astoria setup wouldn't be essential on a seven day mission."

Hermes capsule was essentially leak-free, but it was not designed to withstand pressurization. Since a finned radiator of the type that might be used to dissipate heat into the vacuum of space could not be simulated, water was supplied from outside the capsule and circulated through an internal cooler to keep cabin temperature down. On the first night, Metzger forgot he had a temperature control inside, and slept with socks and sweater on.

Survival Equipment

Capsule also carried survival and flotation equipment. An oxygen bottle and mask, an outfit of down clothing vacuum-packed in a 350 cu. in. bag and a pneumatic raft were supplied for emergencies.

A water landing of the capsule was assumed, and four spherical, nylon-covered latex bladders were attached to booms and folded into the sides of the capsule. One pull by Metzger on a ring inside the capsule inflated the four bags from carbon dioxide bottles. Inflation pushed off the breakaway panels covering the bags and pulled them upward and outward so that they formed four outriggers at the expected water line. Bags would serve mainly for stabilization, but, if the capsule should leak, they would keep it afloat. Such a system has been tested on the Convair B-58 pilot escape capsule (see p. 101).

No attempt was made to obtain psychological or physiological data during Hermes or to have Metzger perform tasks because researchers did not want to add any burdens that might make it more difficult for him to spend a full seven days in the capsule.

Metzger's menu included high-calorie foods in addition to the meals in squeeze bottles, but the puree consistency of most of the food after it was squeezed through the tube openings, coupled with the fact that he was inactive, left him with a reduced appetite. He ate only twice a day—late in the morning and later in the evening—and consumed only about 2,200 calories a day.

Air Samples

Researchers did take air samples and measure carbon dioxide and oxygen content continuously, and they counted respiration and heart beat visually when they could through the capsule's 20 x 31 in. window. Metzger also took air samples in bottles each day so that a progressive buildup of poisons, etc., could be studied later.

Metzger took a copy of the Bible into the capsule, hoping to read it all the way through at one time, but because of his lack of activity he soon became lethargic, and did not complete the reading, researchers said. He watched television through the capsule window from early evening until late at night. He slept only about six hours a night.

Metzger said after the test was concluded that he was lonely and would have talked more often to the re-

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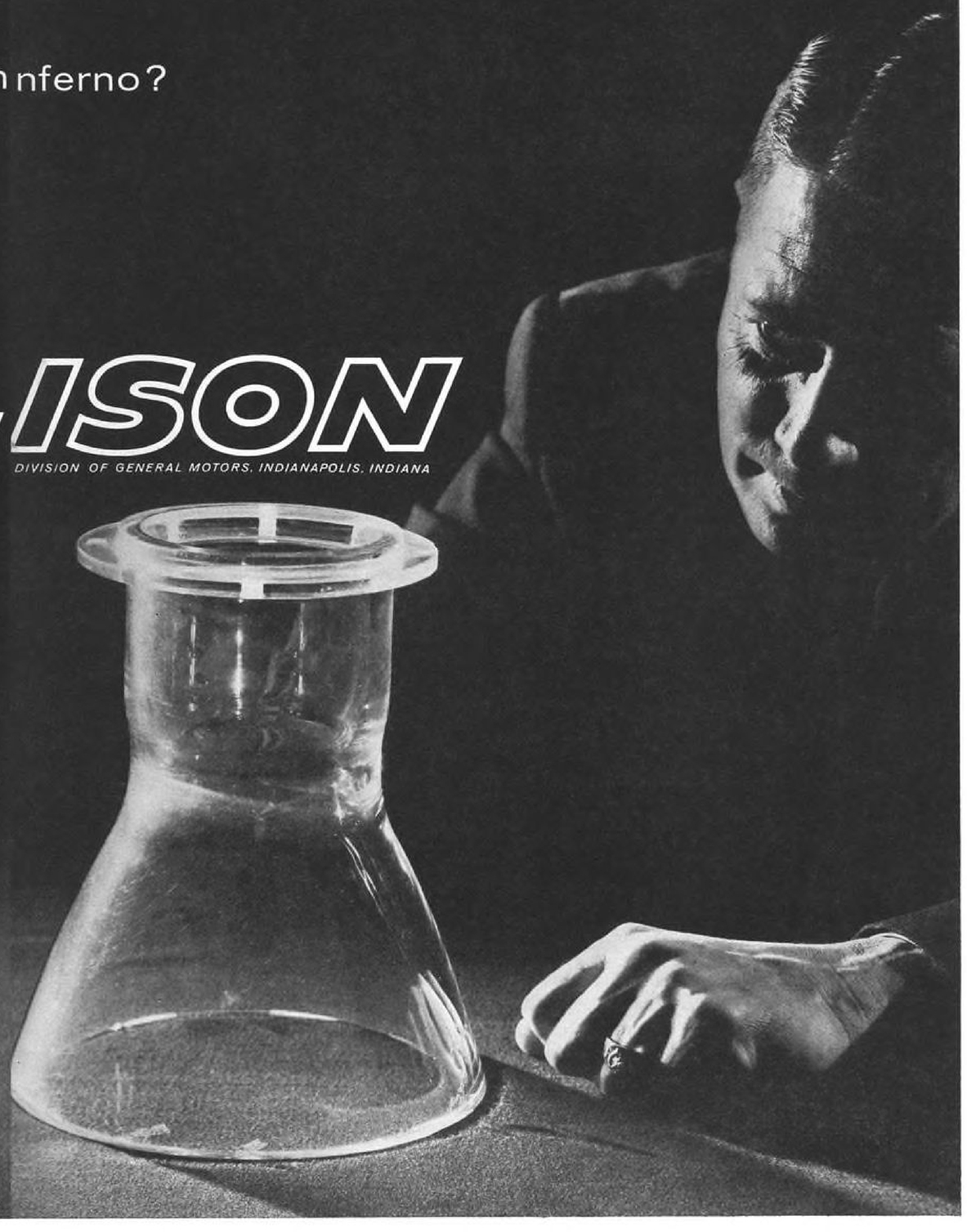
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searchers outside the capsule by means of the intercommunication box provided for him, but he thought he would be interfering with their work. In any such future test, researchers will attempt to talk frequently to the man in the capsule.

Metzger's water intake was relatively low for the first few days. Internal temperature and humidity were well within the comfort zone, so Metzger perspired little, but researchers also found that he was worried at first that he might run out of water until they told him that he could drink every two hours without exhausting the supply.

The capsule's equipment included a "panic button" that would ring a bell outside, but Metzger did not use it.

The laboratory branches which worked on Hermes also are monitoring approximately 70 contracts, averaging about $30,000 per contract, on various components of life-support systems. Squeeze tube tests have led to two contracts for development of containers that will not reduce the food to a puree. One is a square aluminum container that may have a plunger to push the food forward, and the other is plastic. Although some problems remain in storing processed foods in plastic bags, they save weight over metal containers.

In addition to Metzger, project personnel included Richard Bennett, urinal and water storage unit; Dr. Robert Hayes, oven, refrigerator and in-flight feeding equipment; Donald Keating, oxygen-generating equipment; Lt. Alfred Hallam, emergency oxygen equipment; Warren Hypes, survival gear, flotation systems and communication systems; George Filson, installation supervisor; Konrad Weiswurm, assistant for respiration equipment and communication gear and calibration of instruments.

PRODUCTION BRIEFING

Lear, Inc.'s, Industrial Products Group has received a contract to produce 10 remotely-operated automatic control systems for nuclear reactors being developed by Martin's Nuclear Division. The specially-designed control rod positioning systems will be used in critical tests where fine precision measurements are required. Martin's liquid fluidized bed reactors were cited as an application of the systems.

Douglas Aircraft Co. is working with Air Force in an intensive aircraft testing program to predict the fatigue life of an airplane and to provide a firm basis for improving design of future aircraft. A Douglas C-133 Cargomaster will carry the bulk of the testing workload. Program includes fatigue analysis and development of load spectrum; interim service loads; flight test of instrumented aircraft; airplane cyclic fatigue testing, and recording of gust data on a fleet of aircraft.

Lycoming Division of Avco Corp.'s T55-L-5 gas turbine completed its 50-hr. USAF preliminary flight rating test one month ahead of schedule. The test was run at an average rating of 2,190 shp.; specifications require 1,970 shp. guaranteed power. The production T55 is expected to be qualified in August at 2,200 shp.

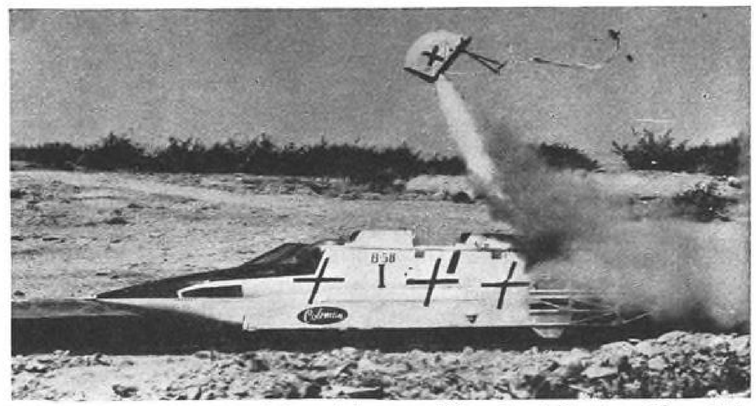
Pye Instrument Landing System will be installed at Nairobi Airfield, Kenya, Africa. System will be used to bring turbojet transports to touchdown by radio guidance on the airport's 13,500-ft. runway.

Consolidated Diesel Electric Corp.'s Aircraft Equipment Division will build 53 water servicing trucks for the Air Force under a $1 million contract. The tank units carry 2,600 gal. of demineralized water to service jet aircraft equipped with water injection engines.

Lockheed Aircraft Services, Inc., will handle the American sales of the Midas airborne flight recorder. The Midas recorder, developed by Royston Instruments, of England, records 270 channels of information on magnetic tape with 160-hr. capacity. The data capsule, equipped with a float and a homing beacon, is ejected in the event of a crash.

Hamilton-Standard Division of United Aircraft Corp., Windsor Locks, Conn. will build 150 mobile control towers and 53 trailer-mounted electronic shops under $2.5 million Air Force contract. The two-wheeled control vans, measuring 5 ft. square by 5 ft. high, will be used by the Tactical Air Command at temporary landing fields.

Standard Railway Equipment Mfg. Co., Chicago, is transferring production of airport terminal loading walkways from its P. I. Steel Corp., Los Angeles to the subsidiary's Ogden, Utah, facility due to increased production demands. Current backlog of the telescoping "Jetway" walkways is 55 including 39 slated for United Air Lines.



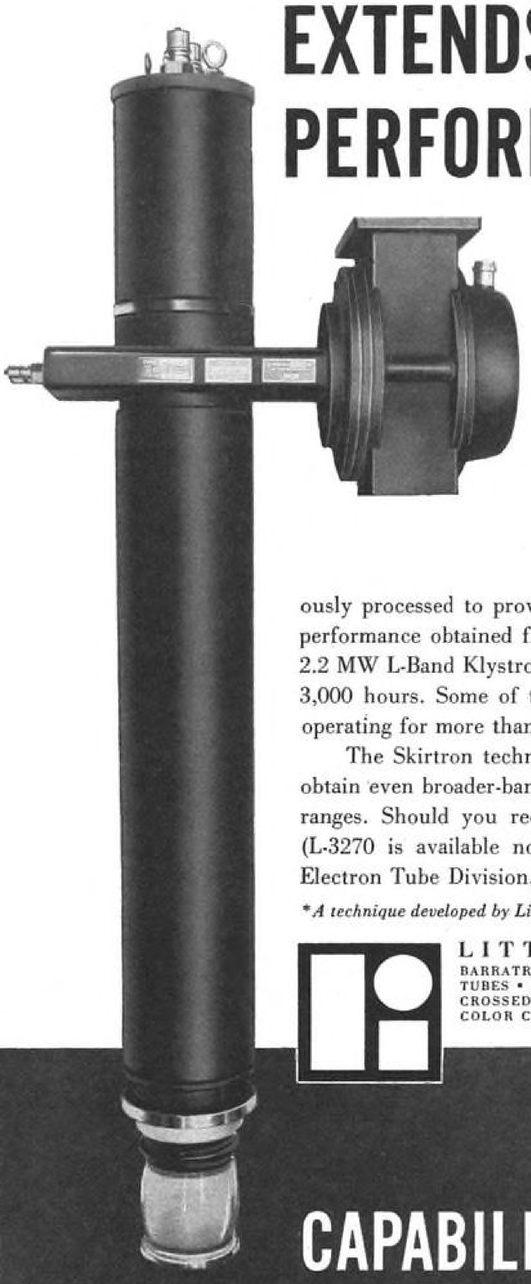
B-58 escape capsule is ejected from sled at near-700 mph. at Hurricane Mesa, Utah.

B-58 Escape Capsule Test

Research program to refine the Convair B-58 Hustler jet bomber escape capsule system is under way at Stanley Aviation Corp., Denver, Colo., under contract from Convair Division of General Dynamics. Capsule configuration is shown at right; unit is ejected by a ballistic charge, equivalent to the power of a .37 mm. cannon shell and then a rocket motor on the capsule fires automatically to push the capsule and airman farther away from the aircraft. Parachute opens automatically to lower the capsule to the ground. Stanley Aviation used football players to run tests of initial shock forces through instrumentation. Findings shows football players withstood brief forces of upward of 70g without injury.



L-BAND KLYSTRON EXTENDS BROADBAND PERFORMANCE



This addition to Litton Industries' Klystron family not only extends the bandwidth of our broadband L-band amplifier tubes, but does so in a reduced package size. Through improvements of the recently developed Skirtron* bunching technique, the L-3270 achieves gain and power output characteristics, which are essentially flat over the minimum bandwidth of 100 Mc. Its minimum peak power output at the band edges is 2 MW. A linear phase shift versus frequency characteristic makes it ideally suited for application in sophisticated radar systems, where electronic tuning and pulse shaping are required.

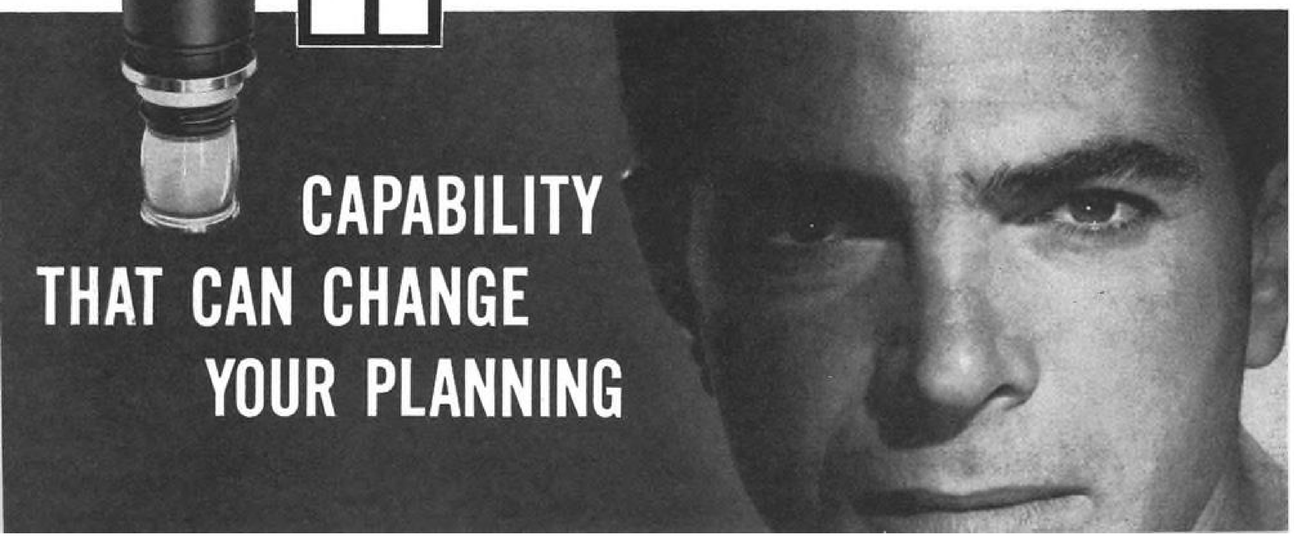
This tube, like all other tubes produced by Litton Industries, is conservatively designed and rated; and rigorously processed to provide thousands of hours of reliable operation. Typical of the performance obtained from applying this design philosophy is that of the L-3035, a 2.2 MW L-Band Klystron, whose *average* operating life in field service is approaching 3,000 hours. Some of these tubes are continuing to provide top performance after operating for more than 10,000 hours.

The Skirtron technique is being applied to other tubes now being developed to obtain even broader-band performance at higher power levels and in other frequency ranges. Should you require high power broadband performance for your current (L-3270 is available now) or future system planning, write to Litton Industries, Electron Tube Division, Office A13, 960 Industrial Road, San Carlos, California.

**A technique developed by Litton Industries which provides improved broadband performance.*

LITTON INDUSTRIES Electron Tube Division

BARRATRON® TRANSMITTING TUBES • MAGNETRONS • KLYSTRONS • TRAVELING WAVE TUBES • BACKWARD WAVE OSCILLATORS • GAS DISCHARGE TUBES • NOISE SOURCES CROSSED-FIELD AMPLIFIERS • HIGH DEFINITION CRT • DIRECT-WRITING CRT COLOR CRT • STORAGE TUBES • MICROWAVE FILTERS • DUPLEXERS • TR TUBES



McDonnell Is Optimistic on Future

New York—Brokers reacted to the appearance of James S. McDonnell, president of the McDonnell Aircraft Corp., before the New York Society of Security Analysts here with a brief flurry that sent the stock as much as $3 higher in an afternoon.

The probable reasons:

• **Earnings** were forecast at $7 a share for the fiscal year ending this June and probably the equivalent to that in 1961.

• **Lack of acquaintance** with the company previously by many New York financial people, especially with its work on the Mercury project. Cumulative value, including backlog, of its total space contracts was $64 million, McDonnell announced.

• **Optimism** on the part of McDonnell. To many analysts, he seemed to be the first aircraft company president to look and talk optimistically before the society in the last six months.

In an effort to dispel "the one man myth," that McDonnell is a company run solely by himself, McDonnell turned most of the presentation over to a McDonnell vice president, Thomas G. Rutledge.

Rutledge described the financial position of the company as the soundest in its history. Cash flow from depreciation and amortization has reached $6 million, and debt—totaling $26 million today—could be reduced to zero by 1961.

Both of these contentions reflect the virtual completion of McDonnell's second five year facility program in which $35 million has been spent.

Comments on present and future business for the company included:

• **Canada** may be a prospective customer for the F-101B, now phasing out of production for USAF, because of Bomarc cutbacks.

• **Market survey** will be made internationally to determine the executive airplane sales potential of the Model 220. This is McDonnell's Model 119 utility transport built for a USAF competition but equipped with General Electric CF700 aft-fan engines.

• **Cumulative contract** totals including backlog are $127 million for Quail, $50 million for Talos. Of McDonnell's total Mar. 31 backlog of $433 million, 77% is for fighter aircraft.

• **Spares** have been running an average of 8.3% of McDonnell's annual sales. The F4H Phantom II program should involve production through 1965 plus spares and modification business for five years after that.

• **McDonnell stock** has sold below book value at times during the last year, and McDonnell has bought back about 3,000 shares. Through this policy, and through an increase in authorized shares from 2,000,000 to 8,000,000 shares for a two for one stock split, McDonnell hopes to add to shares held in the company treasury for use in possible acquisitions.

Temco Quarterly Earnings Decline

Dallas, Tex.—Net income of $375,692 after federal income taxes was reported by Temco Aircraft Co., Dallas, for the first quarter of 1960. Net earnings for the same period last year were $467,156.

Sales for the first quarter of 1960 totaled $19,112,729, compared with sales of $28,142,563 in the same period last year. Temco's backlog at

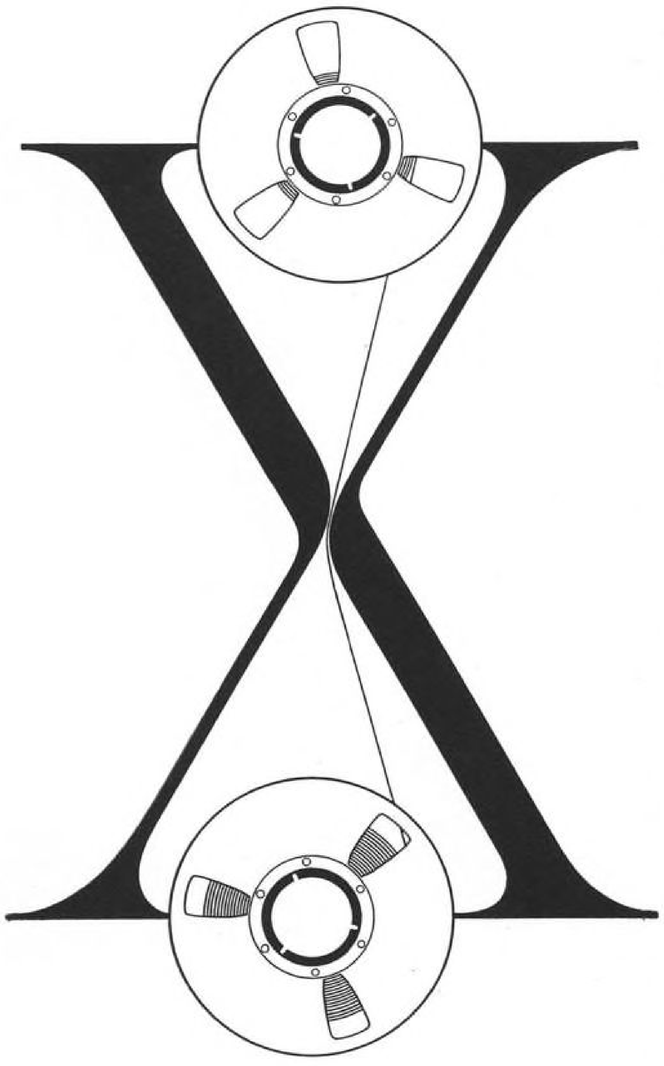


Model 500A Aero Commander Makes First Flight

Aero Commander 500A, first of a new series of Aero Commanders being produced by Aero Design & Engineering Corp. (AW Apr. 11, p. 116), makes its first flight. Airfoil-shaped engine nacelles have exhaust ports on top to reduce cabin noise. Powerplants are two Continental IO-470-M engines delivering 260 hp. each. Maximum gross weight is 6,000 lb.; useful load is 1,925 lb.

NO DOUBT ABOUT IT—

"SCOTCH" BRAND Sandwich Tapes wear 10 times as long without errors



IN THAT NARROW LITTLE LIFELINE OF DATA known as magnetic tape, a miss is magnified into a mile. A missed bit, or one picked up by error is confusing, frustrating and time-consuming. If you're in doubt about the kind of performance you're getting, perhaps "SCOTCH" BRAND Sandwich Tapes can solve some of your tape and equipment problems.

The exclusive construction of the Sandwich Tapes combats the causes of error because it eliminates the source—oxide rub-off and head build-up. Tests prove it wears a minimum of 10 times as long as ordinary tapes before it errs. As a by-product, you can rely on it to drastically reduce maintenance and replacement costs on equipment.



The Sandwich is constructed as shown in the diagram at the right. The famous "SCOTCH" BRAND high potency oxide coating is sandwiched between a tough polyester base and a 50 micro-inch layer of plastic. Since the oxide is never in contact with the head, tape movement is smooth and low in friction—easy on both tape and equipment. Oxide can't rub off and distort valuable data.

Yet, the real meat of this remarkable Sandwich is the "SCOTCH" BRAND high potency oxide coating. Even under the protective plastic, the oxide's potency is quite sufficient to pick up 500 pulses per inch—and give desirable high-frequency response in many AM, FM and PDM applications. Sandwich Tape is but one of the developments to come out of 3M research—the same research responsible for "SCOTCH" BRAND Video Tape—the first video tape in commercial use.

Whatever your application—you'll find the right tape for reliable, error-free performance in the "SCOTCH" BRAND line-up. Check them all. *High Resolution Tapes 158 and 159* pack more bits per inch, offer either standard or extra-play time. *New Heavy Duty Tapes 198 and 199* offer good resolution and exceptional life even in poor environments. *High Output Tape 128* gives top output in low frequencies, even in temperature extremes. And *Standard Tapes 108 and 109* remain the standard of instrumentation.

Your 3M Representative is close at hand in all major cities—a convenient source of supply and information. For details, consult him or write Magnetic Products Division, 3M Co., St. Paul 6, Minnesota.

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SCOTCH BRAND MAGNETIC TAPE
FOR INSTRUMENTATION

MINNESOTA MINING AND MANUFACTURING COMPANY
...WHERE RESEARCH IS THE KEY TO TOMORROW

Mar. 31, 1960, totaled $80 million in orders, letters of intent and contracts being negotiated. Company is discussing a merger with Ling-Altec Electronics (AW May 2, p. 37).

Temco now has a preliminary draft of Navy intentions on the Corvus air-to-surface missile covering Fiscal 1961, which, when negotiated, is expected to provide a substantial dollar volume, according to company sources. Its subsidiary, Fenske, Federick & Miller, Inc., now has a backlog of approximately $4.4 million in orders for its Iconorama data display systems, and indications are that this backlog will grow to approximately $11 million by the end of 1960.

The subsidiary already has instituted a major subcontracting program on the system to Temco's Dallas facility, covering some $500,000 in work and it is expected to increase this program "substantially."

Acquisitions And Mergers

Precise Electronic & Development Corp., New York, has merged with Automatic Coil Co., Inc., Brooklyn, to expand its work in test equipment, coils, transformers and filters.

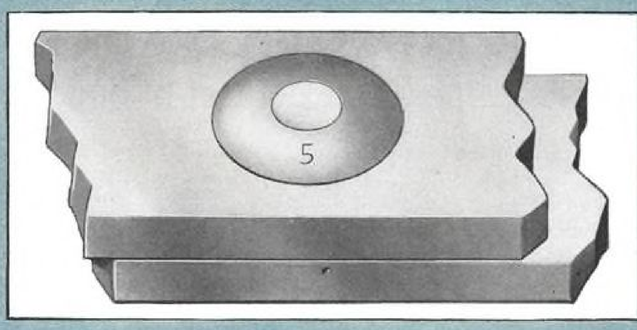
Atlee Corp., Woburn, Mass., has acquired the assets of and merged with Industrial Electronics Co., Inc., and Applied Dynamics Corp. Firm will continue under the Atlee name and headquarters will be in Waltham, Mass., in Applied Dynamics' new plant. Allan Q. Mowatt, Atlee chief, will continue as president, and Michael G. Stratton, president of Applied Dynamics, becomes board chairman. John E. Mossman, president of Industrial Electronics, is executive vice president.

Loral Electronics Corp. has acquired Alpha Wire Corp., which will operate independently as a Loral subsidiary; Peter Bercoe continues as president. Howard B. Saltzman has been elected executive vice president.

Financial Briefs

Fairchild Engine & Airplane Corp. reported a loss of $326,000 or 11 cents a share for the first quarter of 1960 compared with a loss of $277,000 or 9 cents a share in the 1959 first quarter.

Space Electronics Corp. backlog in April totaled almost $1.5 million, a new high, and $500,000 more than the company's February backlog. A large proportion of the new business is for design and construction of electronic subsystems for data handling, missiles and space vehicles.

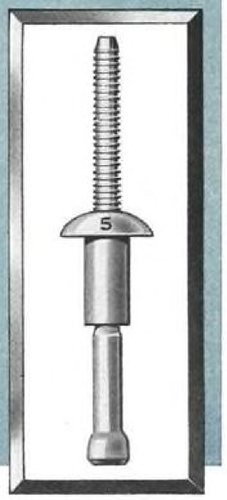


Only Cherry Gives You The Complete Line

Now

★ **Serrated Stem Rivets *with***

★ **Grip Markings on Rivet Head**



The new Cherry "9000"* Series MS type rivets are now a part of our standard product line, along with our familiar knob stem rivets.

Cherry is again FIRST to provide grip markings on the rivet head—for easy identification in bins or work boxes, plus positive visual inspection after installation.

Fully approved under MIL-R-7885A, the new Cherry "9000" Series rivets are available in your choice of metals, and are installed with existing serrated stem pulling heads.

For those who prefer serrated stem type blind aircraft rivets, the Cherry "9000" Series completes the line which includes the new Cherrylock "2000" Series Mechanically Locked Stem with flush fracture, the Cherry High Clinch Series rivets—"600", "700", "800"—and the Cherry Standard MS line of knob stem rivets—the "100" and "500" Series. For information write: Cherry Rivet Division, Townsend Company, Box 2157-N, Santa Ana, Calif.

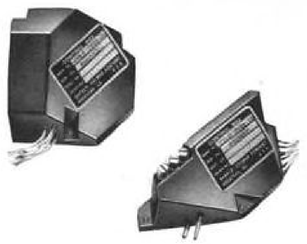
CHERRY RIVET DIVISION
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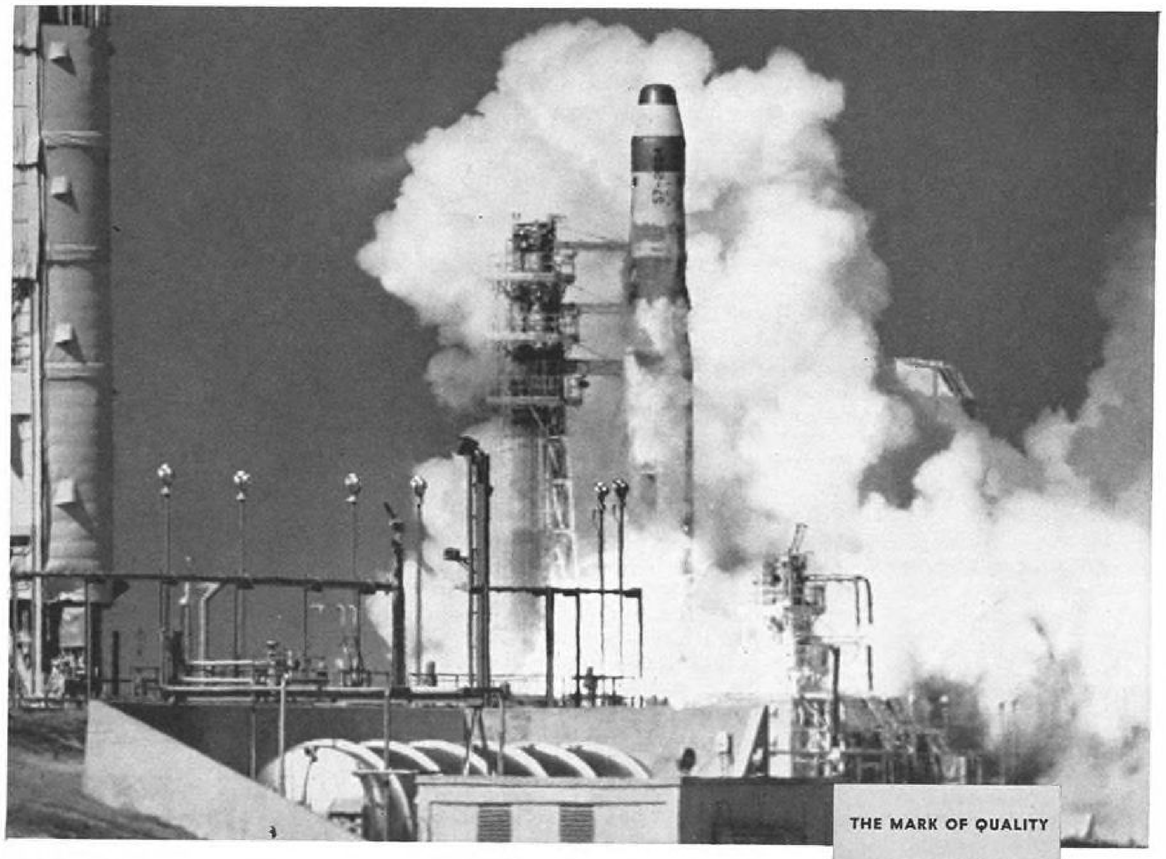
how Barber-Colman engineers meet critical tolerance and envelope challenge of Titan temperature control project

Assignment to Barber-Colman Company from Air Force TITAN associate contractor, AC Spark Plug, Milwaukee: Take one part of the Air Force TITAN guidance platform and develop a complete temperature control system that will fit into the odd-shaped, very limited space available. Hold temperature to the exceptionally close tolerances specified. *Result:* A precision Barber-Colman temperature control system incorporating an ingeniously formed set of compact control boxes and sensing element (right) which control temperature of the internal structure to within a few hundredths of one degree. Unusual assignments like this are the kind of challenge that Barber-Colman people like to accept. For help with your temperature control problems consult the Barber-Colman engineering sales office nearest you: Baltimore, Boston, Fort Worth, Los Angeles, Montreal, New York, Rockford, Seattle.

FORM-FITTING TEMPERATURE CONTROL BOXES FIT SMALL, IRREGULAR SPACE



Related control boxes and sensing element for Air Force TITAN guidance platform temperature control application.



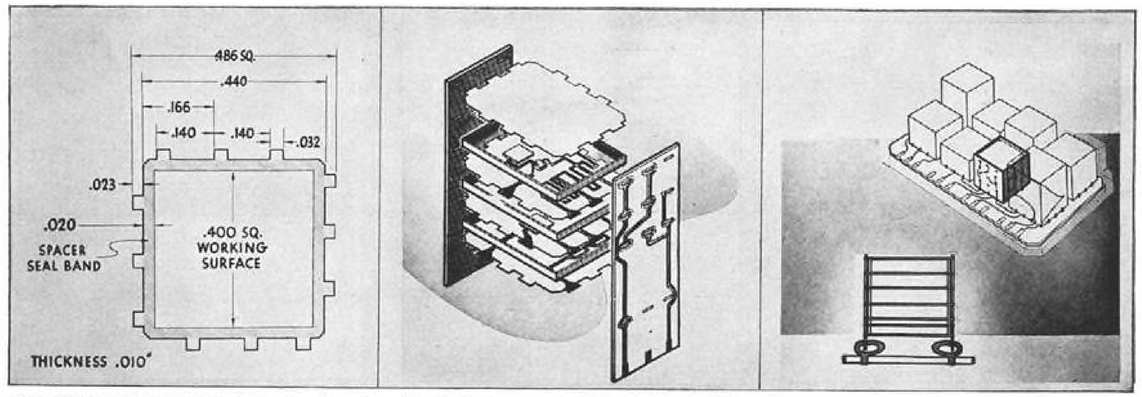
BARBER-COLMAN COMPANY

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AIRCRAFT AND MISSILE PRODUCTS: AIR VALVES, ELECTROMECHANICAL ACTUATORS, TEMPERATURE CONTROL SYSTEMS, POSITIONING SYSTEMS, TRANSDUCERS AND THERMOSTATS, SPECIAL GROUND TEST EQUIPMENT

THE MARK OF QUALITY

BARBER COLMAN



NOMINAL DIMENSIONS of the circuit wafer with shaded area around its periphery, designating surface area to be occupied by the spacer, is seen in drawing at left. Artist's view (center) shows various elements which comprise the Sylvania Microminiature Module, including four wafers, three spacers and two of the four interconnection boards. Individual modules are interconnected on a molded ceramic board (right) capable of accommodating eight modules in this case. Preformed metal connector fingers are inserted into the board holes and furnace fused to the wiring to establish the interconnection.

Microminiature Modules Show Potential

By Barry Miller

Waltham, Mass.—A microminiature module program designed to accommodate contemporary as well as future high-temperature and high-density avionic components will be unveiled this week by Sylvania Electric Products, Inc.

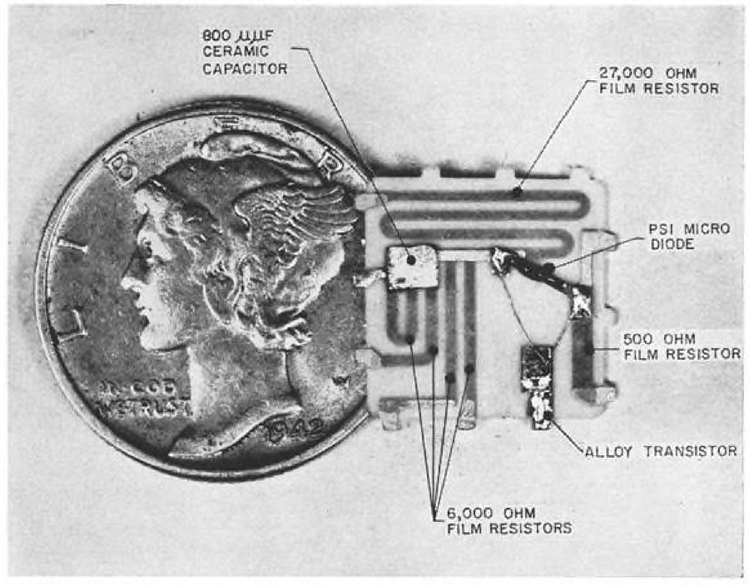
With other microcircuit developments elsewhere, this program shares a common objective of efficient and reliable use within restricted volumes of the large numbers of components required in military and space systems. Sylvania engineers, for their part, are using materials, protection techniques and a construction approach which they think will lead to microminiature modules with growth potential—the ability to satisfy tomorrow's, as well as today's system needs. If, for example, a module whose upper operating temperatures are prefixed by those of available semiconductor components, is made by high-temperature fabricating techniques and employs high-temperature materials and seals, then the transition to higher temperature semiconductor devices, which may be made more extensively available within the next few years, will be an orderly one requiring no severe changes in the construction or assembly of the modules.

Now in the development stage at Sylvania's Applied Research Laboratory here, the program has been entirely company-supported since its inception one year ago. To some degree the applications phase of the program will benefit financially from an Air Force contract for the development of laboratory techniques for designing an ultra-reliable airborne receiver adaptable to microminiaturization.

This Wednesday Gerald J. Selvin, Sylvania's manager of microelectronics, is scheduled to reveal details of the program before the Electronic Components Conference in Washington. Some of the principal features of the company's microminiature module, cited by Selvin, are:

- **Stage-to-stage** interconnection without wires.
- **Functioning stage** of circuitry on each wafer of the module.
- **Hermetic sealing** of every wafer in the module without plastics or other potting compounds.
- **Construction** of the modules by methods and with materials capable of withstanding temperatures up to 400 or 500C.

The microminiature module, like the



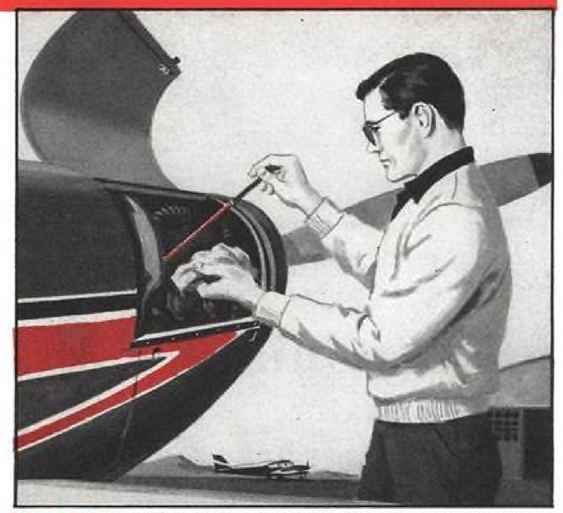
WAFER CIRCUIT supporting nine discrete components—six precision vacuum deposited metal-film resistors, one capacitor, one diode, and one transistor—is dwarfed by a dime.

Esso

WING TIPS



FIX NICKS. Check metal propellers regularly for nicks and have them filed smooth as soon as possible. Nicks can develop into cracks, and cracks can result in the breaking of blades while in flight.



SET TIGHT. When checking the oil, make sure the dip stick is set in place securely. If it isn't in tight, the stick can work loose and oil may spray over the plane, causing serious loss of oil and a hazardous flying condition.



CHARGE IT. With an Esso Credit Card, you can charge gasoline, oil, lubricants – plus tire and battery service, landing fees, overnight in-transit storage, and minor repairs. In addition, you can now charge Esso marine and automotive products with the same card.

This convenience is yours at selected airports from coast to coast, and Canada, too. Naturally, top flight service is provided by your dependable Esso Aviation Dealer, whose service is designed for *your* flying pleasure and safety.

ESSO STANDARD, Division of Humble Oil & Refining Company

Highways or Skyways..."ESSO RESEARCH works wonders with oil"

Army-RCA Micro Module, will be built around a single, square-shaped wafer substrate on which components are mounted. Made of alumina or Fotoceram, each wafer can handle a minimum of five components, such as uncased transistors, vacuum deposited resistors and capacitors, plus conductors. The wafer has twelve uniformly spaced tab connectors which protrude from its outer perimeter. Once a circuit function has been mounted properly and tested on the wafer, selectable height spacer frames are glazed onto the periphery of the wafer.

Alternate wafers and spacers are then successively stacked—wafer, frame, wafer, frame—under a dry inert atmosphere so that each circuit stage on each wafer is hermetically protected from the outside. Wafers can be stacked to any convenient height, depending on the subsystem function of the module. The number of wafers employed and the heights of the selected spacer frames determine the final height of the module.

Four rectangular Fotoceram printed circuit interconnection boards are then fitted about the stacked wafers to form the module. Rows of slots on the interconnection board become the receptacles for adjoining tabs on the wafers. Connections among the individual circuits are established when conductive material predeposited on the wafer tabs is fused to the conductors on the printed circuit interconnection board with a medium temperature, high-ductility solder.

Component Density

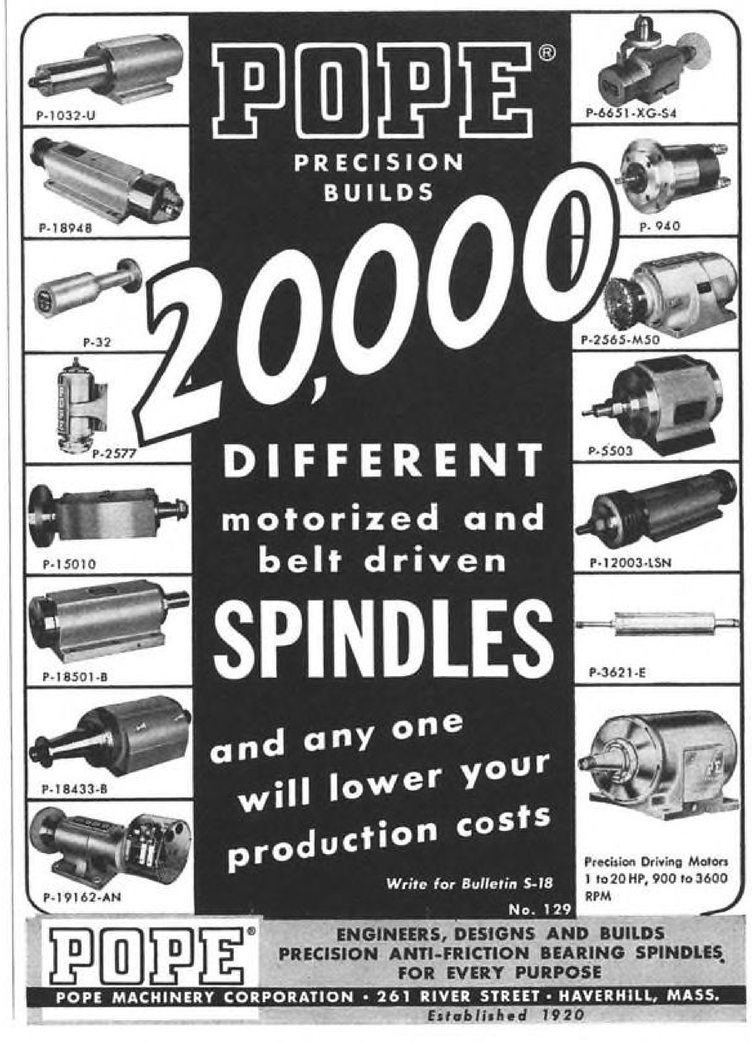
The minimum packing density of the microminiature module, computed on the basis of five parts per wafer, including one uncased transistor per wafer, is expected to be 600,000 parts per cubic foot, according to Selvin. If component density was computed at 9 or 10 parts per wafer—a larger, less conservative but still reasonable estimate for its component wafer density—then the parts density for Sylvania's module would climb to about one million per cubic foot.

So far as estimates or guesses about potential or ultimate parts density with future functional or molectronic devices are concerned, Selvin declines to get ensnared in what he and others working in microminiaturization are now calling the "numbers game" or "numbers racket." A more meaningful measure of density or performance may evolve, Sylvania hopes, which would relate the stages or circuit functions rather than components to unit volume. This would be specially useful for functional or molecular electronic circuits in which there will be no individual, identifiable components.

Sylvania engineers are progressing with a plan to demonstrate several types of operating module circuits. A 200-kc. flip-flop module is now operating. A broadcast band wireless transmitter completely contained in a single wafer stack is under construction. In addition, work recently began on a high-frequency (in excess of 50 mc.), multiple stage IF amplifier using silicon transistors throughout. With these three devices, which are expected to be fully functioning late this summer, the company hopes to demonstrate the versatility of its microminiature module. These three samples, Selvin explains, will illustrate the more difficult low-frequency audio type circuits, in which high inductance and high capacitance are mandatory; the simple, straightforward IF range pulse-type circuits; the high frequency RF amplifier circuits.

Module Details

The precise working area on each wafer, 0.4 in., with an outside dimension of 0.486 in., is sufficient for at least five components of the type being built by various subcontractors and vendors for the Army-RCA Micro Module program. Wafer thickness is 10 mils. Thus, each wafer can handle a circuit stage and the manufacturer can fabricate, test and adjust circuit stage action rather than individual compo-





ARTIST'S CONCEPTION:
GAM-87A SKY BOLT
AIR-LAUNCHED BALLISTIC MISSILE

SAC IN TRANSITION

A Special

Aviation Week

Report on the

Strategic Air Command's

Transition

into the

Aerospace Age

The changing role of the Strategic Air Command in the national defense picture will be featured on June 20th in a special 36-page report prepared by AVIATION WEEK editors with on-the-spot coverage of the SAC Command—The nation's shield against aggression.

This exclusive report will be published in answer to the growing requirement for an improved national understanding of SAC's changing role as the primary deterrent force guarding national security. The annual R&D issue will be devoted to this message which is today's most challenging subject.

The Strategic Air Command's deterrent position has undergone complex and fundamental changes in its transition to a Strategic Aero-Space Command—with its formidable bomber fleet soon to be reinforced by intercontinental ballistic missiles operationally deployed to instantly counter any aggressive action.

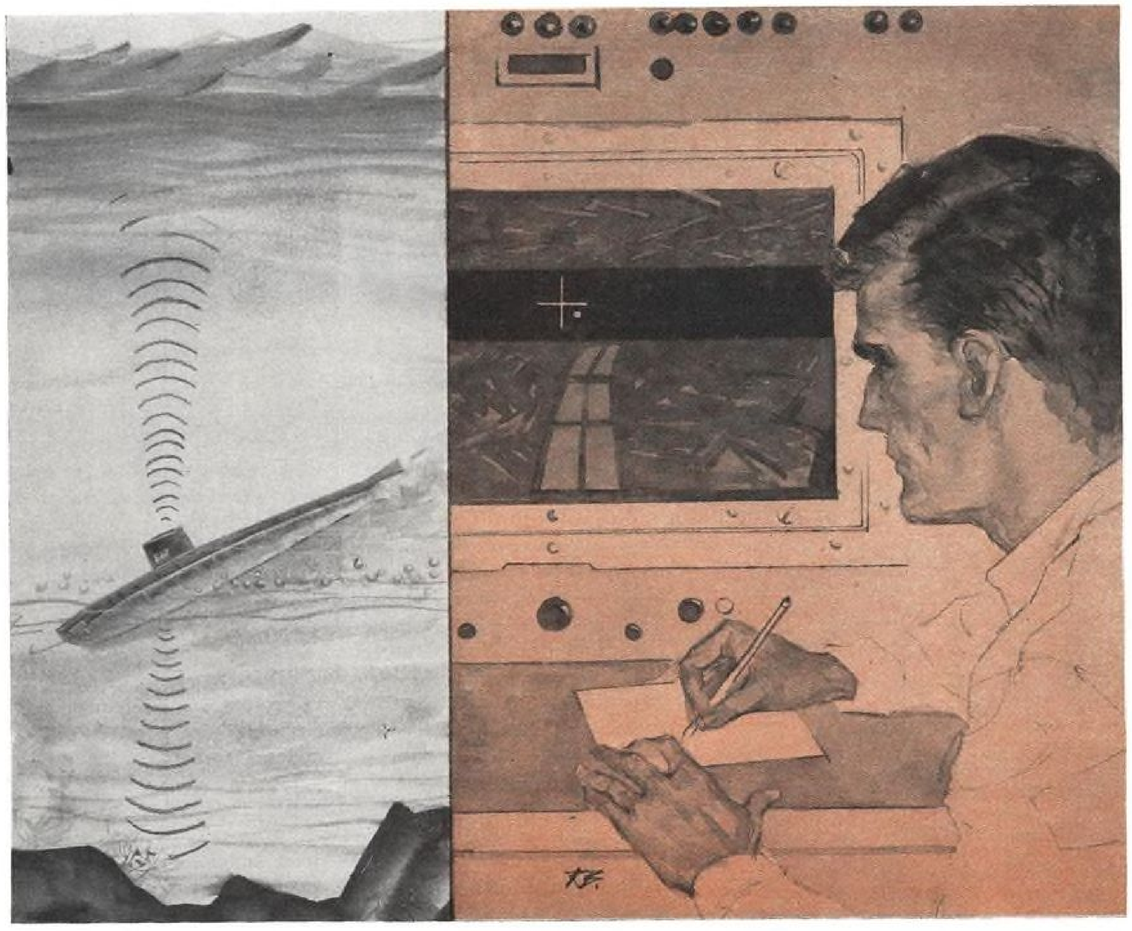
The transition of SAC is one of the most rapid and exciting events in the history of our nation and its defense. What SAC needs, what lies ahead and the weapon systems to be employed in the immediate future will be key subjects included in this first-time technical evaluation. The impact of new technologies and weapon systems has changed the entire defense concept and the response of SAC to these new requirements has been effective and positive.

AVIATION WEEK editorial teams are now engaged in the compilation of the new SAC story—one that will generate world-wide readership. This issue, "SAC In Transition," offers manufacturers and suppliers of the aerospace industry an unusual opportunity to advertise and identify their role in the national defense effort.

Aviation Week and **Space Technology**

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Norden Contact Analog Display... man's sight beneath the sea

A recent and significant Norden achievement is a contact analog display which orients man in the unnatural environment beneath the sea. This compact system provides a pictorial pathway for a submarine, displaying on a single screen all pertinent parameters: pitch, roll, heading, speed, surface and bottom positions. It forms an integrated control station for the craft. A sophisticated electronic system utilizing advanced television and computer techniques, it was developed for the Bureau of Ships and brought from concept to hardware in less than 18 months.

This is just one of several key programs at Norden involving advanced television, radar, digital computing and digital control systems. And as man continues to probe his universe, Norden engineers will be helping to make his craft safer and more efficient . . . for Norden is dedicated to extending man's capabilities.

• • •

Stimulating positions are available at all levels of responsibility for qualified engineers and scientists.

NORDEN

DIVISION OF UNITED AIRCRAFT CORPORATION

Stamford, Connecticut

nent performance. Eventually, today's single circuit per wafer is expected to grow into multiple stages per wafer with molectronic circuits.

(The 12-notch Army-RCA Micro Module wafer is 0.31 in. square and normally one component is allotted per wafer, although multiple components, four resistors, for example, have been mounted on one wafer and R-C filters will similarly be mounted.)

Conductive material in the form of silver bonded glass frit ink is fired onto Sylvania's wafer in suitable patterns to interconnect components. Each of the wafer's twelve protruding tabs (three per side) has conductive material fired onto it also for subsequent interconnection with other wafers, as previously indicated.

Sealing Process

After the circuit has been properly laid out and tested, a glazed ring is placed over both faces of the wafer to improve the glass-to-ceramic bond in sealing. Spacer frames, 10, 30, 50 or more mils in height (with 20 mils wall thickness), are then fused to each wafer by short duration, high-intensity heating performed under an inert atmosphere. Care is taken in selecting each spacer frame's height as each frame must be able to clear the highest component on its wafer. The spacers are Corning Fotoform which withstand temperatures up to 500C. Seal area is then the 20 mil wall frame around the periphery of each wafer.

Temperatures of the sealing process are limited by the maximum temperature which any of the avionic components can endure, and where semiconductors are employed, this precludes the use of furnace techniques. But as the higher temperature semiconductors become available, different seal materials can be used to continue this hermetic sealing process up to 500C. The seal is the only handicap on the high temperature capability of the module and it can be changed within 60 days. In fact, Sylvania says the higher the temperature at which the seal can be made, the broader the suitable choice of materials and the easier the processing.

This hermetic sealing of each circuit is one of the key features of the Sylvania program, Selvin contends. The entire circuit is protected in a single stroke, thus eliminating the need to protect the semiconductor in one way and other components in another. Plastic potting of a transistor, he argues, does not provide the necessary long-term protection from moisture and contamination. This makes the true hermetic seal essential. It also avoids such problems as the stressing of thin vacuum deposited films, chemical interactions, electrical leakage and dielectric effects and limitations on upper operating and fabricating temperatures imposed by potting.

After a stack of hermetically sealed wafers has been assembled, each protected from one another and from the atmosphere, the Fotoceram interwiring boards are inserted over the tabs along the four lengths of the stack. Conductive wiring patterns, previously silk screened and fired onto the board, and the protruding tabs are fused together. A thin (2 to 3 mils) plastic coating is applied over everything except the ends of the board to protect the modules against moisture and abrasion. The resulting module is a half inch square, rectangular shaped body whose lengths are variable, dependent on the height of the stack.

Modules are then interconnected with a molded ceramic or formed Fotoceram intermodule connection board, which is preformed with through holes for connectors. A fineline wiring pattern is precision screened onto one or both sides of the board and preformed metal connectors are inserted into the board holes and furnace fused to the fineline wiring. According to the company this provides a printed circuit interconnection without connector bodies and plastic material which might peel, be delaminated, or be temperature sensitive. Ends of the intermodule boards can be plugged into a conventional printed circuit type of board connector.

In the event that spring type friction connectors are undesirable, as they may be in missile equipment, the spring connector fingers are pretinned with a solder alloy. Heat applied to the back side of the intermodule board freezes the microminiature module into the board. Because special materials are used throughout the board, wiring and fingers can withstand temperatures comparable to those of conventional soldering for periods of time.

High Reliability

Selvin believes that the method of interconnecting circuits and hermetically sealing each circuit promises high reliability because of the paucity of joints, the ruggedness of the joints, hermetic protection and the absence of wires.

Because the program is still in its infancy, Sylvania has not run extensive life tests with the modules. In one relatively brief test, however, engineers loaded slightly over one watt at 75 volts through metal film resistor strips on alumina substrates for over 1,000 hr. The only protection for the resistors was a loose glass covering to prevent dust from settling on the surfaces. There were no failures in any of the 12 strips tested with one watt dissipated by each strip. Tests were run at room temperature and the heat of



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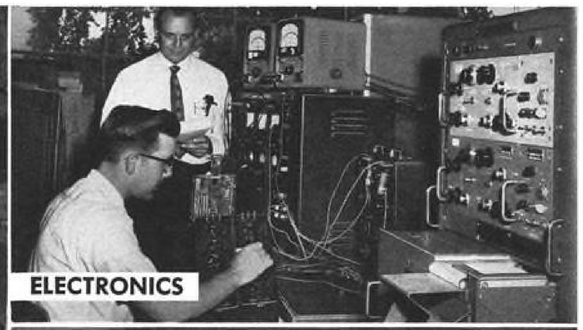
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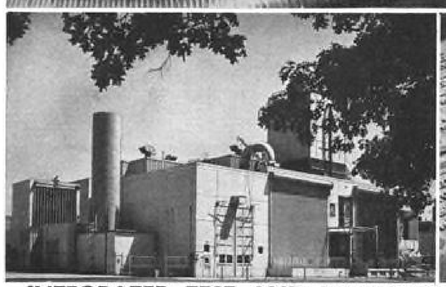
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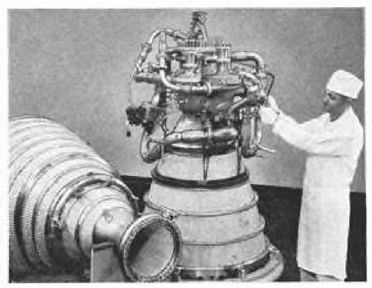
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power dissipation raised the surface temperature of the resistors to over 120C. At the conclusion of the test, resistance values had changed by less than 1/10 of 1%, within the measurement accuracy of the test instruments.

As far as maintenance is concerned, a faulty module can be removed from the intermodule board and replaced by a functioning unit. The faulty unit can be discarded, or where it is necessary or economically desirable to repair the individual faulty circuit wafer, the interconnection board must be removed and the module opened at the seal of the bad wafer. With anticipated reliability, however, the failure frequency should shrink, Selvin believes.

One of the more severe problems confronting any microminiature program is the need to remove heat. Its calculations and preliminary tests show, Sylvania says, that thermal conduction by alumina wafers directly to the interconnection boards is an efficient method of getting heat away from the active electronic materials and to a radiator surface with the fewest possible heat transfer interfaces. Calculations indicate that well over one watt per module can be dissipated at 85C ambient.

The only specific and valid test run thus far, Selvin adds, involved a six wafer stack at about 30C ambient in which one watt was dissipated on one wafer in the center of the stack. Under this condition the wafer surface temperature on which the resistive metal film strip was dissipating its heat reached 83C, a safe figure for a germanium transistor. Adjacent wafers recorded temperatures in the order of 34 or 35C. Further tests are planned.

The Sylvania microminiature module is the product of a year's work by Selvin's group which consists of what he describes as an integrated blend of transistor circuit engineers, chemists, ceramicists, metallurgists and solid-state physicists.

In converting from the development to the production stage with its modules, Sylvania plans to actively seek financial support from military agencies. The company feels that the application of microminiaturization to military electronics today and to commercial electronics in the future makes this work essential.



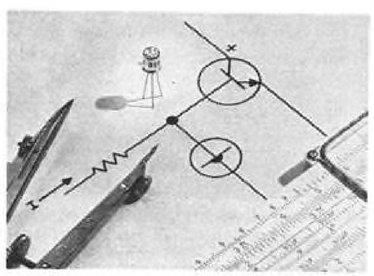
NEW AVIONIC PRODUCTS

Components & Devices

• **Synchro, Type UDSH-10-D-11G1,** is a combination of any two of company's synchros from its size 8 and size 10 lines packaged in a cylindrical housing 2.875 in. long. Pictured unit is a control differential resolver. Stainless steel construction provides necessary vibrational rigidity and zero lineup is obtained by positive mechanical coupling. Clifton Precision Products Co., Inc., 9014 West Chester Pike, Upper Darby, Pa.

• **Static inverters and converters** which may be used in missile guidance and control applications are being offered by Delco Radio. These devices are capable of high capacity, ranging from 150 to 4,000 volt-amperes and efficiencies of 65 to 90% depending on power and control required. Phase control is accurate to 0.5 deg. and frequency control up to six parts per million is achieved under all load and environmental conditions, according to Delco Radio Division, General Motors Corp., Kokomo, Ind.

• **Tunnel diodes,** Types IN2941 and 1N2969, designed for use as circuit reference elements, are available to original equipment manufacturers in production quantities priced at $5.50 and $6.00



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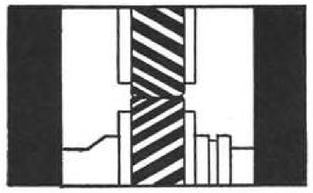
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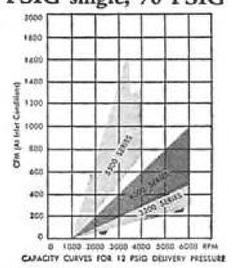
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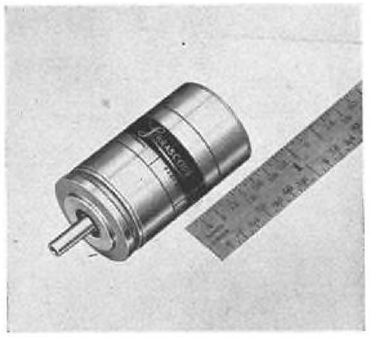


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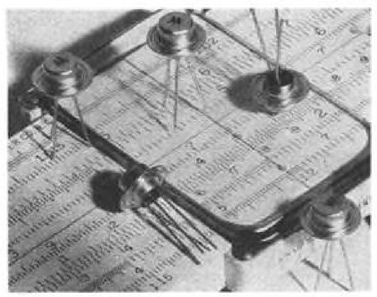


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each, respectively. Both devices have typical peak-to-valley ratios of 8 to 1; can operate over temperature range from −55C to 100C, and are housed in TO-18 case. The 1N2941 has typical peak point current of 2.2 mils (within 10%); total capacity of 30 picofarads while for the 1N2969 these values are 4.7 mils and 20 picofarads, respectively. General Electric Co., Semiconductor Products Department, Syracuse, N. Y.



• **Binary encoder,** Model 793 M, is a 13-bit subminiature shaft position-to-digital encoder packaged in a standard size 8 casing measuring ¾ in. in diameter and 1.25 in. in length. Unit has a resolution of 128 counts per input shaft revolution and a capacity of 8192 binary counts. A combination of two cascaded disks and 25 contact pickups provides serial or parallel binary readout representing shaft position or rotation. Librascope Division, General Precision, Inc., 808 Western Ave., Glendale 1, Calif.

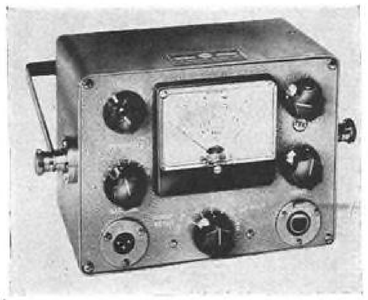


• **Mesa transistors,** Types 2N1561 and 2N1562, capable of delivering ½ watt at 160 mc., are available for use in sonobuoy transmitters, telemetering devices, air-sea rescue radio transmitters, etc. With a collector current capability of 500 ma., the transistors are packaged in a cold-welded package to ensure low internal temperature gradients. These pnp diffused junction transistors will dissipate up to 3 watts at 25C case temperature and are designed to meet mechanical and environmental requirements of MIL-S-19500. Motorola, Inc., Semiconductor Products Division, 5005 East McDowell Rd., Phoenix, Ariz.

• **UHF Ferrite Isolator,** Model LI 01, is designed for operation in the 440-470 mc. band and can cover a bandwidth of 30 mc. centered at 455 mc., providing more than 10 db. isolation with less than 1 db. insertion loss. Isolator measures 3½ x 2½ x 1 in. including two BNC connectors and weighs about 8 oz. It is available for delivery with 30 to 60 days in production quantities. Motorola, Inc., 8201 East McDowell Rd., Scottsdale, Ariz.

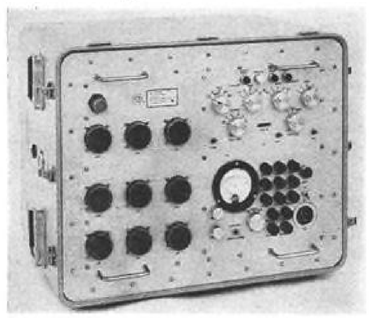
Instruments

• **Power meter,** model B832T, is a temperature-compensated meter which can measure continuous wave or pulsed RF power in five full scale direct reading ranges from 30 micro to 3 milliwatts and readout in milliwatts or dbm.

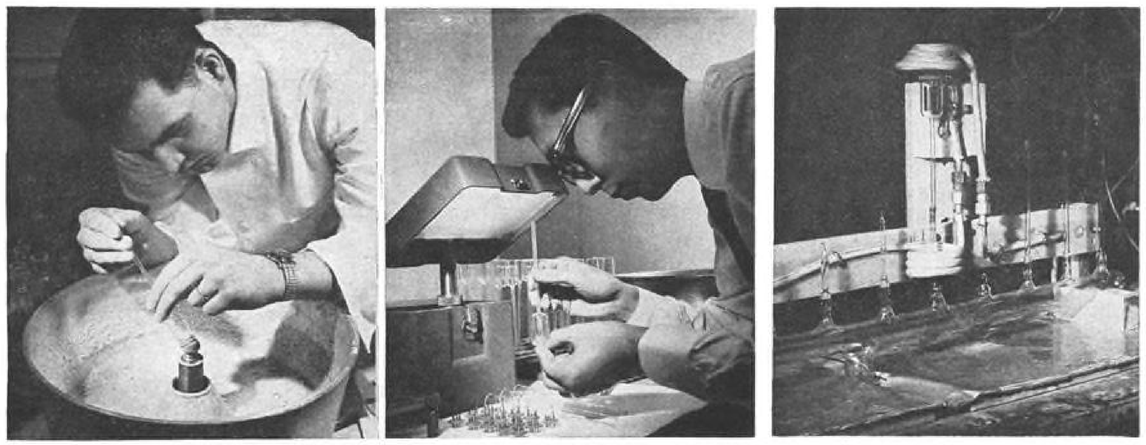


Charging circuit operates from 105 to 125 v., 50 to 400 cps. source. Readings are virtually drift free and temperature compensation makes instrument more stable than comparable measuring devices, according to the firm, FXR, Inc., 26-12 Borough Place, Woodside, 77, N. Y.

• **Cable tester,** Model 196, can measure cable leakage and continuity at a maximum rate of five wires per second under automatic operation. Tester will check 150 simple circuits, 75 main circuits with any combination or number



of branch circuits to a total of 75 branches or any intermediate combination of main and branch circuits up to 150. Designed to meet MIL-T-945A, tester is housed in moisture, air tight case. California Technical Industries, 1421 Old County Rd., Belmont, Calif.



POLISHING of mating surface of hard glass electron tube bulb (left) is the most critical step in the polyoptic sealing process being studied by Chatham Electronics. Bulb is polished on ball lap made of rolled canvas micarta rotating at 1,000 rpm. Monochromatic helium light is used (center) to check preciseness of fit between mating surfaces of tube bulb and button stem. Interference rings, or fringe patterns, give a visual indication of the correctness of the surface contour. At right a Type 1258 tube is ready to be vacuum-sealed by the polyoptic process in a baking oven. Tube is mounted on trolley exhaust riser.

Optical Polishing Adds to Tube Reliability

By Harry Raven

Livingston, N. J.—An optical polishing process of vacuum-sealing electron tubes lowered the number of rejects and significantly extended tube life in tests conducted on a pilot batch by Chatham Electronics Division of Tung-Sol Electric, Inc., under contract from U.S. Army Signal Supply Agency.

Until automated production equipment is developed, the process, called polyoptic sealing, probably will be considered economically impractical except for sealing tubes in which high reliability is a major consideration as in satellites, missile systems, unattended outpost stations and underwater cables. Army is expected to specify tubes sealed with the polyoptic technique before the end of this year, according to Brig. Gen. Elmer L. Littell, commanding general of Army Signal Supply Agency.

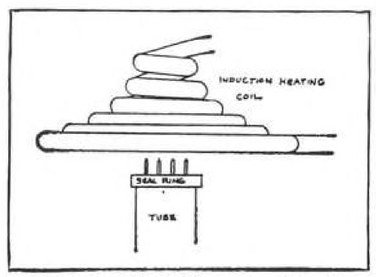
The process may ultimately have application in sealing special types of tubes, including those made of aluminum silica glasses which have very high melting and strain points, and in sealing high precision quartz crystals.

Premium type tubes sealed by optical polishing under present laboratory methods would cost approximately 15% more than if conventional gas flame sealing were used. This figure is based on the assumption that a manufacturing yield would be sufficiently increased to compensate for the high labor costs incurred by using the process.

At 2,000 hr. in Chatham Electronics' pilot evaluation, more than 60% of a batch of 38 polyoptic-sealed Type 1258 miniature hydrogen thyratron tubes were still operative when all of a control batch of 50 flame-sealed 1258s had failed.

The polyoptic tube is sealed in a baking oven. The tube is mounted on a trolley exhaust riser by which all contaminants emitted during sealing are drawn off. The area to be sealed is centered within an RF coil. A graphite ring is placed on the tube over the mating surfaces at the sealing zone. The tube is then evacuated to a pressure of 2 x 10^{-8} mm. of mercury and baked at 400C. The graphite ring is heated to 950C for 15 sec. by induction heating from the RF coil. Vacuum sealing prevents contamination of tube elements due to oxidation.

Graphite rings are subject to relatively rapid erosion and are therefore not wholly satisfactory. Care must be taken to control ring contour, since variations in cross section are apt to cause variations in temperature, and poor sealing may be the final result.



TUBE is placed in baking oven and centered within induction heating coil. Graphite seal ring is placed over mating surfaces which are to be sealed.

Type 1258 tubes were chosen for the evaluation of the sealing process because these tubes are made of hard glass with the mount structure close to the seal zone. In this type of construction the tube elements are particularly susceptible to damage, since hard glass tubes are subjected to relatively high and prolonged temperatures during conventional gas flame sealing, a method which has the following disadvantages:

• **Oxidation of tube elements** (including the cathode base metal, in severe cases) can occur during sealing and annealing.

• **Impurities in the heating gas** may contaminate tube elements.

• **Melted glass** in the sealing zone releases contaminants such as water vapor, carbon dioxide and oxygen which may be absorbed by the element surfaces.

• **High temperature at the seal** may vaporize metallic impurities or even constituents of the glass and contaminate tube elements including, at worst, the cathode surface.

As a result of these difficulties conventional production yields of the Type 1258 tube are erratic and reliability uncertain. Therefore this tube seemed a good choice for testing the polyoptic sealing process.

Polyoptic sealing is an application of the long-known fact that a pair of highly-polished and precisely-mated glass surfaces become securely sealed by true molecular bonding when placed together. Compagnie Generale de Telegraphie San Fil (CSF) of France attempted to apply this sealing technique



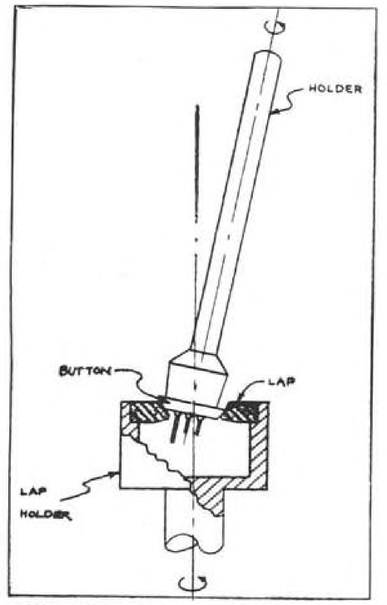
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TUBE BUTTON STEM is held in a device made from a conventional miniature seven-pin socket attached to a plastic rod.

to tubes in which high reliability was desirable, as in submarine cables.

Due, apparently, to technical difficulties and economic reasons, the company settled for a quasi optical sealing technique which proved satisfactory for making tubes in which reliability was paramount, according to Ward Watrous, manager of Chatham Electronics' power tube department.

The U. S. Army Signal Corps learned of the French company's process in 1956 and in June of that year awarded Chatham Electronics a contract to produce, test and evaluate a quantity of tubes with polyoptic seals. Chatham Electronics made an agreement with CSF to obtain technical data and manufacturing knowledge. Army Signal Corps Supply Agency has awarded Chatham Electronics a new contract to continue study of the vacuum-sealing technique, and expects that the results of this investigation will permit a decision as to whether volume production with polyoptic sealing is justified.

The designation "polyoptic" is a misnomer; CSF describes its process as 'du system de scellement par polioptique," which translates as "system of sealing by optical polishing." Thus the American designation "polyoptic sealing" is misleading.

"In Chatham Electronics' polyoptic sealing technique the mating surfaces of a Type 1258 tube's glass envelope and stem mount are optically polished to an accuracy of a few millionths of an inch so when they are joined the tube can be evacuated before the glass is fused.

The mating surfaces can be flat, conical or spherical, depending on the type of tube involved. A spherical seal shape was selected for the Type 1258 tube. When a tube is made of soft glass, enamels with low melting points may be fused to the mating surfaces before polishing and the seal may be effected at relatively low temperatures. However, since the Type 1258 tube is constructed of hard glass, direct-contact sealing was required.

Polyoptic sealing has these advantages:

• **Oxidation is practically eliminated** because the tube elements are under vacuum during sealing.

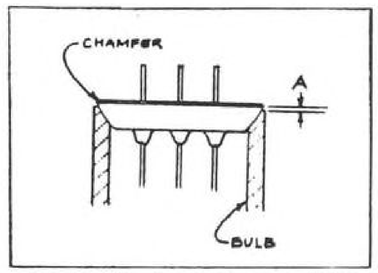
• **Gas combustion products** cannot enter the envelope.

• **Metallic vapors** and gaseous products driven from the glass are removed through the exhaust system before they can appreciably contaminate the tube elements.

• **Period during which the glass** is heated to the softening point is only about 15 sec. (The quantity of contaminants released is a function of the time interval at sealing temperature.)

• **Glass temperature** during the sealing period is considerably lower than during gas flame sealing, so that fewer contaminants are released from the glass.

• **Distortion of mount** due to softening of the glass adjacent to the base pins is obviated.



ROUGH GRIND chamfers button to 0.20 in. (A); coarse lapping to 0.15 in.

• **Premature breakdown** of the cathode binder is not critical because decomposition occurs under vacuum conditions.

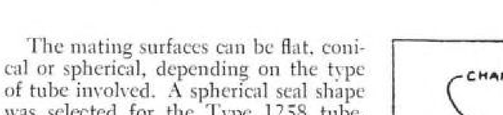
Critical factors in polyoptic sealing include:'

• **Polishing mating surfaces** of the tube envelope and stem mount. Major disadvantage of the process is the cost of labor required to prepare surfaces.

• **Sealing time.** Too long a sealing time leads to bulb "suck in" by atmospheric pressure. Too short a sealing period results in leaky seals, or cracks.

• **Baking temperature.** Oven baking at a minimum of 400C before and during actual sealing was found necessary to prevent seal cracks.

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GE Tests Radome for Radar Deflection

General Electric's Heavy Military Electronics Department is testing this geodesic radome at Cazenovia, N. Y. The dome is erected on a new radar test tower built for the company by E. W. Bliss Co., Canton, Ohio. Tower, which has a tiltable platform coupled to the steel framework, is used to determine amounts of deflection introduced into incoming radar signals by various types of radomes which house the antenna.

FILTER CENTER

▶ **New Transistor Company**—Kearfott Semiconductor Corp. will be the name of the new semiconductor organization (AW Apr. 25, p. 115) set up by Kearfott Division of General Precision, Inc. Stephen Cudlitz and Robert S. Henderson, previously with Massachusetts Institute of Technology, will be president and executive vice president, respectively, of the West Newton, Mass. firm.

▶ **Signed on the Dotted Line**—Major contract awards recently announced by avionics manufacturers include:

• **Raytheon Co.** will produce and install eight additional long range air traffic control radars for the Federal Aviation Agency under a $6 million contract. This brings to 41 the total flight tracking radars ordered from Raytheon.

• **Diehl Manufacturing Co.** will produce resolvers for Navy under a $325,000 award from Bureau of Weapons.

• **Space Electronics Corp.** will conduct further research and development on Titan terminal guidance under a $225,000 extension of a contract from Avco Corp.

• **Hallicrafters Co.** will produce electronic countermeasures equipment for Strategic Air Command Boeing B-52 bombers under a $12 million Air Force award.

• **Sperry-Utah Engineering Laboratory** has received $5.3 million for continued research and development on Sergeant weapons system from the Army Ordnance District, Los Angeles.



ENGINEERS

SITE ACTIVATION

We're rolling up our sleeves for the next important step of activating bases throughout the United States. Design or liaison engineers with B.S. in M.E. or E.E. and experience in electrical or mechanical systems are required for liaison work at missile launching complexes, or design support work on launch control equipment, propulsion systems, automatic programming and missile checkout equipment operations.

Assignments are at Warren Air Force Base, Cheyenne, Wyoming; Offutt Air Force Base, Omaha, Nebraska; Fairchild Air Force Base, Spokane, Washington; and in San Diego.

Please send complete resume to Mr. R. Merwin, Engineering Personnel Administration, Dept. 130-90, 5599 Kearny Villa Road, San Diego, Calif.



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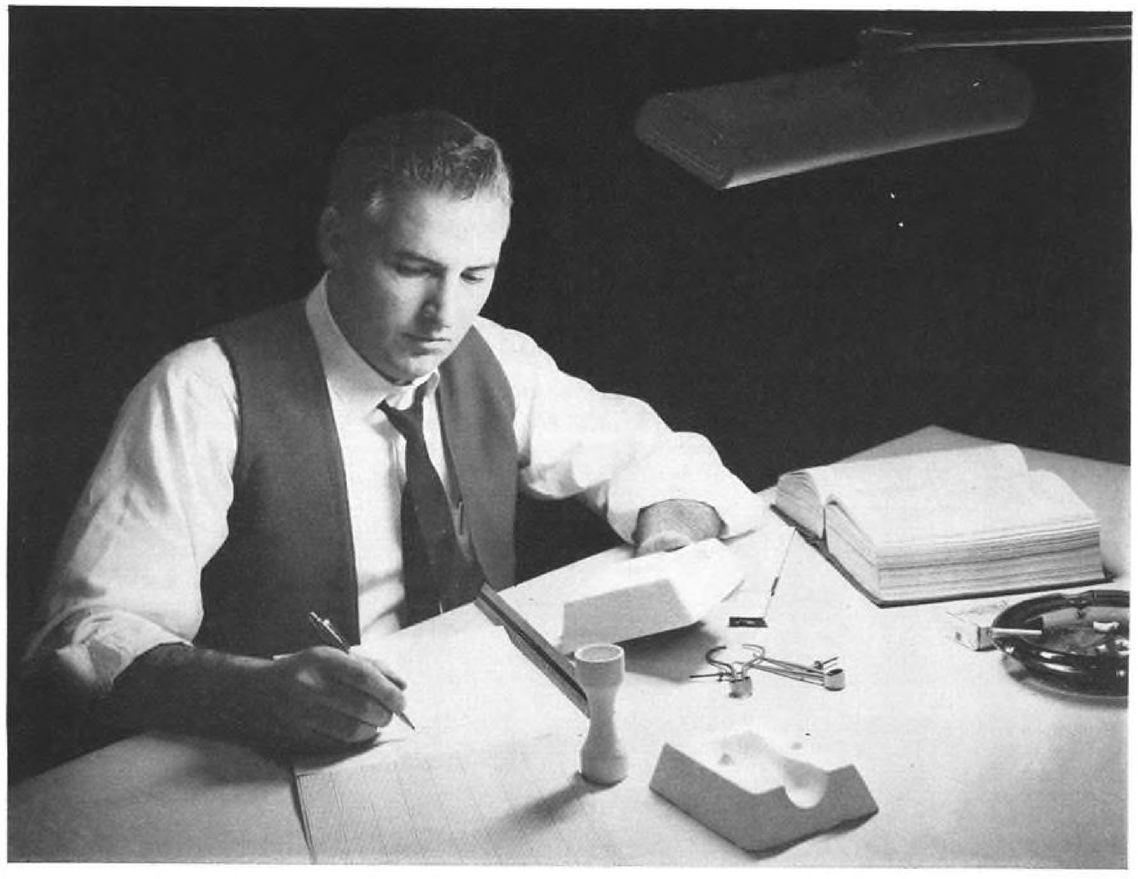
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BOEING / WICHITA

WHO'S WHERE

(*Continued from page 23*)

Changes

Dr. Leslie W. Ball, director of reliability, Boeing Aero-Space Division, Seattle, Wash.

H. H. Christensen, manager-advance space navigation engineering, Advance Engineering Operation of General Electric's Light Military Electronics Department, Armament and Control Section, Johnson City.

Benjamin O. Delaney, technical operations manager, and **William L. Freienmuth,** assistant technical operations manager, Vitro Laboratories, Silver Springs, Md.

Bertram Mintz, chief application engineer, Aircraft Division of Hughes Tool Co., Culver City, Calif.

Douglas Meadowcroft, assistant to the president, Teco, Inc., Burbank, Calif.

Frederick J. Anderson, director of Engineering, Data Systems Operations, Sylvania Electronic Systems, a division of Sylvania Electric Products, Inc., Needham, Mass.

Roswell W. Gilbert, director of corporate research, Daystrom, Inc., West Caldwell.

Donald S. Jones, executive assistant to the general manager, Scintilla Division of Bendix Aviation Corp., Sidney, N. Y. **Thomas B. Kreutz** succeeds Mr. Jones as director of industrial relations.

Donald C. Fleming, senior project engineer-reliability and standards program, Spectrol Electronics Corp., San Gabriel, Calif.

John B. Pitkin, European F-104 project director for Lockheed Aircraft Corp., with headquarters at Koblenz, West Germany. **Eugene C. Frost** succeeds Mr. Pitkin as quality assurance staff manager at Lockheed's California Division.

Dr. Frederick F. Caserio, Jr., has joined the technical staff of National Engineering Science Co., Pasadena, Calif.

Dr. Milo Macha, manager of International Rectifier Corp.'s Astro-Power Division, El Segundo, Calif.

O. F. Henning, marketing manager, Instrumentation Product Group of the Geosciences & Instrumentation Division of Texas Instruments, Inc., Houston, Tex.

Dean O. Bowman, director-long range planning, Autonetics, a division of North American Aviation, Inc., Downey, Calif.

Dr. Emil Onaca, marketing analyst, Leach Corp., Compton, Calif.

W. O. Chamberlain, Jr., director of advanced planning, Cook Technological Center of Cook Electric Co., Morton Grove, Ill.

Dr. Richard B. Nelson, manager, Tube Division Research and Development, Varian Associates, Palo Alto, Calif.

John A. Stern, United Air Lines' European factory representative, stationed at Sud Aviation, Toulouse, France.

Quinn Gow, chief thermal engineer, Zippertubing Co., Los Angeles, Calif.

E. M. Dagerman, West Coast (El Segundo, Calif.) district sales manager, Marine and Ordnance Department of Vickers, Inc., Waterbury, Conn.

Dr. Howard S. Seifert, has joined the technical staff of United Technology Corp., Sunnyvale, Calif., and also has become a professor of aeronautical engineering at Stanford University.

Burton M. Kuck, senior project engineer, Kinetics Corp., Solana Beach, Calif.

John G. Ziemann, chief metallurgist, Metals Division, Kelsey-Hayes Co., New Hartford, N. Y., and **Stanley Abkowitz,** manager of refractory metals product development.

Walter W. Benedict, production manager, On Mark Couplings, Inc., Los Angeles, Calif. Also: **Fred Hoff,** chief of quality control; **Frank J. Kommer,** production control manager.

William F. Hafstrom, director of marketing, Autonetics, a division of North American Aviation, Inc., Downey, Calif., succeeding **Charles A. Wolf,** now operations manager of Autonetics' new Armament and Flight Control Product Division.

Dr. Richard W. Eppley has joined the Astro Systems and Research Laboratories of Northrop Corp.'s Norair Division, Hawthorne, Calif.

Dr. David Sayre, manager of programing planning, International Business Machines Corp., New York, N. Y.

James E. Heath, director of manufacturing, Mechanical Division of General Mills, Inc., Minneapolis, Minn.

The Garrett Corp.'s AiResearch Manufacturing Division of Los Angeles (Calif.) has appointed the following new managers for sales: **Robert J. Tatge**—flight and electronic systems; **Henry N. Titzler**—missile systems; **Raymond J. Gambon**—environmental systems; **Ernest A. Wilder**—heat transfer.



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Human Factors Engineer—capable of analysis and direction of experiments in human motor skills, and application to man-machine systems involving automatic control techniques.

Systems Analyst—capable of conducting research studies involving new techniques of space navigation and guidance.

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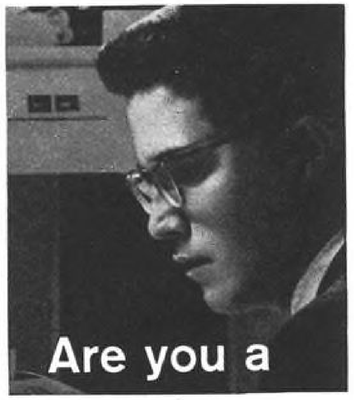
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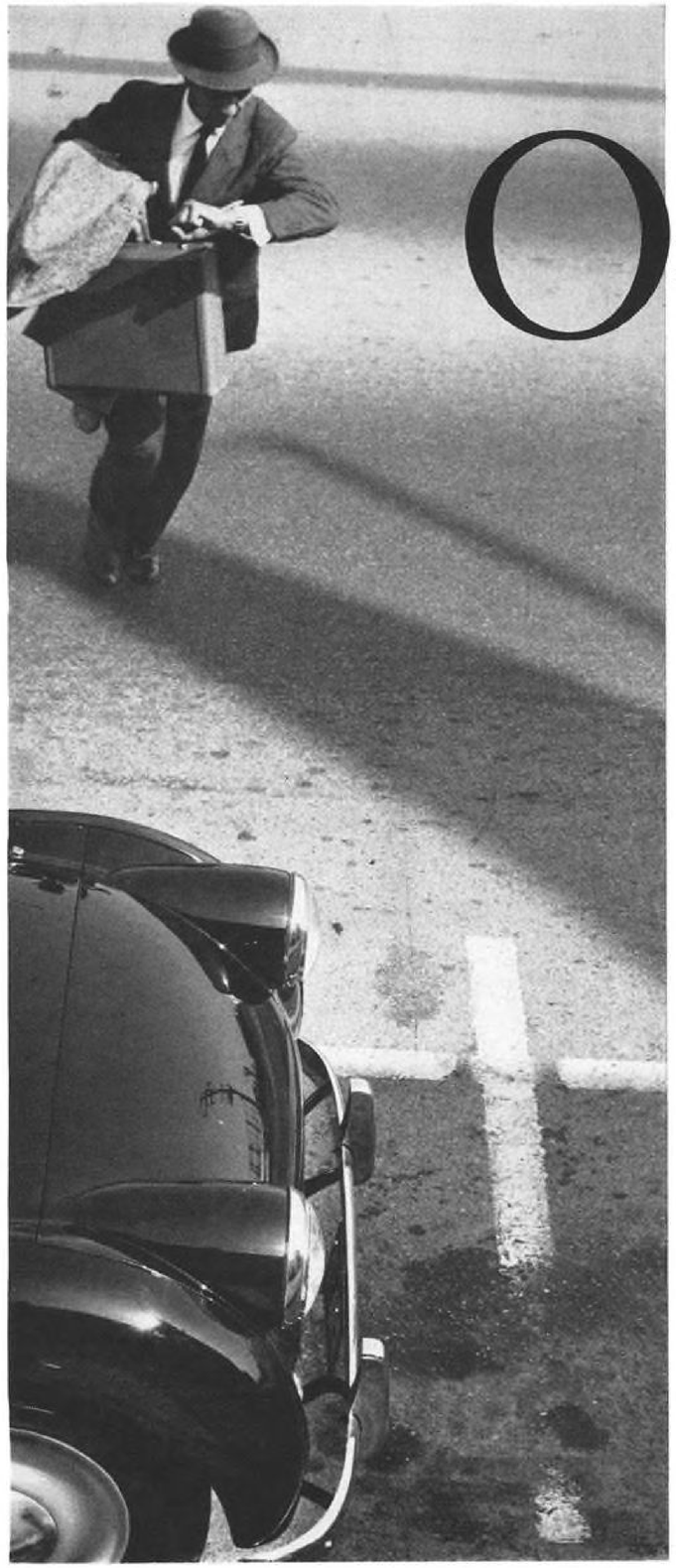
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SELLING OPPORTUNITY OFFERED

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Representatives wanted—men familiar with aircraft parts, one residing in Ottawa, one in Washington, D. C. RW-4316, Aviation Week.

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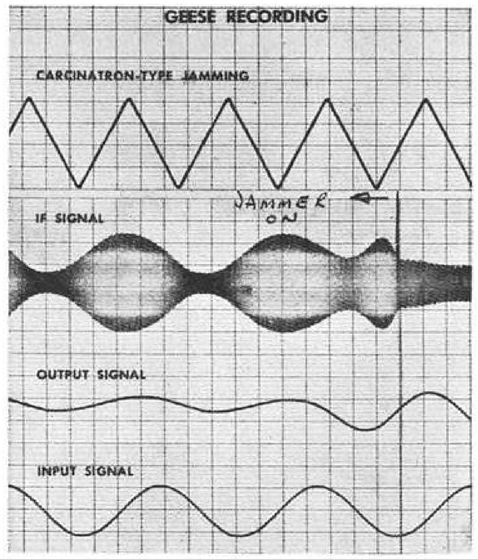
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To accomplish this ambitious task, a growing number of studies are being directed toward the development of unique tools that will aid in the design of superior systems in less time, at lower cost.

A recent contribution by Defense Systems Department in this technological area is GEESE (General Electric's Electronic System Evaluator). Utilizing advance computer techniques, it enables systems engineers to accurately predict, optimize and synthesize system performance prior to design.

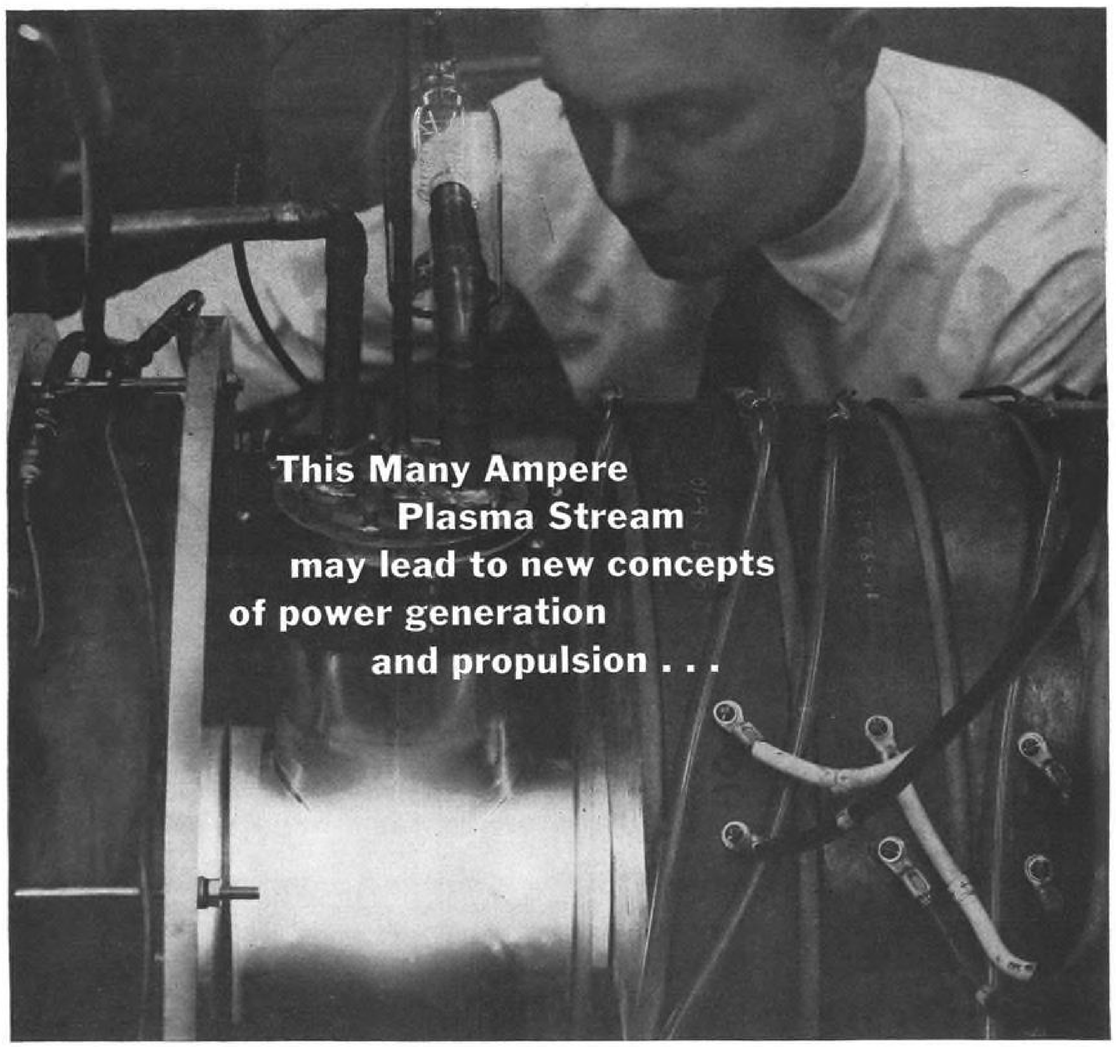
GEESE is indicative of the scope of Defense Systems Department's involvement in the systems technology. Many programs offer systems-oriented engineers and scientists an opportunity to participate in new areas of long-term importance.

Senior members of our technical staff would welcome the occasion to discuss personally and in detail the career positions available with this growing organization. Address your inquiries in professional confidence to Mr. E. A. Smith, Box 5-B.

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A mathematician whose clock had stopped wound it, but did not bother to set it correctly. Then he walked from his home to the home of a friend for an evening of hi-fi music. Afterwards, he walked back to his own home and set his clock exactly. How could he do this without knowing the time his trip took?

—adapted from the ancient Hindu

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LETTERS

Budget Limitations

The constant plea of AVIATION WEEK for more defense funds raises certain questions which ought to be answered by the editorial staff.

The U.S.A. is indeed involved in a World War III of a new type not previously experienced. It is generally recognized that the initiative lies with the USSR. They can and do control the type of war to be fought. They can win by smashing us by ICBMs, by exhausting us by brush-fire wars, by causing us to spend ourselves into failure, or by such superior merchandising as to lead to our financial collapse. AW asks for more spending for aircraft and missiles. These can be paid for by going further and further into debt, i.e. by more and more inflation robbing those on fixed income and leading to more and more debt; the money can come from higher taxes, thus raising all costs—less export business, more debt; or we can stop all the federal service spending, i.e. no more money for farmers, no more money for education, no more money for national highways, no more federal money for commercial airports, perhaps even no more money for steel workers.

I want more defense spending, too, but what shall we give up to get the extra aircraft and missile money? Remember the USSR can keep up the present "cold" war indefinitely. I feel that AW would do a real service if a complete "defense" policy could be presented once instead of merely calls for more aviation money. If you consider that such over-all policy is the problem of the politicians, of the executive, then is not equally the problem of aviation defense funds also beyond AVIATION WEEK?

I do not like the President's limitations on military defense funds any more than the editors of AW, but must not someone take the all-over view and perhaps the limitation on the budget is just as much a defense (all-over defense) effort as would be a few more billions (and more debt—more inflation, i.e. reduced value of the dollar) for better missiles and aircraft?

NIEL F. BEARDSLEY
Santa Barbara, Calif.

Pilot Problems

Your publication of Apr. 4 carried a letter headed "Pilot Complaints" (p. 146). I will have to agree with Mr. Wendt when he states, "Nobody knows a pilot's problems but a pilot."

To get to the point and be as brief as possible, following is a small fraction of the not so well known beefs of pilots.

1. Moving. Since the whole pilot structure is built on seniority, it's a first come-first served basis. If, for some reason, a number of trips are curtailed at a base the junior pilot will be displaced and will have to move bag and baggage. He may choose to commute to see his family from his new assignment, which might give him as much as one or two days a week at home. There is really no security at any base as the airline can eliminate or curtail the time at any airport. Not much fun moving as much as twice a year.

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.

2. Days off. CAR Part 40 states that one 24-hr. period free of all duty in seven days is quite sufficient for airline pilots. How many men in this day and age are there who can only demand one day off in seven? It is true that pilots get more days off than stated above, but they cannot demand it. If the phone rings on a day off and there is no one at home except the poor underworked pilot, he's in trouble. If the pilot answers the phone and hears the familiar voice say, "This is the airport calling," he knows right then that he has had it. Once the airline gets you, you have no choice but to fly no matter what plans you might have had for the day.

3. Sickness. I know of one pilot who had not been ill for four years. The airline called him on a scheduled day off—he wasn't thinking too far ahead because he answered the phone—and he told them he wasn't feeling well. They ordered him to fly anyway, and stated that they would send a doctor around to check on his story if he didn't go.

4. Proficiency checks. Really hate to bring up this sore subject, but there is one point that I would like Mr. Wendt to understand. On a six-month ride, a pilot is expected to perform various maneuvers that he has not done for over half a year. Granted a man must be able to cope with an emergency at any time, but to be asked to perform perfect steep turns without practice is asking a lot.

5. Time. Since 85 hr. per month is the maximum goal of airline pilots, the sooner he can legally acquire this time the faster he can call his life his own. In order to reach the maximum time aloft it is not uncommon for a man to put as much as 400 hr. on duty per month. Quite high when you figure that the average man works only 160 hr. per month. When an average is figured on the duty time it comes to $2.00 per hr. for a six-year copilot; not too good when a bricklayer earns as much as $5.00 per hr .and no physicals or checks to pass.

When you are bitten by the flying bug there is little else that you can do but fly. However, the scant few pilots who are making big money are only as good as their next physical.

BRIAN POWER-WATERS
Airline Captain
Bayside, N. Y.

P.S. Please excuse the terrible writing. I am presently deadheading in the back of a plane in turbulent air. Had to get this to you as soon as I read the letter.

Specialized Duties

In the Apr. 4 publication (p. 146) there was an intelligent letter from a Mr. A. J. Wendt. It is refreshing to read an article inspired by safety and common sense in flying.

The airlines have built up their business on the confidence of the paying passenger who expects to be ensured of a safe trip, and a full staffed, efficient crew is his protection. People place the same confidence in the reputation of an airline and the reliability of its crew members that you would in a hospital and its surgeons. A surgeon who refused to take the American Medical Assn. examination and operated without the specialized services of an anesthetist in surgery would soon lose the confidence of patients, if not their lives.

The number of people flying is still comparatively small, and even if every adult in these United States flew it would not give any airline or group of men reason for taking a chance with safety measures. The public owes a debt of gratitude to men like Quesada who set up strict rules and regulations and are not afraid to see to it that they are adhered to.

As a former stewardess, I experienced some quite unroutine trips during which every crew member had his hands full performing the specialized duties assigned to him alone. On those trips the spirit of cooperation was obvious and unquestioned; those intelligent men showed the greatest perception regarding safety and common sense in flying as well as respect for their fellow crew members and their performance of their respective duties. These facts do make you wonder about the pilots who want to be Jack-of-All-Trades.

FORMER STEWARDESS
Cutler Ridge, Fla.

Defense Position

Although these comments may have been stated in one way or another previously, one cannot avoid but give emphasis to the feeling that the present and future defense position of the United States is suffering among others from a combination of the following factors:

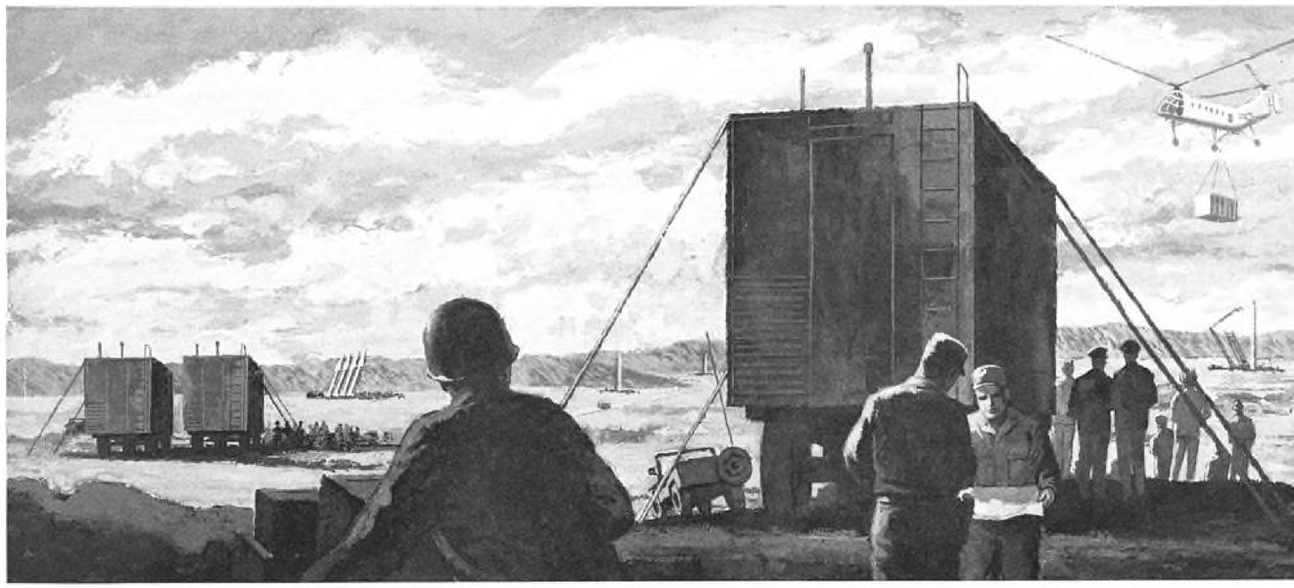
1) Harassment and attempted conditioning in one way or another of certain personnel in the United States government by Communist-type seduction and pressure tactics so that such personnel either resign or their employment is forcibly terminated.

2) An Administration that is reluctant to follow the recommendations of some of the apparently best qualified military personnel in the Defense Department, such as Gen. (Thomas S.) Power, and that is also reluctant to provide adequate Defense Department financing which could probably be achieved without deficits if the needed tax reforms were made, thereby making a more equitable and sensible distribution of taxes.

EDWARD KRAMER
Glenshaw, Pa.

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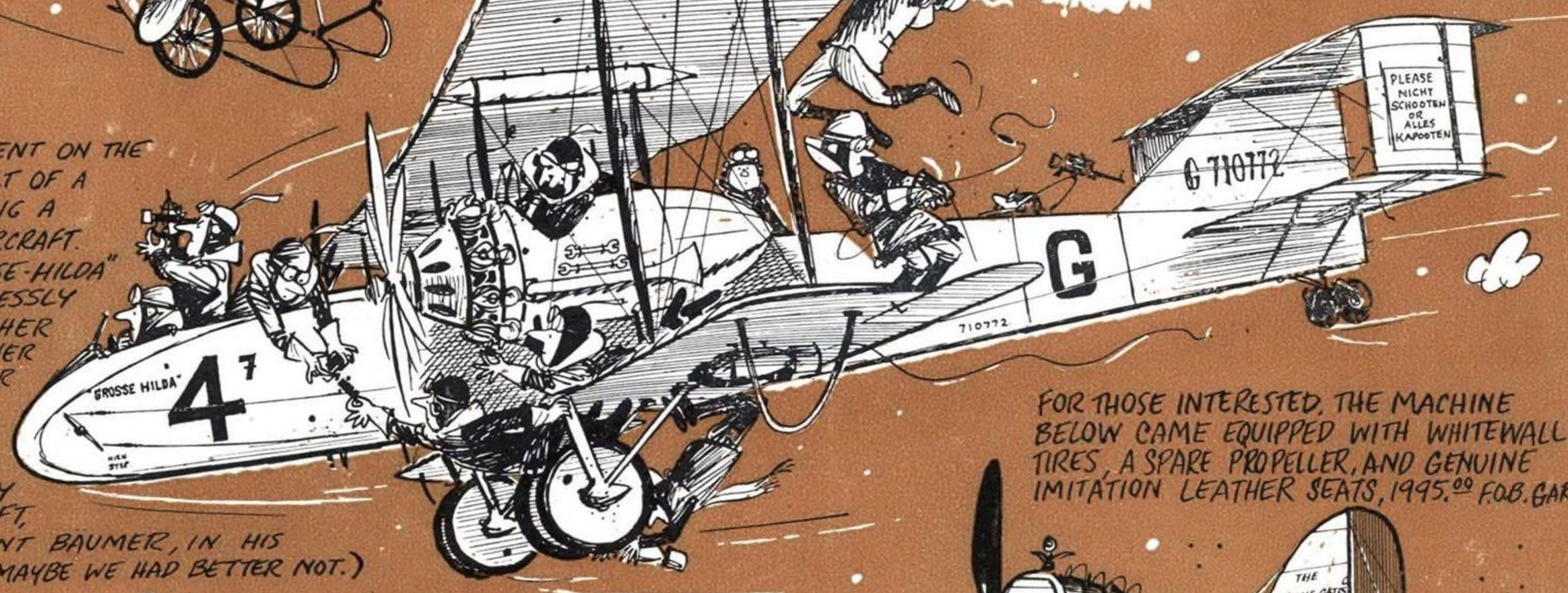
Y OF RELIABILITY



THE QUESTION ARISES-"HOW FAR CAN RELIABILITY BE CARRIED?" ACCORDING TO L'AVIACON ITALIANO, CO-DESIGNERS SALVATORI-BONSIGNORI AND BARTOLOMEO SAVONI REMAINED ALOFT 6 YEARS IN THEIR UNIQUE "FRESH AIR MACHINE" THEY EVENTUALLY WERE SAFELY SHOT DOWN BY A "GOVERNMENT AIRCRAFT TO PREVENT THE CONTINUATION OF THEIR EXTREME HUNGER.

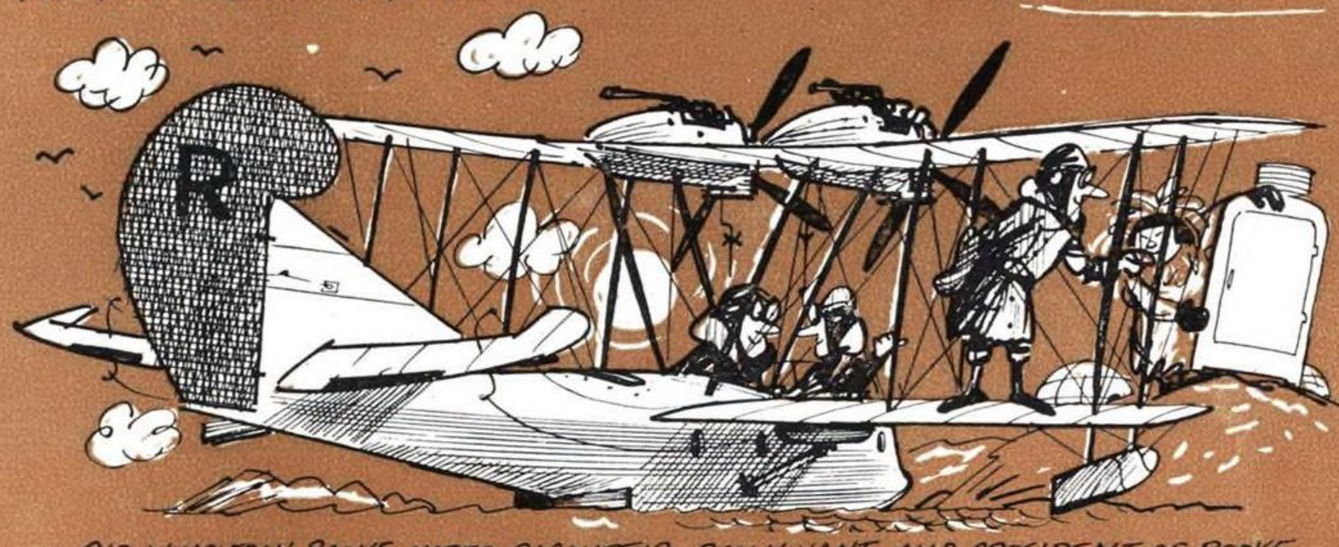


WALTHER VIPPER'S UNICOPTER, THE VIPPER "SCHNAPPER" ADDED TO THE GREAT RELIABILITY OF THIS WORTHY STEEPLEJACK

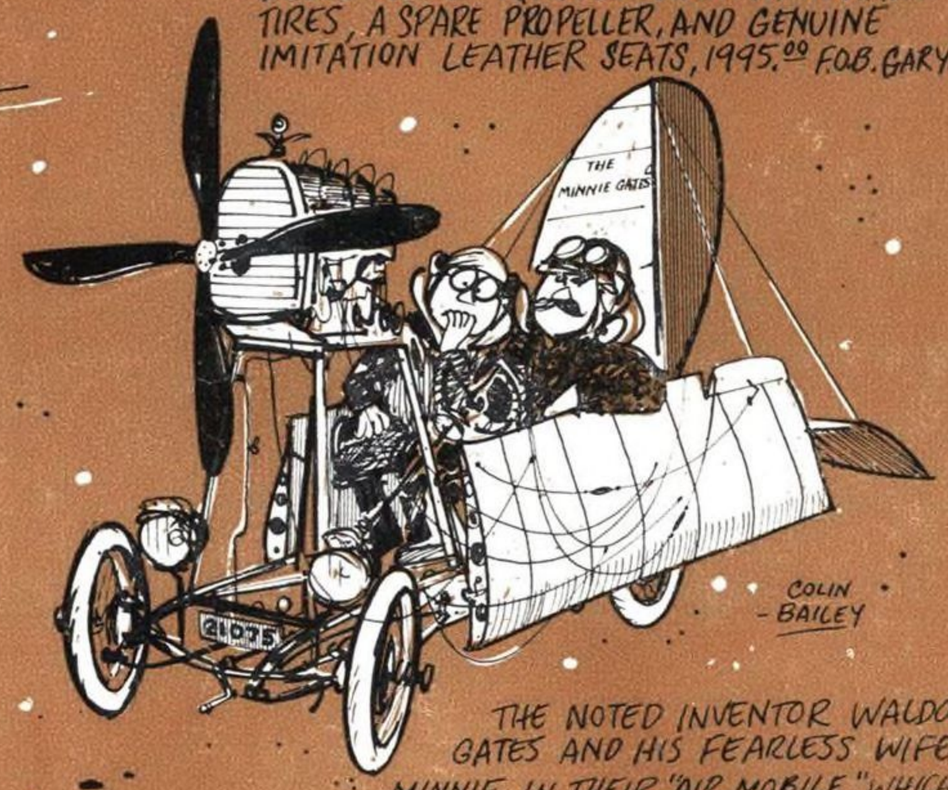


THE DISTRESSING EVENT ON THE RIGHT WAS THE RESULT OF A RELIABLE CREW FLYING A QUITE UNRELIABLE AIRCRAFT. THE ILL-FATED "GROSSE-HILDA" FLOUNDERING HOPELESSLY OVER THE BALTIC, HER AILERONS AWRY, HER NAVIGATING OFFICER TRYING DESPERATELY FOR A FIX, AND THE REST OF THE CREW TRYING DESPERATELY TO FIX THE AIRCRAFT, — TO QUOTE COUNT BAUMER, IN HIS MEMOIRS... (WELL, MAYBE WE HAD BETTER NOT.)

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SIR WIMBLEDON ROOKE, NOTED RACONTEUR, BON VIVANT, AND PRESIDENT OF ROOKE ENTERPRISES, GAVE HIGH PRAISE TO HIS "WHALE" CLASS FLYING-BOAT, IN HIS BOOK, "THE LABRADOR SWYNDLE" BUT HASTENS TO EXPLAIN IN CHAPTER 5 THAT AS TO THE QUESTION OF RELIABILITY, IT WAS HIS EXCELLENT REFRIGERATORS TO WHICH HE WAS REFERRING.



THE NOTED INVENTOR WALDO GATES AND HIS FEARLESS WIFE MINNIE, IN THEIR "AIR MOBILE," WHICH, AFTER EXTENSIVE TESTS, PROVED A MOST EXCELLENT MACHINE, FOR HUSKING CORN.

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